UNIVESITY OF PADOVA

Department of Developmental and Social Psychology

Master Degree in Psicologia dello Sviluppo e dell'Educazione
Study track in Developmental and Educational Psychology

Final Dissertation

Math Attitudes and Math Performance in Primary School Children:

A Comparison between International and Italian State School Systems

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ACCADEMIC YEAR 2023/2024

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Introduction

During child development math abilities are of great importance, even if they present themselves as multifaceted since they include both domain-specific and domain-general skills. In psychological contexts related to mathematics, perceived control and perceived value have been found to be connected to an individual's personal motivations which are linked to domain-general skills. These variables have been found to be the main predictors for positive and negative attitudes towards mathematics, together with math anxiety. Looking at different educational school systems and teaching methodologies of these mathematical skills, is important to understand possible differences in the display of positive and negative attitudes such as math anxiety, perceived control and perceived value. International schools often employ modern, flexible teaching methods that incorporate technology and interactive activities, fostering positive attitudes towards math. In contrast, Italian state schools use traditional teaching methods focused on passive learning and recurrent testing, which can lead to higher math proficiency but also increased math anxiety.

This present study investigates the relationship between math attitudes and math performance in primary school children, focusing on comparisons between the international and Italian state school systems. The study aims to explore how math anxiety, perceived control and perceived value impact academic achievement in mathematics in different educational settings.

In the first chapter of this thesis, the complexity of mathematical abilities and the development of the educational system will be described, with a focus on both the Italian state system and the international one. In the second chapter, different math-related attitudes will be illustrated, such as math anxiety, perceived control, and value. For each construct, a definition will be provided, along with their main characteristics, the presence of gender differences, and their relationship with math performance. In the third chapter, the research will be outlined by defining its objective and describing the reference sample. Furthermore, the procedure and tools used will be explained. In the fourth chapter, the descriptive analyses, the analyses of variance conducted, and lastly the correlations will be presented. Finally, the results that emerged in relation to the reference literature will be discussed, and possible future developments will be outlined.

Chapter 1 – Mathematical learning and school systems

1.1 Math Abilities

Even before going to school children already have develop basic math skills such as counting orally (Baroody,1983). This early foundation sets the stage for further mathematical learning, bridging the gap between innate numerical understanding and formal education (Baroody,1983). Math abilities are found to be of great importance during child development yet they are quite complex, as they include both domain-specific and domain-general skills. The model by LeFevre and Krettenauer (2020) explains how these two skills contribute to high mathematical proficiency. Domain-specific skills refer to abilities directly related to mathematical content, such as understanding numbers, operations, and the ability to manipulate mathematical symbols (LeFevre & Krettenauer, 2020). These skills are key for performing mathematical tasks and solving problems. On the other hand, domain-general skills are cognitive abilities that are not unique to mathematics but are crucial for learning and applying mathematical concepts effectively. These include working memory, logical reasoning, and problem-solving strategies that support the understanding and application of mathematical principles across various contexts (LeFevre & Krettenauer, 2020). They also include, more generally, social factors and individual factors such as emotional-motivational factors (Levine & Pantoja, 2021). The interaction between domain-specific and domain-general skills underlines the complex nature of mathematical competence, highlighting the need for a comprehensive approach to the mathematics education. It is important to consider how both types of skills can be nurtured and developed to enhance students' mathematical proficiency and their ability to apply mathematical concepts in diverse situations, looking at different educational school systems and the teaching of these mathematical skills.

1.2 The evolution of the educational system

Throughout history, educational systems between countries have always differed greatly due to differences in culture and educational reforms. Despite this, all countries agree on the fundamental subjects for students' development and success. These include the learning of the country's mother tongue, math, science, history, geography and the learning of a foreign language (in many cases it's English, Spanish or French; Ivic, 2016).

The foundation of every national education system is its structure (Popov, 2012). Some of the most crucial aspects of education such as the age of which students must attend, the length of time students must attend each level of school, textbook contents as well as curricula and syllabus are all defined by the structure (Popov, 2012). National customs have a far greater influence on the structure than other factors. In the past 20 years many reforms have been done on school structures in many countries in Europe, Latin America and Africa, to increase compulsory education or increase total duration of school education. However, these where only implemented after long political debates, considerations and experiments. As school structures are still far more traditional than other parts of education, making it harder to change its learning objectives, funding sources, curricula, textbooks, standards and teaching methods (Popov, 2012). A total of six structural models are used worldwide to this day. In general, the years of primary education range from 4 up to 10 years, depending on the country. While the years of secondary education range from 5 up to 9 years, depending on the country. The majority of countries (51%) use *"the British-American model"* which consists of 6 years of primary education with an additional 5 to 7 years of secondary education (Popov, 2012). Countries following this model include: Belgium, Netherlands, USA, Finland, Spain, New Zealand, UK etc. The second most common model is *"the French model"* (11%) as it consists of 5 years of primary school with an additional 6 to 7years of secondary school (Popov, 2012). Countries following this model include: Italy, France, Turkey, Pakistan, Colombia etc. No structure system is formally better than the other, the differences within the structures lay in the customs and beliefs of the country. However, the structure of a school system is not the only thing different in children's education worldwide, as teaching methods also differ.

There are a multitude of teaching methods and pedagogical ideas. The two main approaches to teaching are traditional and modern. As the name suggests, traditional teaching strategies focus the transfer of knowledge from the teacher to students as passive listeners and receivers (Ivic, 2016). Having a teacher reading and explaining from the textbook while students take notes and listen, known as frontal (lecturing) method would be considered a traditional approach. Modern teaching strategies, instead, focus on students' creativity and the development of skills and competences (Ivic, 2016). They encourage children to solve problems and interpret information as their own to be able to share it with others. Working in groups or pairs to share ideas and create a project is a more modern approach to teaching (Ivic, 2016). Studies show that the most often used teaching strategy worldwide is lecture-based teaching, where the teacher assesses children critical thinking skills through homework and presentations. The least used teaching methods are project work both in groups and pairs and filed teaching (museum, nature; Ivic, 2016). Results of standardized tests, such as PISA, from different countries show that the Anglo-American, more traditional, approach to teaching to be less performing than the Northern European (Finland and Netherlands) modern strategies where they encourage collaboration amongst students and do not put an emphasis on testing, rather on learning (Garcia-Huidobro et al., 2017).

Education is constantly undergoing dynamic, non-linear and complex change. Especially in this day and age, where technological advances have intensified global connectivity despite the increase of educational gaps within countries, races and socio-economic status (Garcia-Huidobro et al., 2017). Due to the discrepancy of socio-economic status, some parents can pay for their children to go to private institutes to receive a more complete education like Catholic schools, Montessori schools or international schools. Whilst governments provide free and accessible education with public schools, also known as state schools.

1.2.1 The state system

As per article 14 of the Charter of Fundamental Rights "Everyone has the right to education and to have access to vocational and continuing training. This right includes the possibility to receive free compulsory education". In Europe children from the age of 6 till 16 must attend school, not only as it is their right but it is their obligation. In other parts of the world like America, depending on the state, children must be enrolled in schools by the age of 4 but can suspend their studies between the ages of 14 to 18 years old. Public schools world-wide are accessible and free to children until the age of 16 or 18 depending on country. Consequently, over half of children attending public schools come from a low socio-economic background (National Centre for Education Statics, 2023).

The Italian educational system, has existed since 1859 and is superintended by the Ministry of Education, University and Research (MIUR). The MIUR establishes the national curriculum and sets the standards for schools to follow across the country. However, each region has their own educational authority and responsibility for implementing these standards at the local level (Ministero dell'Istruzione e del Merito, 2018). Private schools in Italy must also follow the national curriculum established by the MIUR, so that children receive national qualification. The Italian education system has faced many referenda and changes, nevertheless, education is compulsory for children between the ages of 6 and 16 and public education is free at all levels. It is divided into primary school (5 years), lower secondary school, more commonly known as middle school (3 years), and upper secondary school, in other words, high school (5 years). It is common for parents and guardians to send children to schools close to their neighbourhood, mainly for convenience but also to create a sense of community. For high school, instead, adolescents have to choose the school they prefer to attend based on their personal academic qualities and passions, options of schools include classical, scientific, artistic, linguistic or technical (Ministero dell'Istruzione e del Merito, 2018).

According to the principles of the Italian Constitution and European cultural tradition, the purpose of school is the balanced and extensive development of the individual achieved through the respect for individual diversity, promotion of knowledge, and the active interest of students and their families. The aim of primary education, in Italy, is to facilitate the student's development of cultural competence through the acquiring of essential knowledge and skills (Ministero dell'Istruzione e del Merito, 2018). The subjects taught throughout primary school in Italy are: Italian, English, history, geography, mathematics, science, technology (IT skills), music, art, sports science (the study and practice of movement and sport), Catholic religious education (optional) and citizenship and Italian constitution. The latter, is part of a new reform, it is not to be taught as a separate subject but to be included through teaching projects and school wide initiatives to promote community and altruism. Learning objectives are created by teachers to allow students to reach the goal of the development of specific skills within each subject. National Italian guidelines dictate that teachers have the liberty in preferred teaching methods and materials used, however they must adhere to education objectives set by the MIUR. They suggest different methodological approaches such as: the encouragement of group work, individual research and expansion of previous knowledge, out of class formative experiences (such as laboratories or activities) and so on (Ministero dell'Istruzione e del Merito, 2018). Teachers choose preferred textbooks and teaching materials from a set of materials that follow state curriculum guidelines, hence there can be differences between schools. As agreed by regional legislation on the right to study, the textbooks are free of charge for students as the costs are covered by Italian government. Teaching materials and tools in Italian primary state schools are usually provided depending on government funds (Ministero dell'Istruzione e del Merito, 2018). With the innovation of technologies, some primary schools have IT laboratories with several computers and a limited number of classrooms are equipped with interactive whiteboards (IWB) used to support interactive teaching activities. Public school has its advantages, as its free and accessible to everyone, but children might benefit more from a private education with a more resourceful system.

1.2.2 The international school system

Private schools, compared to the state schools, are accessible for those who have the resources to access them, making it so majority of the school's population has a high socio-economic status (National Centre for Education Statics, 2023). The most common and popular private schools around the world are international schools. Students attending these schools are from many nationalities creating an environment rich of multiculturalism. Bigger campuses, can not only offer a diverse community but allow students and families the opportunity to choose between programs within the same school such as the Advanced Placement program or the traditional state program. However, the most important program that is offered in international schools worldwide is the International Baccalaureate (IB) program.

The International Baccalaureate was founded in 1968 in Geneva by a group of educators that believed an international approach to education was needed to better prepare children for the real world (International Baccalaureate Organization, 2005). The IB encourages children to think critically, solve complex problems and drive their own learning. Furthermore, through the development of a second language it inspires children to be more culturally aware of the people around them and the world they live in (International Baccalaureate Organization, 2005). Moreover, it aims for children to be able to engage with people in an increasingly globalized and rapidly changing world. This educational program core aspect is to lead the students to some of the highest-ranking universities around the world due to its difficulty (International Baccalaureate Organization, 2005).

Students throughout the different programs, have additional exhibitions and projects to carry out (PYP exhibition, MYP exhibition, DP Art exhibition). The PYP exhibition, for example, is a way for students to present and share their understanding of a global or personal issue. The whole school community comes to celebrate this event as it's a key part of a student's journey and rite of passage to the MYP program (International Baccalaureate Organization, 2005). Specific learner profiles, which consist of 10 attributes, are valued by IB World Schools. These attributes help individuals and groups become responsible members of global communities. IB learners constantly strive to be: Inquirers, Knowledgeable, Thinkers, Communicators, Principled, Open-Minded, Caring, Risk-Takers, Balanced and Reflective (International Baccalaureate Organization, 2005). The IB is divided in Primary Years Program (PYP), Middle Years Program (MYP) and Diploma Program (DP). Students in PYP are aged between 6-12 years old accounting for the years of primary education. Students in MYP are aged 11-16 covering the years of middle school and the first two of high school and students in DP are aged 16-19 taking part in their final two years of high school (International Baccalaureate Organization, 2005).

The PYP program, was introduced in 1997 to encourage the development of caring and life-long learners. It is currently being taught in over 2000 IB school across 110 countries. It's a student-centred approach that encourages students, from ages 3 to 12, to be inquires, leaders and build a conceptual understanding of the world around them (International Baccalaureate Organization, 2005). Individually schools must design a program of inquiry that consists of six units, one for each transdisciplinary theme: who we are, where we are in place and time, how we express ourselves, how the world works, how we organize ourselves and sharing the planet

(*Figure 1.1*). Each unit consists of three to four lines of inquiry, which are short phrases connected to the chosen key concepts. In the PYP seven key concepts (e.g. Form, Change, Function) are in place to simplify the panning and stimulate the learning of this transdisciplinary model. The traditional subjects: languages, math, science, social studies (Humanities), art and physical education, are studied through the 6 transdisciplinary themes (*Figure 1.1).* Another essential part of PYP is the learning of agency, self-efficacy and action. The learner is responsible for their own learning and directs their own learning with a sense of identity and self-belief (International Baccalaureate Organization, 2005). By taking individual and group action students learn the benefit of working together to achieve a common goal and acknowledge the responsibilities associated with being internationally-minded. The PYP is a transdisciplinary model that extends across three key pillars: the learner, learning and teaching and the learning community. The first describes the outcomes for individual students and the results they seek. Learning and teaching focuses on all the means to support children's learning (International Baccalaureate Organization, 2005). Learning in PYP is engaging, challenging, relevant and significant. Students become knowledgeable self-driven learners that have cognitive, affective and social tools to engage in lifelong learning. The learning community highlights the social outcomes of learning and the role that the IB community plays in achieving it.

Figure 1.1: PYP framework (International Baccalaureate Organization, 2005)

Overall, children in PYP develop attributes of the IB learner profiles by becoming internationally-minded through the different approaches to learning, the development of knowledge and conceptual understandings.

The PYP has been found to be an exceptional demonstration of the depth a transdisciplinary approach can reach, as with guidance and specific teaching strategies, children develop a strong sense of self-belief and identity (Slotta et al., 2020). Various studies on the impact of the PYP in children have found that children are more internationally-minded, inquisitive and take more action (Kushner et al., 2016). Additionally, the 5th grade exhibition is found to help students' development of critical thinking skills, learner profile qualities and international-mindedness. It fosters "real world" skills such as evaluating information and reflectiveness (Medwell et al., 2017). Such skills are also necessary in the learning of mathematics.

1.3 The learning of Mathematics

Mathematics refers to the study of quantity, structure, space, and change (Hoang et al., 2023). Despite its abstract nature, mathematics is fundamentally the search for absolute answers and solutions. The learning of mathematics is in fact a fundamental aspect of children's development. Though there are varied mathematical teaching methods, some strategies remain constant (Hoang et al., 2023). Firstly, the use of visual aids in the explanation of such abstract concepts such as using wooden or paper 2D-3D objects is a key teaching method (Hoang et al., 2023). In some schools these visuals are now computer-generated virtual objects and teaching is supported by math platforms. Secondly, verbal math problem solving skills are normally measured with questioning or interrogations. Linked to this are activities using problem-solving, such as the designing of tasks or real-life application of mathematics (Hoang et al., 2023). Teaching practices used by teachers can vary but are not restricted to counting and grouping, digital game-based learning, case studies, co-teaching, math projects and investigation. Lastly, the most common and traditional method to teach maths is through the lecturing of content (Hoang et al., 2023). However, creating positive math attitudes for students is something all teachers should always keep in mind. To do so teachers should illustrate how math can make life easier and therefore improve it (Sanchez et al., 2023). The environment and context the students are learning in is another key aspect to involve students in the learning of mathematics. The more the environment stimulates the children's individual intellectual efforts and abilities the more they will be eager to acquire such knowledge (Sanchez et al., 2023). As many different methods and strategies go into teaching mathematics, it is interesting to understand how different school systems approach the teaching of mathematics.

1.3.1 Mathematics in the Italian state system

As mentioned previously, the means of explanation of mathematics can vary depending on teaching style and requirements mandated by the state. In the Italian state system, teachers by the end of 5th grade, as per National curriculum guidelines, should have completed to the fullest extent the following topics: decimals and numeric quantities, 2-D and 3-D basic geometry, problem solving, long form expressions, divisions, fractions, and proportions (Ministero dell'Istruzione e del Merito, 2018). Preferred teaching methods of mathematics in primary school, are traditional by lecturing through the use of a text book. Additionally, teachers use interrogations, solving problems in front of everyone at the blackboard, in class tests and homework.

Italy is a country showing a low-level math achievement, especially when there is a bigger discrepancy between children within the same class, due to the number of refugees present in Italian schools, making it harder for teachers to explain the content required in the most efficient manner. Italy is one of the countries with the largest gender gap, especially in the South, in math attainment (Matteucci & Mignani, 2011). Girls display less math self-efficacy in solving math-related problems and beliefs in their own abilities. Not only that but girls have more anxiety and stress in doing math-related activities (Contini et al., 2017). The presence of this female disadvantage in math is of particular importance, because it is likely to be a cause of the critically low portion of women choosing STEM (Science Technology Engineering and Mathematics) disciplines at university, of gender segregation in the labour market, and gender pay gaps (Contini et al., 2017). All in all, the public Italian systems teaching of mathematics remains traditional whilst international schools have a more modern approach teaching mathematics.

1.3.2 Mathematics in the international system

Mathematical attainment in the PYP varies greatly from the state system. As children are introduced to mathematical concepts such as data collection and handling, space and shape, measurement, patterns, numbers and functions, which can be used to build a foundation for higher-level thinking in future years (International Baccalaureate Organization, 2005). International schools do not follow a textbook, it's the teachers that create mathematical activities, projects, assignments and games to relate to the unit of inquiry and inspire children's learning of mathematics. Currently, many IB schools have implemented the use of technology (tablets and computers) in their teaching methods, including in the teaching of maths; the introduction of software systems like InnovaMat. In some IB schools, children in the PYP program don't have homework assignments, due to the use of software where they can practice daily on, on top of that they give summative tests to check their level of understanding of an entire unit.

Studies have shown significant differences between IB and non-IB students in math literacy. IB students have a higher level of math literacy in Grades 5, 7 and 9, showing how the schools and educational methods and practices also seem to matter (Tan, 2021). As specifically focusing on teaching strategies including problem solving, class-discussions and investigative work has been found to improve girls' performances in mathematical attainment (Contini et al., 2017). The use of technology in IB schools, specifically, for the teaching of mathematics has brought many benefits to students' self-efficacy and general math attainment.

1.3.3 Use of technology in schools and its application in math

The use of technology in schools has evolved greatly of the years, from the introduction of desktop computers in schools, to projectors and interactive white boards, to being able to work on personal laptops and now to the use of tablets. Technology-based, pedagogical strategies and teacher support have been essential in sustaining such advances (Garcia-Huidobro et al., 2017). As technological advancements keep evolving, so do teaching strategies and learning environments (Taib & Awang, 2020). A strong shift in teaching and learning processes has happened in the past 5 years, as the outbreak of COVID-19 led to a substantial increase in distance learning and new methods of long-distance teaching, even for young children. Moreover, the current generation of children have proven themselves to be experts in the use of digital tools. All in all, the implantation of technological devices in schools has shown many benefits (Taib & Awang, 2020).

Currently, there are more than 1000 projects in the USA that use tablets with developed software that make practice consistent and repeated, but also fun and engaging (Gitsaki & Robby, 2015). The use of tablets and educational software has been found to be beneficial for student learning. Other studies have found that the use of mobile devices for mathematics lead to a better understanding of mathematical concepts and better results overall (Gitsaki & Robby, 2015). Students find math courses to be more exciting and motivating thanks to the use of the devices. On top of that it has developed a strong sense of self-efficacy (Gitsaki & Robby, 2015).

Additionally, the use of technology in math classes has created a more productive and supportive student-teacher environment (Gitsaki & Robby, 2015).

As phenomenal as the use of technology has become in day-to-day student life, strong differences between state and private schools remain. Due to lack of funding state schools cannot afford to provide the necessary equipment to all children. Especially in Italy, there is a severe lack of funding allowing only a limited set of computers for both teachers and students to use. It is true that in private schools, like international schools, students from 4^{th} grade onwards bring in their own device, however, the school not only supplies tablets and computers for children that don't have one, but has plenty of resources for teachers to use like TV's, iPads, and innovating teaching software. Recently, teachers in primary IB international schools have implemented InnovaMat as a tool for the teaching of mathematics.

InnovaMat was founded in Spain in 2017 and is now used in over 2100 schools, scattered over 9 countries (Innovamat Education, 2017). InnovaMat is a global organisation specialised in math education; it is currently operating in Spain, Mexico, Italy, Chile, Ecuador, Colombia, Brazil, Peru, and in the United States. It is accessible math learning that can promote student thinking and theoretical understanding (Innovamat Education, 2017). The aim is for students to develop problem-solving, reasoning, creativity, and communication skills while learning about mathematics. InnovaMat has developed a research-based, resourceful and accessible curriculum program for teachers and students to use in classrooms and at home (Innovamat Education, 2017). With InnovaMat, children from the ages of 3 to 16 acquire math through manipulative materials and dynamic lessons focused on problem-solving, communication skills, and critical thinking (Innovamat Education, 2017). They provide a shift in the traditional instruction and learning of mathematics, as technology can enable active student involvement (Innovamat Education, 2017). This software, and in general the use of technology, is tremendously changing students’ attitudes towards mathematics in a positive way.

In conclusion, the integration of technology in the teaching of mathematics has the potential to transform students' emotional experiences with the subject. By making learning more engaging, interactive, and supportive, technology can help improve the negative emotions associated with mathematics, such as anxiety and stress, and replace them with feelings of confidence and interest. This shift not only improves mathematical understanding and attainment but also fosters a more positive overall attitude towards learning.

Chapter 2 – Attitudes towards mathematics

2.1 Introduction

Mathematical learning is complex and as, explained previously, it is strongly influenced by the interaction of domain-specific and domain-general factors. Among the domain-general skills emotional-motivational factors play a crucial role. The latter, as defined by Levine & Pantoja (2021), refer to attitudes toward mathematics, which can manifest as either positive or negative tendencies. Positive attitudes include a sense of enjoyment or pleasure resulting from solving mathematical problems, which can boost engagement and persistence in the learning mathematics (Levine & Pantoja, 2021). Instead, negative attitudes generally manifest as math anxiety or a lack of confidence in one's mathematical abilities, leading to avoidance of mathematical tasks and a potential drop in mathematical performance (Levine & Pantoja, 2021). Despite the importance of these emotional factors, the literature reveals limitations in the complete understanding of their impact, particularly in elementary school students. Nearly all, of the existing evidence focuses on adults and adolescents, leaving a developmental gap of these attitudes. Additionally, there are few comparisons made between different school systems, which could offer insights into how educational environments influence students' attitudes toward mathematics. In the following paragraphs, some of these attitudes will be explained in depth.

2.2 Math anxiety

Anxiety disorders are some of the most extensive mental health problems worldwide. All major types of anxiety disorders, such as generalized anxiety disorder, obsessive–compulsive disorder, panic disorder, phobia, posttraumatic stress disorder, and social anxiety disorder, compromise nearly 17% of prevalence in over 40 countries such as USA, France, Hong Kong, Italy and the Netherlands (Luttenberger, Wimmer & Paechter, 2018). Women are more likely to suffer from anxiety-disorders compared to men, and it is also the most common mental health problem among young individuals (15-25 years old; Luttenberger, Wimmer & Paechter, 2018). When observed in a school setting, anxiety can be related to social aspects, overall learning, public speaking and performance. Specific forms of performance anxiety, related to certain academic domains, have been defined. The most prominent one being math anxiety (Luttenberger, Wimmer & Paechter, 2018).

2.2.1 Definition and Characteristics

Math anxiety has been defined as a feeling of anxiety and tension that affects the solving of mathematical problems and the use of numbers in both academic and everyday life (Richardson & Suinn, 1972). Individuals with math anxiety may experience physical symptoms, such as increased heart rate, sweating, and even panic attacks when faced with mathematical tasks (Ramirez et al, 2018). Moreover, math anxiety can result in a poor performance on math-related tasks, avoidance of math-related activities, and negative self-talk. Math anxiety is a worldwide problem effecting all age groups. In fact, 93% of American adults have, to different extents, experience with math anxiety and approximately 17% of Americans suffers from high math anxiety (Luttenberger, Wimmer & Paechter, 2018). In a British sample, 30% of adolescents report high levels of math anxiety, with an additional 18% that was affected at some point (Luttenberger, Wimmer & Paechter, 2018). PISA studies from 2012 show that across 34 countries nearly 60% of 15- to 16-year-olds worry about math classes being too difficult for them; 33% report having a feeling of tenseness in completing homework and 31% get nervous when doing math problems (Luttenberger, Wimmer & Paechter, 2018). Therefore, math anxiety can manifest at different developmental stages, research suggests that early experiences with mathematics can shape an individual's perspective on mathematics over time. Young children who struggle with basic math concepts may develop math anxiety that persists into adolescence and adulthood. Furthermore, the pressure to perform well in math-related tasks, such as standardized tests, can exacerbate existing math anxiety and contribute to a continuous cycle of fear and avoidance when it comes to mathematics (Luttenberger, Wimmer & Paechter, 2018).

Even though exist distinct forms of anxiety, math anxiety has been found to be closely related to general anxiety, as individuals often exhibit symptoms of generalized anxiety disorder, such as worry, fear, and avoidance behaviour (Mammarella et al, 2017). Anxiety takes on many different shapes and forms, it is a part of all of us in different extents. Triggers, such as failing a math test or making mistakes, can lead to anxiety-like symptoms that are beyond mathematics but effect other areas of an individual's life. Anxiety can create feelings of threat when attention is directed on a particular stimulus, like a math problem. Attentional control theory states that anxiety interferes with goal setting, obstructing students control. Impairments in working memory and inhibition are therefore related to negative effects of anxiety on processing efficiency (Mammarella et al, 2017).

Interestingly, research has found that genetic factors can account up to 40% of the differences in mathematical anxiety, the remaining is attributed to the child's environmental factors. Wang et al (2014), conducted a genetic analysis and found that math anxiety is not only predisposed by environmental risks related to general anxiety but also individual genetic differences related to problem solving. Thus, the development of math anxiety is not only due to the negative experiences related to maths but involves genetic components connected to math cognition and anxiety (Wang et al, 2014). Incorporating cognitive and emotional aspects in day-to-day academic achievement may be beneficial for the reduction of math anxiety in children (Wang et al, 2014).

Different factors such as class, gender, school, socioeconomic status can influence math anxiety (Radišić, Videnović, & Baucal, 2015). In literature, gender discrepancies between females and males related to math anxiety have been found and discussed thoroughly.

2.2.2 Gender Differences

Many studies have highlighted the gender differences found in math anxiety, specifically how females are more likely to experience it than males. Males' achievement in math has been demonstrated to be higher than females in different countries, such as the USA, Italy, India, and England (Tapia & Marsh, 2004). Despite females and males of the same age attending the same courses and learning in the same conditions, females still have lower scores. Thus, there must be external factors creating these gaps. In several countries, these differences have been found to be more prevalent around puberty and have been associated to biological and social factors frequently experienced by females (Tapia & Marsh, 2004). Female students have been found to not recognize the importance of mathematics in their future life as much as males. Additionally, they simply do not enjoy math as often as males (Tapia & Marsh, 2004). Throughout development, female students may be subject to cultural and/or social pressures that help shape their attitudes toward mathematics as a subjects and possible future career. Resulting in college and high school female students displaying more math anxiety than males of the same age (Tapia & Marsh, 2004). Researchers have found that specifically for this age group (14–21-year-olds) positive feelings about mathematics are not related to gender but to individual and personal experiences in the matter (Tapia & Marsh, 2004). Most of the reported literature on this topic states that there is a strong connection between math anxiety and gender, however, it can be said that as the students get older the correlation diminishes as it depends more upon individual differences. Therefore, greater attention should be focused into the education of mathematics at a young age, as the development of math anxiety starts as early as the first years of primary school. Teacher preparation and education upon this matter can help reduce the discrepancy created between young girls and boys, hence promoting girls' future in STEM. As consistent high levels of math anxiety throughout a student's academic career have been found to carry its negative consequences into the furthering of one's math education.

However, Hill et al (2016), conducted a study on primary school children, they also found that girls have higher math anxiety than males. Suggesting that the patterns observed in older students can begin much earlier. Moreover, Devine et al (2012) conducted a study on adolescent's experience of test anxiety and math anxiety in secondary school. They found that students in secondary school, in general, experienced math anxiety. Poor levels of math performance were related to high levels of math anxiety, and females consistently showed higher levels of MA (Devine et al, 2012). However, regardless of female students reporting higher levels of math anxiety, no gender differences were found in math performance indicating that female students had the ability to outperform male students but, due to their high levels of math anxiety, their performance diminished (Devine et al, 2012). Socio-cultural factors, such as gender stereotypes regarding math, can be partly responsible for the persistent elevated levels of math anxiety in females. Gender roles and societal expectations of females exacerbate math anxiety in females. Moreover, math anxiety has been shown to have a detrimental impact on math achievement, students experiencing high levels of math anxiety tend to be performing worse in different math tasks compared to their peers.

2.2.3 The relationship with Math achievement

The relationship between math achievement and math anxiety has always been very complex and many studies suggest that this relationship is strong and negative, as the higher the math anxiety the worse the mathematical performance. Students can exhibit inferior levels of math achievement and so diminishes their possibility to master the subject. Several metaanalyses have demonstrated that people with high math anxiety perform worse than their counterparts on a range of numerical and mathematical tasks (Barroso et al., 2021; Caviola et al., 2022). Math anxiety, in fact, is negatively related to math performance in secondary school students, especially for mathematical test and end of term exams (Hill et al, 2016). An individual's ability to learn and apply mathematical concepts effectively can be hindered by the feelings of fear and avoidance linked to math anxiety. This can lead, especially young students, to a reduced motivation and self-confidence in math related tasks (Hill et al, 2016).

Verbal working memory impairments have been found in children with math anxiety (Mammarella et al, 2017). Consistent troubling thoughts such as, irrelevant and intrusive thoughts, in adults with MA have been found to interfere their ability to perform mathematical task as they draw back their working memory resources (Mammarella et al, 2017).

However, the relationship found in older students is not nearly as present in primary school children. Different studies have found that children between the ages of 6 to 9 years old, in the lower primary years do not have a significant correlation between math fluency and math anxiety (Hill et al, 2016). Suggesting that math anxiety starts effecting children from 4th grade onwards. Children within this age group have demonstrated high feelings of worry which showed to low math performance, particularly regarding problem-solving and judgement in maths (Hill et al, 2016).

The relationship between math anxiety and performance has been heavily discusses in literature, different theories have been proposed to explain this relationship. The first theory is the Deficit Theory, which proposes that low math performance can increase math anxiety levels (Carey et al., 2016). Similarly, the Debilitating Anxiety Model suggests that future math performance can be hindered by math anxiety (Carey et al., 2016). The evidence for these theories is very conflicting; studies on different anxiety levels and changes in performance support the Debilitating Anxiety Model. While, longitudinal studies on children with dyscalculia support the Deficit theory. Neither theory can explain to the full extent the relationship between math anxiety and math performance. These differences in findings suggest that there is a bidirectionality in the relationship between math anxiety and math performance (Carey et al., 2016). Hence, the Reciprocal Theory was proposed, which implies that the relationship between math anxiety and math performance is mutual. Therefore, they influence each other in a never-ending vicious cycle, where math anxiety can further reduce math performance (Carey et al., 2016)

Understanding math anxiety is fundamental for improving math achievement in students and to promote positive attitudes towards mathematics. By creating a positive and supportive learning environment that can benefit students, not only to build confidence in their mathematical abilities but also motivates them to perform at their higher standards can help to reduce high level of math anxiety. However, math anxiety is not the only variable to observe and take into account for the promotion of a better learning environment, ones perceived control and value should be also considered.

2.3 Perceived Control and Value

In psychological contexts related to mathematics, perceived control and perceived value have been found to be connected to an individual's personal motivations. These variables have been found to be the main predictors for positive and negative attitudes towards mathematics (Mata, Monteiro, & Peixoto, 2012). Attitudes are affective responses that complement a behaviour started from a motivational state. Attitudinal and motivational processes include one's expectations, receiving feedback, goal-setting, organisation, autonomy and competence in the subject (Mata, Monteiro, & Peixoto, 2012). Studies have shown that students' organisation and long-term goals contribute to their constant engagement in academic life (Perrell, Erdie, & Kasay, 2017). Perceived control and perceived value ultimately reinforce a students' motivation to learn as they encourage students to explore their knowledgeable at a deeper level (Perrell, Erdie, & Kasay, 2017).

2.3.1 Definition and characteristics

Perceived control refers to persons belief in their capacity to change their own outcomes (Skinner, Wellborn & Connell, 1990). It compromises feelings of agency, determination, autonomy, courage, self-assurance, self-confidence and persistence. All these attitudes can easily affect one's motivation and well-being in academic life. Skinner, Wellborn and Connell (1990) in a new conceptualization of perceived control defined three sets of beliefs linked to perceived control: beliefs on the causes that are successful in producing outcomes, beliefs on the how much one can produce the wanted and beliefs on the extent to which the person approaches known causes (Skinner, Wellborn & Connell, 1990). These set of beliefs are described respectively as 'Strategy beliefs' so the probability of performing well in school such as ability, effort and luck. Control beliefs are expectations on if it is possible to do well in school or not. Lastly, capacity beliefs are expectation on if ones is capable and has all the abilities to do well in school (Skinner, Wellborn & Connell, 1990). From this theory they proposed a motivational model that explains the links between individual experience, social context, control beliefs, action and outcomes of performance. According to this model, perceived control is influenced by the involvement of the child in learning which results in either interested or disinterested patterns of action school (Skinner, Wellborn & Connell, 1990). This model predicted that by teachers' use of engaging learning tasks it can drastically influence academic performance and positively influence children's perceived control as they feel more involved in the learning school (Skinner, Wellborn & Connell, 1990).

In general, results of a task can be valued individually for multitude of different reasons. Perceived value, in fact, is defined as how people asses the importance of a subject or task based on their perceptions and emotions (Putwain, 2018). Students with math anxiety will have lower perceived value which is associated with feelings of stress, inadequacy or fear of the subject.

One of the key characteristics of perceived control and perceived value are their multidimensionality. Many researchers have identified various subscales or dimensions of perceived control and perceived value that capture different aspects of an individual's beliefs about control and value. Subscales for perceived control include: intrinsic control, extrinsic control, outcome and action control. Intrinsic control refers to the belief in one's own abilities and actions (Staunton et al., 2015). Instead, extrinsic control is the belief in external factors or luck influencing outcomes (Staunton et al., 2015). Outcome and action control refer to the ability of completing a task successfully (Putwain et al., 2022). On the other hand, different dimensions of value include: task value, personal value, intrinsic value, attainment value, utility value. Task value and personal value, refer to one's motivation in performing a set task (Hemin *et al.*, 2010). Intrinsic value first refers to how much happiness the child gets from doing a task (Schrader& Helmke, 2015). Attainment value, refers to the importance of doing well in a subject or task. Lastly, utility value, looks at goal setting and future achievements (Schrader& Helmke, 2015). The many dimensions and subscales of these two variables have been found to complement one-another, hence a theory combining the two was proposed.

Control-Value Theory

Perkrun et al (2006) proposed an innovative framework called the control-value theory of achievement emotions that supposes a pathway between prior emotions and achievements in school. It defines emotions that are provoked in relation to achievements in activities (studying and learning) or achievements in outcomes (test success or failure; Pekrun, 2006). Achievement emotions are divided into three dimensions: valence, which can be positive or negative, activation which can be on or off, and object focus which are activities related to past or future outcomes of success or failure (Pekrun, 2006). For example, anxiety is considered to be a negative, activating and future-outcome related emotion (Klee, Buehl, & Miller, 2021). According control-value theory achievement emotions are influenced by prior situational factors: cognitive appraisal, individual learning, task value and activity performance. Control and value appraisal are prior situational achievements as they refer to the perceived control and ability, like self-concept and self-efficacy, and personal importance of achievement outcomes and activities (Pekrun et al., 2011). Value judgements regarding educational activities and outcomes could be positive or negative. Positive values are meant to inspire useful, interesting and desired outcomes while negative values do the opposite making them undesirable outcomes (Pekrun et al., 2011). Learning and social environments are linked with achievement emotions due to the appraisals of control and value. Relationships between anxiety, cost and achievement have been made to express the experiences of success and failure in math achievement (Putwain et al., 2021). Putwain et al. (2022) defines perceived control as specific self-concepts of ability determined by action-control expectations and action-outcome expectations. The first, refers to beliefs on the ability to perform successfully a behaviour, like completing a math problem. The latter, refers to how the action will produce the wanted outcome, like achieving a better math grade. Greater action-control and action-outcome expectations for mathematics are found in students that believe to be good in maths (Putwain et al*.,* 2022). Additionally, high control and value are directly related to higher test scoring and indirectly mediated by enjoyment and anxiety (Putwain et al*.,* 2022). The interaction between the intrinsic value and control was also found to predict math test scored (Putwain et al*.,* 2022). Furthermore, gender differences in emotions and motivation have been found for both of these variables in relation to mathematics.

Perceived control and perceived value play a pivotal role in understanding the dynamics of learning, highlighting how an individual's belief in their capabilities and the significance they attribute to a task collectively influence their motivation and engagement in educational activities.

2.3.2 Gender differences

Gender differences in self-concepts are found to be domain-specific and often comply with stereotypical gender patterns (Levine & Pantoja, 2021). Like for math anxiety many studies on perceived control have shown that there may exist gender difference. With respect to different domains, males tend to report higher levels of perceived control compared to females (Frenzel, Pekrun, & Goetz, 2007). A study found that males with high perceived control over their academic success display superior level of motivation and self-confidence in math subjects compared to females having lower levels of perceived control (Frenzel, Pekrun, & Goetz, 2007). Research also found that perceived control is a mediator in the relationship between gender and math achievement; meaning that the gender differences already present in perceived control explain the gap in math performance between males and females (Frenzel, Pekrun, & Goetz, 2007). Girls typically perceive their abilities to be lower in math and sports but higher in reading and music compared to boys. These gender differences in domain-specific self-concept may stem from differences in math and reading achievement, where individuals' relative strengths influence their self-concepts in specific academic areas (Levine & Pantoja, 2021). For example, a study conducted by Stoet & Geary (2018) found that girls generally outperform boys in reading and thus have a higher reading self-concept. Whereas they tend to perform worse in math and so have a lower math self-concept (Stoet & Geary, 2018).

Additionally, a disruptive pattern of low intrinsic value and high attainment value has been found present in females. This is consistent with girls reports of hopelessness and shame in mathematics despite having similar grades to the male counterparts (Frenzel, Pekrun, & Goetz, 2007). Sociocultural factors like societal expectations, norms and beliefs shape an individual's beliefs of control and value creating the gender differences present in today's society. These differences in perceived control can impact students' attitudes towards learning, overall academic performance and goal-setting behaviours (Frenzel, Pekrun, & Goetz, 2007). Evidence suggests that gender differences in math self-concepts can emerge as early as kindergarten and 1st grade, similar with findings related to math anxiety (Levine & Pantoja, 2021). Researchers are beginning to identify factors that may contribute to these variations as the extent of these differences varies across countries, particularly among adolescents (Levine & Pantoja, 2021). Thus, it is important for educators to promote a sense of control and value in children since a young age to be able to reduce these differences and enhance the relationship with math achievement.

2.3.3 The relationships with math achievement

Both perceived control and perceived value have been found to have a significant relationship with math achievement. For perceived control studies suggest that students having a greater sense of control in their academic outcomes perform better in math tasks. It is greatly believed that motivation, effort and the engagement one puts towards learning are key to for success in understanding mathematical concepts and solving problems (Tapia & Marsh, 2004). Students with high perceived control are prone to adapt their learning behaviours and create better coping strategies when faced with challenges in mathematical learning. The most used approaches are seeking help when needed, not giving up when faced with difficult math tasks, and constant persistent. The ultimately lead to improved math achievement over time. In a study done to assess the relationship between math anxiety and gender it was found that students with no math anxiety score higher in enjoyment of math classes than students with high math anxiety (Tapia & Marsh, 2004). Not only that but, students with high self-confidence where the ones having little to no math anxiety. Additionally, they also found that motivation was higher in students with no math anxiety than students with math anxiety (Tapia & Marsh, 2004). Studies show that perceived value can be enhanced to reduce math anxiety, if students that are able to understand and alter their beliefs about maths. High utility value and task value have been found to be strongly related to high achievement in maths (Putwain, 2018) Thus, teachers must highlight the practical application of maths to build confidence through learning and suppress negative thoughts related to mathematics.

Control-value theory offers a framework for teachers on how classroom environment and individual students' emotions can influence math anxiety (Klee, Buehl, & Miller, 2021). Students with math anxiety are focused on not failing instead of grasping the material presented they display a low sense of control over future outcomes (Klee, Buehl, & Miller, 2021). By supporting learning performance and offering support teachers can decrease students' levels of fear of failure and avoidant behaviours towards mathematics increasing self-efficacy and control (Klee, Buehl, & Miller, 2021).

2.4 The relationship between positive and negative math attitudes

The relationship between positive and negative math attitudes has always been multifaceted and complex. Attitudes towards maths can not only be negative and positive but also implicit and explicit. Some attitudes can be direct and visible, explicit, and others are indirect and personal, implicit. A multilevel analyse conducted by Cvencek et al (2021) found that explicit measures predicted math grades and implicit attitudes varied between first grade boys and girls. Implicit attitudes for girls focused on negative thoughts towards mathematics and possible future aspirations regarding the subject (Cvencek et al, 2021). Whilst for boys it created a lack of self-confidence and had little impact on math grades. This contrast between explicit and implicit attitudes suggest detachment in children which can be observed in adults (Cvencek et al, 2021). Implicit attitudes can be the basis for the development of positive explicit attitudes and beliefs about maths creating higher math achievements for students and reducing math anxiety (Cvencek et al, 2021). Positive attitudes, such as enjoyment and math interest, can enhance a student's engagement and performance, leading to a more positive perception of the subject. On the other hand, negative attitudes, such as fear and anxiety, can delay performance and deepen math avoidance. This bidirectional influence suggests that improving positive attitudes can help reduce negative ones, and vice versa, creating a cycle that can either enhance or impair mathematical learning and achievement (Akin & Kurbanoglu, 2011).

Math anxiety and perceived control are closely connected. When students feel they have control over their learning and can succeed in math, their anxiety levels tend to decrease (Putwain & Wood, 2022). High levels of math anxiety, instead, can diminish a student's sense of control, making them feel helpless and less capable of managing mathematical tasks. This negative sequence can lead to math avoidance and poor performance (Putwain & Wood, 2022). Similarly, the relationship between math anxiety and perceived value is significant and interrelated. When students see math as valuable and useful subject, they are more likely to engage with it positively (Pekrun et al., 2011). However, high levels of math anxiety can negatively impact this perceived value. Students who are more anxious about math may struggle to see its importance and significance, decreasing their motivation and engagement (Pekrun et al., 2011). Improving students perceived value of math can help reduce math anxiety by making the subject more meaningful and effortless.

Perceived control and perceived value are connected concepts that significantly influence a student's attitude towards mathematics (Putwain et al., 2021). When students feel in control of their learning and believe they can succeed, they are more likely to see the value in what they are learning. This positive perception can enhance their motivation and engagement with math. Equally, when students do not see the value in math, their sense of control can diminish, as they may not feel motivated to apply them self's in a subject they believe to be irrelevant. Strengthening both perceived control and perceived value can create a supportive environment that fosters positive attitudes and reduces anxiety (Putwain et al., 2021).

Attitudes towards maths have been explained through motivation and social support in the school environment (Akin & Kurbanoglu, 2011). A study showed that in general students have positive attitudes toward maths however, grade and math achievement can easily alter these attitudes (Akin & Kurbanoglu, 2011). As school progressed girls showed a decline in positive attitudes towards maths. Overall, motivation related variables like perceived control and perceived value are the main predictors of attitudes towards mathematics (Akin & Kurbanoglu, 2011). However, the support from teachers and peers is significant in understanding how these attitudes develop.

Educators are aware of the extensive debilitating effect maths anxiety has on students (Klee, Buehl, & Miller, 2021). Teachers have now developed strategies and tools that have helped to reduce negative attitudes in students promoting a positive learning environment, however a better understanding on what students are experiencing is necessary to further address all the struggles lived by students (Klee, Buehl, & Miller, 2021).

Therefore, this research's objective is to understand the difference between the international school system and the Italian state school system on the relationship between positive and negative emotions experienced in mathematics. In the following chapter the aims and measures of this study will be explained in detail.

Chapter 3 - Methods

3.1 Hypotheses

As mentioned previously, mathematics is a key aspect of academic life. The learning of mathematical theory, methods and concepts in childhood is significant for the development of basic mathematical concepts and real-life applications (Hoang et al., 2023). Children can develop both positive and negative attitudes towards mathematics. Negative attitudes in mathematical learning greatly focus on the anxiety students can develop thought the years of school. Due to math anxiety, many children do not enjoy this subject, in fact, it can be the source of great discomfort for them (Frenzel, Pekrun, & Goetz, 2007).

On the other side, positive attitudes towards mathematics include: motivation, self-confidence, goal-setting and organisation. More importantly, perceived control and perceived value have been found to be strongly connected to an individual's personal motivations (Mata, Monteiro, & Peixoto, 2012). A lot of research on this topic has found that, high levels of both perceived control and perceived value result in higher test scoring and higher levels of enjoyment in mathematics (Putwain et al*.,* 2022).

Most of the evidence in literature on this topic, however, revolve around adolescents, there is little evidence focusing on primary school children. Additionally, literature does not focus a lot on the teaching differences within the systems. Hence it is important to understand the different level of exposure children have towards mathematics; a structured and stricter approach like the Italian compared to a more creative and open-minded approach like the international system (Hoang et al., 2023).

This study aims to better investigate the relationship between positive and negative emotions often experienced during the performance of mathematical tasks, in primary school children from grade 3 to 5. This research focuses on the comparison between international schools in Italy and Italian state schools. As this is part of a bigger research only a limited set of variables have been chosen to further investigate the following hypothesis.

The first hypothesis is that math proficiency for international students will be higher than Italian students. More specifically, grade interactions are expected to be observed, 3rd grade Italian students will be better in math proficiency than 3rd grade international students as there is a huge discrepancy in math attainment between the two systems (Tan, 2021). This gap should then reduce and by 5th grade the international students will be better than the Italian students, due to the difference in system. As by 5th grade international students demonstrate higher level thinking skills in mathematics than state school counterparts (Tarigan et al., 2019). Additionally, due to the controversial nature of the literature, gender differences will be observed. Italian females should show lower levels of math attainment compared to Italian males, the same should be observed for international students.

The second hypothesis is that positive math attitudes are higher for international students than Italian and so the negative attitudes towards maths will be lower for international students than Italian. Before performing these comparisons, no differences in general anxiety levels must be found due to the overlap with math anxiety. If there are no differences there is no need to control for this variable. No grade interaction is expected between different attitudes and performance in mathematics. The potential moderating role of gender will be assessed, specifically in relation to math anxiety. As demonstrated in previous research Italian girls systematically underperform boys in math tasks and have a higher level of math anxiety (Contini et al., 2017). Hence, it is expected that the gender gap is to be smaller for international students. With respect to the positive variables (perceived control, task value and value) since there is no certain evidence this will be an exploratory hypothesis.

Lastly, a third hypothesis will be investigated to show the association of math anxiety, perceived control and value, in relation to math performance with a specific focus on comparing these aspects between international schools and Italian state schools. The objective is to assess whether an educational environment that adopts a more open-minded and flexible approach to teaching mathematics has a greater motivational impact on students compared to a more traditional, rigid methodology prevalent in Italian state schools. This comparison aims to shed light on the effectiveness of different teaching philosophies in fostering a positive attitude towards mathematics, thereby enhancing student motivation and engagement in the subject. Specifically, a negative significant relationship between math anxiety and math performance is expected (Carey et al., 2016), while positive relationships are hypothesized between math perceived control and value and math attainment (Pekrun et al., 2011; Putwain et al., 2021)

3.2 Participants

After the approval from the ethics committee was granted, directors of international schools all of over Italy were contacted asking to participate in the project. Two international schools adhered to the project, both are located in the North of Italy; one in Veneto and the other in Piemonte. The same was done with directors of Italian state schools, of which five participated in the project, three schools are located in the North of Italy in Veneto and two schools are located in the Central East of Italy in the Marche.

The participants for this experiment were a total of 248 primary school students from different schools and grade levels. The age of this sample ranged from 8 to 12 years of age, with an average of 112 months (9 years) and the standard deviation of 2.67. A total of 118 students in 3rd, 4th and 5th grade were from the International School of Turin (Piemonte) and H-Farm International School of Vicenza (Veneto) *(Table 1.1)*. The gender distribution of this sample was made up of a total of 62 males and 56 females. 97.5% of participants from the international schools spoke a minimum of both English and Italian.

A balanced sample was taken from 5 Italian state schools from different regions. This sample is made up 130 students from 3rd, 4th, and 5th grade from the Scuola Primaria Gianni Rodari (Veneto), Scuola Primaria Falcone Borsellino (Veneto), Scuola Primaria C. Darwin (Trento), Scuola Primaria C.A. Dalla Chiesa (Marche) and Scuola Primaria E. Cialdini (Marche) *(Table 1.1)*. The gender distribution of this sample was made up of a total of 73 males and 57 females.

Students who didn't complete task due to absences in either one of the sessions were excluded, as well as those with disabilities mandated by Italian law (104).

Table 3.1 *Sample Demographics*

School	***Location***	***Number of Classes (N)***	***Total number of students (N)***
H-Farm International School of Vicenza	Vicenza, Veneto, Italy	(2) 3rd grade and (1) 4th grade	(23) 3rd grade and (16) 4th grade
International School of Turin	Pecetto-Chieri, Piemonte, Italy	(2) 3rd grade, (2) 4th grade, (1) 5th grade	(30) 3rd grade, (32) 4th grade and (17) 5th grade
Scuola Primaria Gianni Rodari	Padova, Veneto, Italy	(1) 3rd grade	(14) 3rd grade
Scuola Primaria Falcone Borsellino	Padova, Veneto, Italy	(3) 3rd grade	(47) 3rd grade
Scuola Primaria C. Darwin	Trento, Veneto, Italy	(2) 4th grade	(34) 4th grade
Scuola Primaria C.A. Dalla Chiesa	Ancona, Marche, Italy	(1) 4th grade	(18) 4th grade
Scuola Primaria E. Cialdini	Ancona, Marche, Italy	(1) 5th grade	(17) 5th grade

3.3 Procedure

Firstly, schools were contacted and asked to collaborate in the project. It was explained to the school director, head teachers and parents that the research focuses on evaluating the emotional aspects and attitudes associated with mathematics and the learning of the subject itself, in children in primary school aged between 8 and 12. It was also advised that the project would take place in two sessions done within a week's distance from each other, each lasting about 50 minutes. Moreover, it was explained that children will be presented collectively, in class, with different tests and questionnaires in paper-pencil versions aimed at investigating mathematical skills, worries, and attitudes towards this discipline, such as interest, motivation, and perseverance, as well as the perception of competence and self-efficacy.

Informed parental consent was then asked and collected prior to the begging of the first session. Children without a signed informed consent were sent outside of class or involved in extra activity. The data collection occurred during the second academic quarter at the beginning of 2024 between February and April. When researcher entered the classes gave a brief introduction of the project, asked participants to take out a pen and handed out already coded protocols to the children. The alphanumeric codes were created with the acronym of the school, grade, class, and register number (i.e. IST_4X_01), so protocol 1 referred to the first child on the register and so on. This was done in order to maintain anonymity, as research would not know the names of the children, and for confidentiality. The researcher would instruct the children when to turn the page, stop the timed activity and put their pen down, read and explain the given task, and answer any questions. All instructions were standardized, all classes were given the same set of instructions, however, the order in which the tasks were presented would differ between classes. Order A of the protocols had math ability tasks prior to the questionnaires while order B had the questionnaires before the math abilities task. This was done to counterbalance the order of presentation of the trials and avoid that the order influenced the performance on the task or generate fatigue. As this is a part of a bigger project only a limited set of variables was selected, as they attain to the aim of this research. The following section will go in greater detail on the variables selected.

3.4 Measures

The instruments used to investigate the main constructs of the current research include both mathematical tests and self-report questionnaires. The mathematical tasks used in this research come from two different batteries; AC-FL and AC-MT3 (Caviola et al., 2016; Cornoldi et al., 2020). AC-FL battery measures task fluency in solving complex operations that focus on additions, subtraction and multiplication (Caviola et al., 2016). Instead, the AC-MT3 includes a variety of subtests designed to measure different aspects of mathematical understanding and skills: this research specifically used written calculation, numerical reasoning and approximate calculation (Cornoldi et al., 2020).

The constructs of math anxiety, general anxiety, perceived control and value were measured through questionnaires. They were all translated from Italian to English and if needed adapted to age specific groups and mathematical domains.

3.4.1 Math ability tasks

In this research mathematical abilities were tested using two different tasks: the AC-FL and AC-MT3 (Caviola et al., 2016; Cornoldi et al., 2020) Both tools are used by clinicians and researchers to determine the level of difficulty the subject has in solving simple math tasks that underscore their basic and more complex procedural abilities (Caviola et al., 2016). AC-FL is specifically designed to assess the fluency in arithmetic calculations among primary school children, focusing on their speed and accuracy in performing complex calculations (Caviola et al., 2016). On the other hand, AC-MT3 is structured to provide a detailed profile of a student's mathematical competencies using a variety of different subsets measuring different mathematical skills and understanding (Cornoldi et al., 2020).

AC-FL

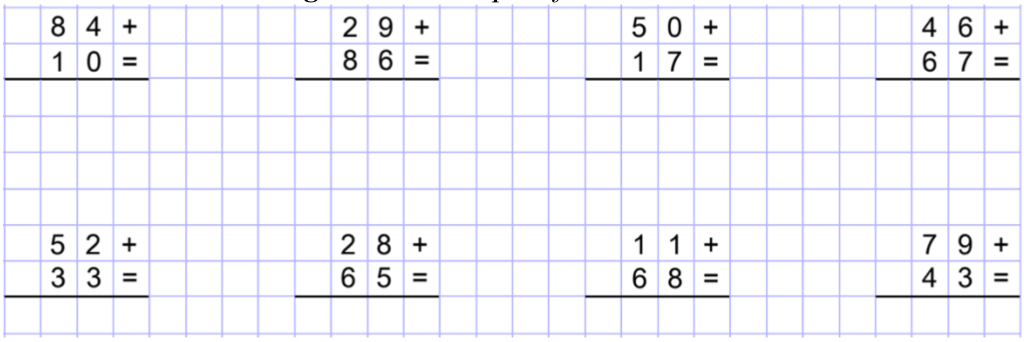
One of the math ability tasks used for this research is the AC-FL Fluency task created by Caviola, Lucangeli, Mammarella, and Gerotto in 2016. The objective of the AC-FL fluency task is to equip clinicians and teachers with a simple test that can give an indication of the accuracy and velocity in the execution of complex calculations. The task requires children to have a good automatization of arithmetic facts such as accuracy and velocity of mental math calculations. While it's simultaneously checking the knowledge of written calculation, like with borrowing or reminders and the procedural steps used to solve complex multiplications (Caviola et al., 2016).

The AC-FL task is targeted to children from 8 to 12 years old, hence they should be administered in 3^{rd}, 4^{th} and 5^{th} grade. The assessment remains the same for all grades, it does not vary in difficulty within grades. The total time of administration of the task is of 6 minutes. The assessment is composed of 3 papers, in each paper 24 operations are presented: the first contains 24 *additions,* the second 24 *subtractions* and the third 24 *multiplications* to be solved in 2 minutes each.

Addition Task

As mentioned above and shown in *Figure 3.1*, this task contains 24 additions. Presented in alternating other are two types of additions for students to solve, ones with carry and ones that don't. Furthermore, the positioning of the addends was also controlled for; on half of the operations the greater addend was placed on top and on the other half it was placed at the bottom (Caviola *et al.*, 2016).

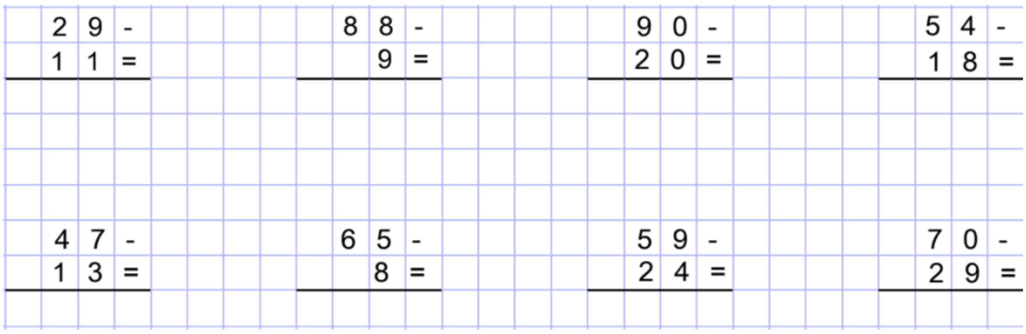
Figure 3.1 *Example of Addition task*



Subtraction Task

This task contains 24 subtractions, an example is shown in *Figure 3.2*. Similarly to the additions, the subtractions have been presented in an alternating order. However, here it focuses on substructions with and without the need to borrow (Caviola et al., 2016).

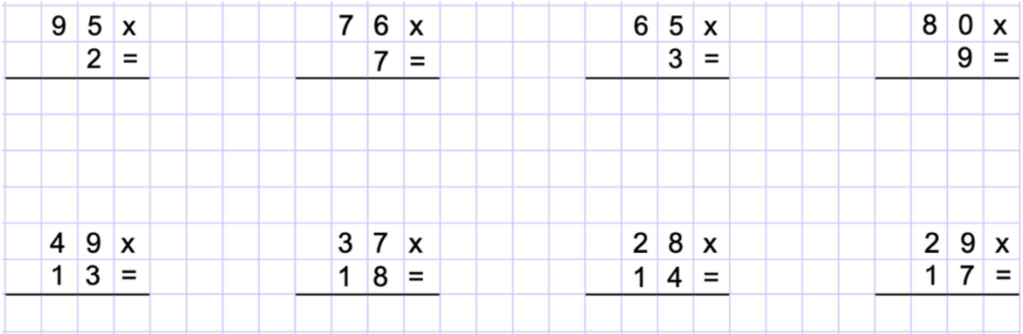
Figure 3.2 *Example of Subtraction task*



Multiplication Task

The multiplication task, as shown in *Figure 3.3*, contains multiplications with one or two factors. This time, however, they are distributed in order of complexity, which is determined by the size of the two factors.

Figure 3.3 *Example of Multiplication task*



All children are explained that, the aim of the task is to solve as many of the given operations as possible in 2 minutes. It is important to follow the order of the rows, so starting from left to right. However, if one does not know the answer they are allowed to skip it, but they must do so following the order. Additionally, students are told that they cannot use whiteout or an eraser if they made a mistake, they have to cross it out and write the correct answer bellow. At the end of the 2 minutes, they must put the pen down and wait for the administrator to tell them to turn the page over and proceed with the next set of operations.

The scoring of these tasks predicts that for any correct answer a 1 is given and for any incorrect answer a 0 is given. A total score is composed by the sum of the level of accuracy of the 3 tasks together. The higher the score the grater the level of fluency accuracy.

AC-MT3

The second math ability task that was used is the AC-MT3 battery created by Cornoldi, Mammarella, and Caviola in 2020. The battery is composed of 4 basic tasks which investigate: *Number dictation, Arithmetic facts, Written Calculation* and *Mental Calculation*. The battery is also composed of 7 timed tasks: *Calculation Fluency, Inferences, Find the number, Numerical Reasoning, Sense of Greatness, Approximate Calculation* and *Numerical Matrices* (Cornoldi et al., 2020). Overall, these tasks are used to assess students' mathematical competencies.

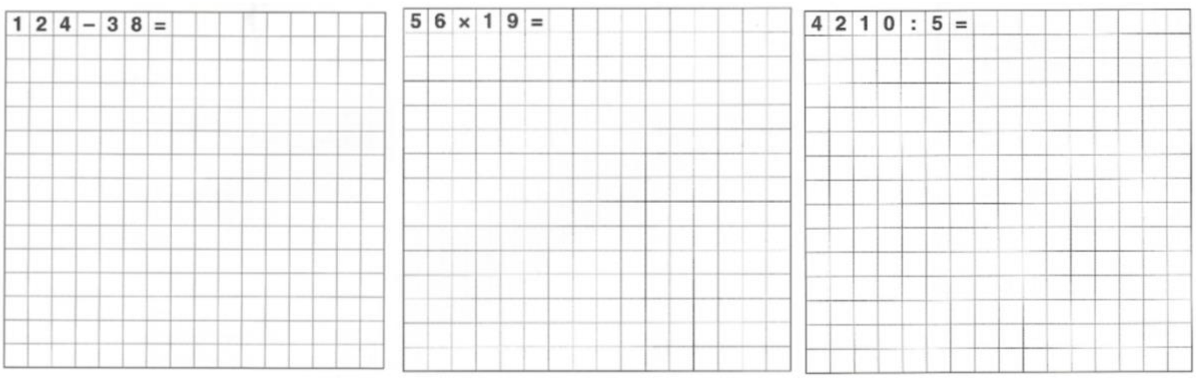
The AC-MT3 battery can be used on children aged 6 to 14, the structure of the subsets will remain the same however the level of difficulty within each task will change according to grade level (Cornoldi et al., 2020). For the purpose of this research only 1 basic task and 2 timed subsets where selected.

Written Calculation

In this task children are asked to solve 6 operations correctly by showing their working out. For this task children do not have a time limit; however, the examiner concluded the test when about 90% of the class had completed it, allowing for a maximum of 15 minutes. As shown in *Figure 3.6*, all children are given 2 additions, 1 subtraction, 1 multiplication and 2 divisions, however, the level of difficulty is increased with grade level. The objective of this task is to demonstrate the child's ability to organise the operation in collum correctly and to show knowledge and application of mathematical method.

The scoring of this task is that for any correct answer a 1 is given and for any incorrect answer a 0 is given. The points for this task are then added together, the higher the total score the better the child's is at written calculation.

Figure 3.6 *Written calculation item examples 3rd grade, 4th grade and 5th grade*

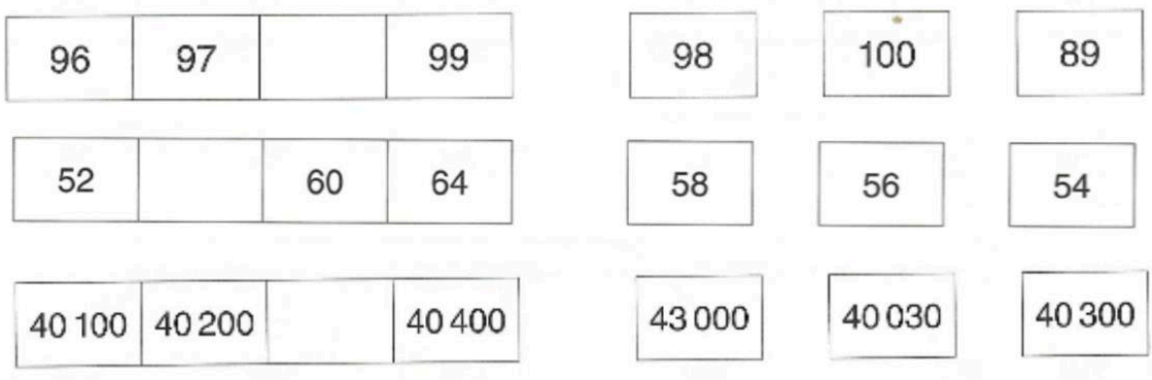


Numerical Reasoning

This subset examines the child's ability to reason about the properties of numerical sequences (Cornoldi *et al*., 2020). Children are asked to choose between three options which number best completes a numerical series. As illustrated in *Figure 3.4*, children are presented with a series of 4 numbers of which one is missing, children need to understand the rule to be able to complete it correctly. The rules of the series can vary, for example, 'add 100', 'subtract 6' and so on. This is a timed task, hence, children had 2 minutes to complete as many as the 12 items as possible. As the task varies in difficulty between grade levels, 3rd grade was only given 8 items instead of 12 as for 4th and 5th grade. The researcher would explain to the children the task with using different example problems, two to be done together and one autonomously. They would be first directed on the left side of the paper were a sequence of 4 numbers is presented with an empty square and then they follow through on the right side of the paper where 3 numbers are presented. Children are then asked to find the number, amongst the ones on the right side of the paper, that best fits in the empty square *(Figure 3.4)*.

The scoring of these tasks is the same as before for any correct answer a 1 is given and for any incorrect answer a 0 is given. The points for this task are then added together, the higher the score the better the child's numerical reasoning skills.

Figure 3.4 *Numerical Reasoning item examples of 3rd, 4th and 5th grade*

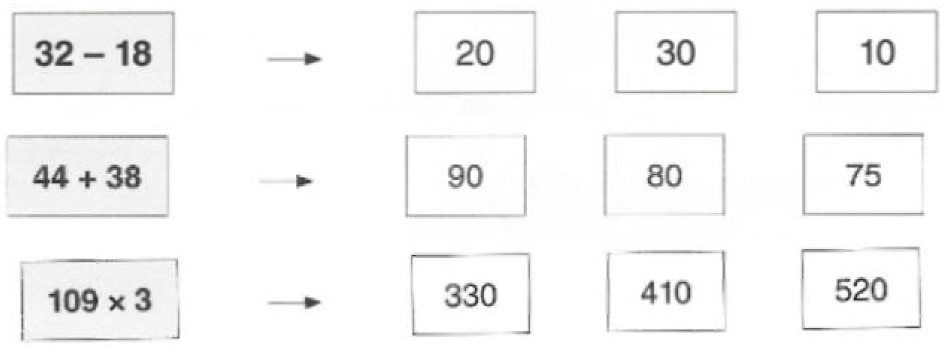


Approximate Calculation

This subset is used to evaluate the children's ability to make estimates of results of mathematical operations. In fact, as depicted in *Figure 3.5*, children have to choose between 3 options the number that is closest to the solution of the given operation. As this is a timed task children had 1 minute and a half to complete 15 items. The possible operations shown to all three grade levels are additions, subtractions and multiplications, however, these vary in difficulty between grade levels. The researcher would explain to the children the task with using different example problems, two to be done together and one autonomously. They would be first directed on the left side of the paper were an operation is presented and then they follow through on the right side of the paper where 3 numbers are presented. Children are then asked to find the number, amongst the ones on the right side of the paper, is closest to the result of the operation *(Figure 3.5).*

The scoring of these tasks is same as all math task, so for any correct answer a 1 is given and for any incorrect answer a 0 is given. The points for this task are then added together, the higher the score the better the child's approximate calculation skills.

Figure 3.5 *Approximate calculation item example for 3rd, 4th and 5th grade*



3.4.2 Math Attitudes Self-Report Measures

In this research a variety of questionnaires were used to assess children's positive and negative self-beliefs and attitudes towards mathematics. More specifically, a math anxiety questionnaire was given to assess children's negative attitudes towards maths. Whilst positive attitudes were measured by looking at children's perceived control and different perceived values. Each questionnaire used for this research will be presented in further detail below.

General Anxiety

In the light of the strong overlap between general anxiety and math anxiety participants general anxiety was also measured using the Revised Children's Manifest Anxiety Scale (RCMAS) short-version scale by Reynolds and Richmond 2008. The RCMAS is the most used measure to asses general or manifest anxiety in students aged 6 to 19. Manifest anxiety refers to having feelings of worry, nervousness or discomfort due to conflicting or repressed feelings (Lowe, 2015). This scale consists of a total of 10 items were students respond using a yes/no format (*Figure 3.7*).

Children are told that the phrases presented will describe different emotions that can be felt in various situation (e.g. at school, at home, with friends...). They are instructed to circle the word "YES" if they often experience that particular emotion during the day. Instead to circle the word "NO" if they don't experience that emotion often during the day. They are reminded that it's what they feel and that there are no right or wrong answers. The 10 items are then summed to have a total score. A high score on this scale would signify a high level of anxiety.

Figure 3.7 RCMAS-2 item example for 3rd, 4th and 5th grade

1. I often have stomach ache	YES	NO
2. I feel nervous	YES	NO
3. I often worry about something bad that might happen to me	YES	NO
4. I'm afraid that my classmates might laugh at me in class	YES	NO

Math Anxiety

Math Anxiety in children was measured using the Abbreviated Math Anxiety Scale (AMAS) revised and validated in Italian by Caviola et al*.,* in 2017. The purpose of this scale is to identify children's negative cognitions, such as fear and tenseness, about math. It is made up of 9 items which are divided into two subscales: one that measures *Math Learning Anxiety* (5 items) and the second measures *Math Test Anxiety* (4 items) (Caviola et al*.,* 2017). The first subscale focuses on negative feelings involving the attainment of math in school. It aims to capture the feelings of tension, fear, or apprehension that students may experience when they are trying to understand mathematical concepts during classroom instruction or while studying on their own (Caviola et al*.,* 2017). Items 6 and 9, as shown in *Figure 3.6,* would be examples of *Math Learning Anxiety*. Whilst the latter looks at negative feelings towards math assessments. It focuses on the anxiety that arises in situations where students' mathematical knowledge and skills are being evaluated, whether through formal testing (finals/midterms) or informal assessments (quiz games) in the classroom (Caviola et al*.,* 2017). Some examples of *Math Test Anxiety* include items 7 and 8 presented in *Figure 3.6*.

Children are asked to imagine themselves in various situations and to rate their level of fear during the activity (*Figure 3.6)*. This is a 5-point Likert-type scale, it ranges from 1 (no bad feeling), 3 (moderate fearful/tense feelings) to 5 (very bad feelings). The 9 items are then summed to have a total score. A high score on this scale would signify a high level of math anxiety, meaning that the child feels a lot of negative emotions in regards to maths.

Figure 3.6 AMAS item example for 3rd, 4th and 5th grade

6. Carefully listening to the math lesson	No bad feeling	Somewhat bad	Moderate fearful/tense or nervous	Bad feelings	Very bad feelings
7. Watching another student solve a math problem	No bad feelings	Somewhat bad	Moderate fearful/tense or nervous	Bad feelings	Very bad feelings
8. Having an oral test on math without knowing in advance	No bad feeling	Somewhat bad	Moderate fearful/tense or nervous	Bad feelings	Very bad feelings
9. Starting a new topic in mathematics	No bad feelings	Somewhat bad	Moderate fearful/tense or nervous	Bad feelings	Very bad feelings

Perceived Control

Perceived control was measured using the Perceived Control (PC) scale which contains 4 adapted items of the Self-Description Questionnaire II by Putwain *et al.,* in 2018. This scale is used to represent the control over one's learning in mathematics. Children were told to read carefully all statements and to choose the answer that felt most true to them. Additionally, it was explained to them that the sentences shown to them depict thoughts and behaviours that individuals can do when they think about math. Participants responded on a 5-point Likert-type scale, it ranges from 1 (Strongly disagree), 3 (Neither), to 5 (Strongly agree). The 4 items are then summed to have a total control score. Therefore, a high score in this measure indicates a greater sense of control in math attainment.

Figure 3.8 Perceived Control (PC) scale for 3rd, 4th and 5th grade

Situation	Strongly Disagree	Disagree	Neither	Agree	Strongly agree
1. If I answer a math question/exercise wrong, I am able to understand what I did wrong	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
2. I have always done well in math class	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
3. I can learn math quickly	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
4. Doing math exercises is something easy for me	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree

Math Value

Math value was assessed by combing two scales on perceived value: the Value Scale and a subscale of the Mathematics Motivation Questionnaire for Children (MMQC) (Putwain et al*.,* 2018; Prast et al*.,* 2012). The first scale measures the real importance children give in academic tasks. The latter focuses on task value which refers to students' motivation in participating in educational activities (Putwain et al*.,* 2018; Prast et al*.,* 2012). These two scale were combined to have a comprehensive measure for students perceived value in mathematics.

Value

Perceived value was measured with the adapted version of the Michigan Study of Adolescent Life scale used by Putwain et al*.,* in 2018. The objective of this scale is to determine children's interest in taking part in academic tasks. The scale is composed of 3 subscales: *intrinsic value, attainment value and utility value*. The first subset refers to how much happiness the child gets from the task, an example of item would be items 2 and 3 in *Figure 3.9* (Schrader& Helmke, 2015). The second subset, on *attainment value*, deals with the perceived importance of doing well, items like item 8 are included (*Figure 3.9*). Lastly, *utility value*, focuses on how the task is related to future life goals, for example item 9 in *Figure 3.9* (Schrader& Helmke, 2015). The instructions given to children were to read the statements on different thoughts or behaviours that people can have when they think about math and to choose the answer that feels most true to them. This scale is composed of a total of 12 items that are then divided into: 4 items on *intrinsic value*, 4 items on *attainment value*, and 4 items on *utility value*. This is a 5-point Likert-type scale, it ranges from 1 (Strongly disagree), 3 (Neutral), to 5 (Strongly agree). Only one item in this scale is reversed scored as it's a negative statement ("Math is not interesting"). The 12 items are then summed to have a total value score. Hence, a high score on this scale signifies a high level of value associated with maths. Therefore, the more value the more the child is interested and motivated in math.

Figure 3.9 Value scale item example for 3rd, 4th and 5th grade

2. I think that the math lessons are interesting	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
3. I think doing math exercises is interesting	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
8. Getting good grades in math class is something important to me	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
9. Math will help me when I'm older	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Task Value

Task value, instead, was measured using the task value subset of the Mathematics Motivation Questionnaire for Children (MMQC) by Prast et al*.,* in 2012. Task value can be defined as the motivation of participating in educational activities (Hemin et al., 2010). It consists of four main components*: intrinsic value, attainment value, utility value* and *cost value*. In this subset, 5 items measure *intrinsic value* (Items 2 and 6 in *Figure 3.10*), however it also includes one item on *utility value* (Item 1 in *Figure 3.10*) and one item on *personal value*. *Personal value* is used to assess an individual's own motivation to carry out tasks, an example would be Item 7 in *Figure 3.10* (Hemin et al., 2010). Children were told to read carefully all statements and to choose the answer that felt most true to the them, additionally, it was explained to them that the sentences shown to them depict thoughts and behaviours that individuals can do when they think about math. Participants responded to 7 items on a 4-point Likert-type scale, ranging from 1 (Strongly disagree) to 4 (Strongly agree). The 7 items are then summed to have a total task value score. Thus, a high score in this scale suggests a greater level of task value in mathematics. The scores of the value and task value scale are added and then averaged to get a total mean score of motivation in mathematics.

Figure 3.10 Task Value item example for 3rd, 4th and 5th grade

Situation	Strongly Disagree	Disagree	Agree	Strongly agree
1. Do you think it would be useful to know how to calculate well?	Strongly Disagree	Disagree	Agree	Strongly Agree
2. Do you think maths is one of your favourite school subjects?	Strongly Disagree	Disagree	Agree	Strongly Agree
6. Do you usually want to follow maths class?	Strongly Disagree	Disagree	Agree	Strongly Agree
7. Do you think maths is important?	Strongly Disagree	Disagree	Agree	Strongly Agree

The methods employed in this study, math ability tasks and questioners on perceived control and perceived value provided a comprehensive structure for the analyses of the results, these will be explained in detail in the following chapter.

Chapter 4 – Results

As previously mentioned, this research focuses on the comparison between international schools and Italian state schools. It aims to understand the difference between the school systems' mechanisms underlying the relationship between positive and negative emotions often experienced during the performance of mathematical tasks and consequently any differences regarding the attainment itself. To answer the hypothesis posed by this research, the variables explained beforehand: math ability tasks, math anxiety, perceived control and perceived value, will be used in different means of statistical analysis.

Analyses were performed by first reporting the means (M) and standard deviations (SD) of both math abilities tasks and mathematical attitudes. Then the reliability of the instruments was investigated to verify the consistency of the adapted questionnaires used in this research. Further multiple ANOVAs were conducted to investigate the first hypothesis and analyse in detail any differences in math proficiency. Additionally, gender differences were explored, for both Italian state school and international school.

Similarly, for the second hypothesis multiple ANOVAs were conducted to analyse the differences in positive and negative attitudes. As the second hypothesis posed emphasizes the difference in positive and negative attitudes between the different systems, alongside the potential moderating role of gender.

For the final hypothesis correlations were conducted to further explore the relationship between math attitudes and math performance separately for each school systems.

JASP 2024 was used as data analysis software for this research. Results of the analysis conducted will be explained below.

4.1 Descriptive statistics

The participants for this experiment were a total of 248 primary school students from 3rd, 4th and 5th grade from both Italian state schools and international schools in Italy. Overall, the age of this sample ranged from 8 to 12 years of age, with an average of 112 months (9 years) and a standard deviation of 2.67. With a gender distribution between the different schools of 135 males and 113 females. Following are the means and standard deviations of both math abilities and math attitudes. All scores presented are raw scores.

4.1.1 Descriptives statistics for Math Abilities

Means and Standard deviations of the individual math tasks and the general composite score 'Mathematical Competencies' are presented in *Table 4.1.1*. The composite scale is created by averaging the scores of all the math ability tasks: math fluency, written calculation, numeric reasoning and approximate calculation. The scores refer to the whole sample which was split across primary school grades and gender.

***Table 4.1.1**. Means and (Standard Deviations) of international school and Italian state school students in Math Ability tasks*

School	*Class*	*Gender*	*Math Fluency*	*Written Calculation*	*Numeric Reasoning*	*Approximate Calculation*	*Mathematical Competencies*
International	3	M	12.34 (7.60)	2.14 (1.62)	5.41(2.37)	5.52(2.32)	6.35 (2.79)
		F	8.88 (4.30)	1.18 (0.92)	4.37(1.74)	3.87(1.73)	4.57 (1.58)
	4	M	22.08 (12.61)	4.18 (1.81)	7.83(3.51)	4.79(3.15)	9.72 (4.71)
		F	19.08 (7.09)	4.29 (1.23)	6.08(2.34)	2.83(1.37)	8.07 (2.59)
	5	M	34.22 (12.98)	3.11 (1.76)	9.22(2.54)	7.89(2.57)	13.61 (3.52)
		F	42.12 (13.50)	3.50 (1.77)	8.65(2.93)	5.25 (2.60)	14.87 (4.86)
Italian State	3	M	27.18 (6.15)	4.93 (1.23)	6.60(3.07)	4.48(1.65)	10.81 (2.08)
		F	21.04 (7.21)	4.32 (1.40)	5.48(1.65)	3.32(1.38)	8.77 (2.28)
	4	M	38.75 (14.10)	5.34 (1.10)	9.69(2.84)	7.28(4.27)	15.27 (5.02)
		F	32.40 (12.06)	4.90 (1.41)	6.60(3.07)	3.55(3.00)	11.86 (4.28)
	5	M	44.00 (12.21)	5.00 (1.18)	8.64(3.30)	6.18(1.78)	15.95 (4.15)
		F	44.18 (11.60)	5.33 (1.21)	9.17(2.32)	6.50(2.81)	16.29 (4.08)

Table 4.1.2., illustrates the mean difference in scores between Italian state school and international school students in mathematical competencies. With reference to the first hypothesis, 3rd grade Italian students do perform better than their international counterparts. The difference between school type reduces greatly as children advance in grade. By 5th grade the difference is reduced to a minimum. However, Italian state school students remain overall better in mathematical competencies compared to the international students. These differences emerge by qualitatively analysing the averages, and will be further investigated through statistical analysis in the following paragraphs.

Table 4.1.2. *Mean Differences between Italian state school and international school students in mathematical competencies*

	3		**4**		**5**	
	M	**F**	**M**	**F**	**M**	**F**
Math Fluency	14.84	12.16	9.95	13.32	9.78	2.05
Written Calculation	2.79	3.14	1.16	0.61	1.89	1.83
Numeric Reasoning	1.19	1.11	1.86	0.52	-0.58	0.55
Approximate Calculation	-1.04	-0.55	2.49	0.72	-1.71	1.25
Mathematical Competencies	4.45	4.19	5.55	3.79	2.34	1.42

4.1.2 Descriptive statistics for Mathematical Attitudes

Means and Standard deviations of math anxiety, perceived control and perceived value are presented in *Table 4.1.3*. The perceived value scale is created by summing both the value and the task value scale. The scores refer to the whole sample, which was split across school grades and gender.

Table 4.1.3. *Means and (Standard Deviations) of international school and Italian state school students in Mathematical Attitudes*

School	***Class***	***Gender***	***Math Anxiety***	***Perceived Control***	***Perceived Value***
International	3	M	15.24 (6.10)	14.69 (3.01)	72.36 (8.76)
		F	15.50 (4.90)	13.62 (2.36)	70.46 (8.10)
	4	M	17.28 (6.90)	13.00 (3.01)	68.15 (10.64)
		F	15.79 (7.02)	13.25 (3.42)	67.28 (14.38)
	5	M	15.89 (6.19)	15.00 (1.66)	64.00 (10.19)
		F	16.75 (5.60)	15.56 (2.86)	66.23 (10.86)
Italian State	3	M	18.47 (7.27)	14.47 (2.60)	75.68 (9.13)
		F	20.52 (7.81)	13.32 (2.29)	76.46 (6.63)
	4	M	20.08 (7.97)	14.53 (3.42)	73.52 (11.33)
		F	24.56 (7.39)	13.15 (3.69)	68.43 (11.46)
	5	M	25.52 (7.25)	11.18 (3.55)	67.76 (11.48)
		F	20.33 (7.86)	13.67 (2.42)	71.33 (9.71)

Table 4.1.4., illustrates the mean difference in scores between Italian state school and international school students in mathematical attitudes. With reference to the second hypothesis, Italian students have higher math anxiety in all age groups compared to international students. Differences in perceived control between the two schools are minimum, however, Italian students have a much higher perceived value compared to international students, this remains with the increasing of age. As stated before, these differences emerge by qualitatively analysing the averages, and will be further investigated through statistical analysis in the following paragraphs.

Table 4.1.4. *Mean Differences between Italian state school and international school students in Mathematical Attitudes*

	3		**4**		**5**	
	M	**F**	**M**	**F**	**M**	**F**
Math Anxiety	3.23	5.02	3.00	8.77	9.63	3.58
Perceived Control	-0.22	-0.30	1.53	-0.10	-3.82	-1.89
Perceived Value	3.62	6	5.37	0.63	3.76	5.10

4.1.3 Reliability

Due to the adaptation and translation of the questionnaires from Italian to English, internal reliability was measured. Thus, the purpose of these analyses is to check the reliability of the questionnaires used for the analysis of the results.

McDonald's Omega *(ω)* is a reliability coefficient used to estimate the internal consistency of a set of items, such as those in a psychological tests or questionnaires (McDonald, 2013). It is considered a more accurate and less biased measure of reliability compared to Cronbach's alpha (Elliott & Woodward, 2014). McDonald's Omega provides an estimate of the proportion of variance in the observed scores that is attributable to the common factor (McDonald, 2013). It ranges from 0 to 1, the values for interpretation are as follow: $\omega \geq 0.90$ excellent reliability, $0.80 \leq \omega < 0.90$ good reliability, $0.70 \leq \omega < 0.80$ acceptable reliability, $0.60 \leq \omega < 0.70$ questionable reliability and $\omega < 0.60$ poor reliability. Generally, higher values of Omega indicate that the items are consistently measuring the same construct (McDonald, 2013).

Table 4.1.5 shows internal consistency values for both Italian and English questionnaires using McDonald’s Omega. Generally, all questionaries have good to acceptable reliability. Meaning that items are consistently measuring the same construct.

Table 4.1.5. *McDonald’s Omega for both Italian and English questionnaires*

	Generalized *Anxiety*	***Math Anxiety***	***Perceived Control***	**Value Scale**	**Task Value**
International school	0.71	0.83	0.66	0.87	0.75
Italian State School	0.68	0.86	0.72	0.85	0.88

Note: *Values displayed are McDonald's Omega (ω)*

4.2 Analysis of Variance

To investigate the first two hypothesis, a series of ANOVAs were used to the determine the differences between Italian state school and international school students between male and female 3rd, 4th and 5th grade students in math competency, generalized anxiety, math anxiety, perceived control and perceived value. Also grade and gender effects and their potential moderating role were tested.

Analysis of Variance (ANOVA) is a statistical method used to compare the means of three or more groups, to determine if there are statistically significant differences among them (Howell, 1992). Unlike a t-test, which is limited to comparing two groups, ANOVA can handle multiple groups simultaneously. The primary goal of an ANOVA is to test the null hypothesis that all group means are equal against the alternative hypothesis that at least one group mean is different (Howell, 1992). Parameters for interpretation include the F-Statistic and p-value. The F-statistic is the proportion of variance between group means to the variance within groups. A higher F-value indicates a greater degree of difference between the group means relative to the variability within the groups (Elliott & Woodward, 2014). The p-value that is associated with the F-statistic indicates the probability of observing the data if the null hypothesis is true. A p-value less than 0.05 is considered to be statistically significant, suggesting that at least one group mean is different from the others (Elliott & Woodward, 2014).

Post-Hoc Tests are conducted when ANOVA has a significant difference in the group means, to recognize which specific groups differ from each other. These tests control for Type I error (false positives) that can occur when making multiple comparisons. Bonferroni correction is a type of post-hoc test that reduces the likelihood of Type I errors (Elliott & Woodward, 2014).

4.2.1 Comparative Analysis of Math Competencies

In order to answer the first hypothesis proposed in this research different ANOVAs were run for all math ability tasks. The tasks were run separately to further inspect the difference in mathematical abilities between Italian state school and international school students. Following are the results of the various ANOVAs divided for all mathematical tasks, starting with the overall differences in mathematical competencies.

Math Competencies

The overall difference in math competence between school systems (Nationality: International school vs. Italian state school), class (3^{rd}, 4^{th} and 5^{th}) and gender (Male vs. Female) was examined using a factorial ANOVA. A significant statistical difference was found between international schools and Italian state school students in math competencies. Italian students show a higher overall math competencies as reported in *Table 4.2.1.* Additionally, a significant difference between classes and mathematical competencies was found. For all math tasks, as students increase grade level, so does their relative mathematical competencies score. Furthermore, a significant difference between gender and math competencies was found. Females in majority of the math tasks display lower scores compared to their male counterparts. However, in 5^{th} grade, females overall mathematical competencies are higher than males. Thus, school system, class and gender were found to have significant main effects, however, no significant interaction was found. Lastly, post-hoc tests were run to examine how the conditions differed from each other; these were corrected to Bonferroni Type-I error (*Table 4.2.2.)*. The difference between all the conditions was found to be significant, hence the Italian children surpassed international students by 3.62 points on average.

Table 4.2.1. *Factorial ANOVA for Math Competencies*

	Mean Square	**Sum of Squares**	***F***	***P***
Nationality	591.03	591.03	48.63	**<0.001**
Class	826.38	1652.77	68.00	**<0.001**
Gender	66.08	66.08	5.44	**0.021**
*Nationality*Class*	24.56	49.12	2.02	0.13
*Nationality*Gender*	10.85	10.85	0.89	0.35
*Class*Gender*	33.95	67.90	2.79	0.063
*Nationality*Class*Gender*	3.65	7.30	0.30	0.74

Table 4.2.2. *Bonferroni Post Hoc Test for Math Competencies*

		Mean Difference	**95% CI Lower**	**95% CI Upper**	**SE**	**T**	**PBONF**
International	*Italian*	-3.62	-4.65	-2.60	0.52	-6.97	<0.001
3	*4*	-3.61	-4.74	-2.47	0.48	-7.47	<0.001
	5	-7.56	-9.20	-5.92	0.69	-10.88	<0.001
4	*5*	-3.95	-5.62	-2.28	0.50	-5.60	<0.001
F	M	-1.21	-2.24	-0.19	0.54	-2.60	0.021

Math Fluency

A three-way ANOVA with math fluency as the dependent variable and school systems (Nationality: International school vs. Italian state school), class (3rd, 4th and 5th) and gender (Male vs. Female) as the independent variables, was conducted. A statistically significant difference in math fluency between international schools and Italian state school students was found. Italian students have higher math proficiency than international students (*Table 4.2.3.)*. Additionally, a statistically significantly difference in math fluency between grade levels was found. Thus, as the students go up in class, so does the math fluency score. Therefore, both nationality and class were found to be significant main effects, however, no significant interactions where found. Furthermore, post-hoc tests corrected to Bonferroni Type-I error, were run to examine how the conditions differed from each other (*Table 4.2.4.)*. The difference between the conditions was found to be significant, hence the Italian children outperform the international children in math fluency tasks by 11.61 points on average.

Table 4.2.3. *Factorial ANOVA for Math Fluency*

	Mean Square	**Sum of Squares**	***F***	***P***
Nationality	6069.93	6069.93	61.67	**<0.001**
Class	7782.66	15565.32	79.08	**<0.001**
Gender	124.54	124.54	1.26	0.26
*Nationality*Class*	261.83	523.66	2.66	0.072
*Nationality*Gender*	2064.32	2064.32	2.10	0.149
*Class*Gender*	256.38	512.76	2.61	0.076
*Nationality*Class*Gender*	28.21	56.42	0.29	0.75

Table 4.2.4. *Bonferroni Post Hoc Test for Math Fluency*

		Mean Difference	**95% CI Lower**	**95% CI Upper**	**SE**	**T**	**PBONF**
International	*Italian*	-11.61	-14.53	-8.70	1.48	-7.85	<0.001
3	*4*	-10.50	-13.74	-7.26	1.98	-11.91	<0.001
	5	-23.548	-28.211	-18.885	1.977	-11.911	<0.001
4	*5*	-13.049	-17.795	-8.303	2.012	-6.485	<0.001

Written Calculation

A factorial ANOVA with written calculation as the dependent variable and school systems (Nationality: International school vs. Italian state school), class (3rd, 4th and 5th) and gender (Male vs Female) as the independent variables, was run. A statistically significant difference in written calculation between international schools and Italian state school students was found. Italian students have higher written calculation skills than international pupils (*Table 4.2.5.)*. This difference was also found to be significantly different by class, hence as the students go up in class so does the score. Therefore, school systems and class were found to be significant main effects and a significant interaction between school systems and class was found. As depicted in *graph 4.2.7.*, the interaction between school systems and class was found to be statistically signficant. Italian state school students systemically perfom better in all classes for written calculation compared to the international counterparts. Post-hoc tests were run to examine how the conditions differed from each other; these were corrected to Bonferroni Type-I error (*Table 4.2.6.)*. The difference between the conditions was found to be significant, thus the Italian children outperform the international children in math fluency tasks by 1.91 points on average.

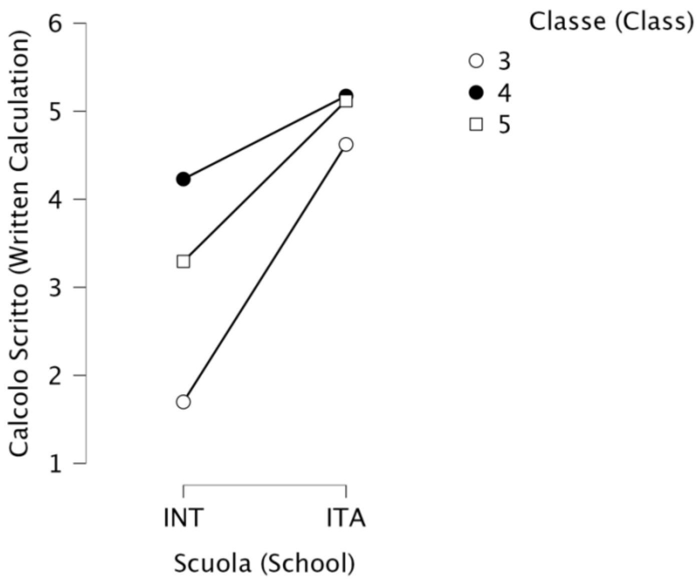
Table 4.2.5. *Factorial ANOVA for Written Calculation*

	Mean Square	**Sum of Squares**	***F***	***P***
Nationality	164.13	164.13	86.28	**<0.001**
Class	63.65	127.31	33.46	**<0.001**
Gender	1.74	1.74	0.913	0.34
*Nationality*Class*	28.41	56.81	14.93	**<0.001**
*Nationality*Gender*	0.087	0.087	0.046	0.83
*Class*Gender*	5.20	10.40	2.73	0.067
*Nationality*Class*Gender*	1.41	2.82	0.74	0.48

Table 4.2.6. *Bonferroni Post Hoc Test for Written Calculation*

		Mean Difference	**95% CI Lower**	**95% CI Upper**	**SE**	**T**	**PBONF**
International	*Italian*	-1.91	-2.31	-1.51	0.206	-9.29	<0.001
3	*4*	-1.53	-1.99	-1.08	0.19	-8.04	<0.001
	5	-1.10	-1.74	-0.45	0.27	-3.99	<0.001
4	5	0.44	-0.22	1.10	0.28	1.57	0.35

Graph 4.2.7. *Interaction* between *school system and class in Written Calculation*



Numerical Reasoning

A three-way ANOVA with numerical reasoning as the dependent variable and school systems (Nationality: International school vs. Italian state school), class (3rd, 4th and 5th) and gender (Male vs. Female) as the independent variable was conducted. A statistically significant difference in numerical reasoning between international school and Italian state school students was found. Italian students have higher numerical reasoning skills than international students (*Table 4.2.8.)*. Also, a statistically significantly difference between classes was found. Meaning that as the students advance in grade level so does the numerical reasoning score. Similarly, a statistically significantly difference between gender in this task was found. Implying that a gender difference in numerical reasoning; females score lower than males in this math task. Therefore, school system, class and gender were all found to have significant main effects and a significant interaction between class and gender was found. As depicted in *graph 4.2.10.*, the interaction between class and gender was found to be signficant. As shown in the graph, the greatest difference between gender is in 4th grade, by 5th grade males and females abtain the same score in this task. Additionally, post-hoc tests corrected to Bonferroni Type-I error, were run to examine how the conditions differed from each other (*Table 4.2.9.)*. The difference between the conditions was found to be significant, hence the Italian children outperform the international children in math fluency tasks by 0.78 points on average.

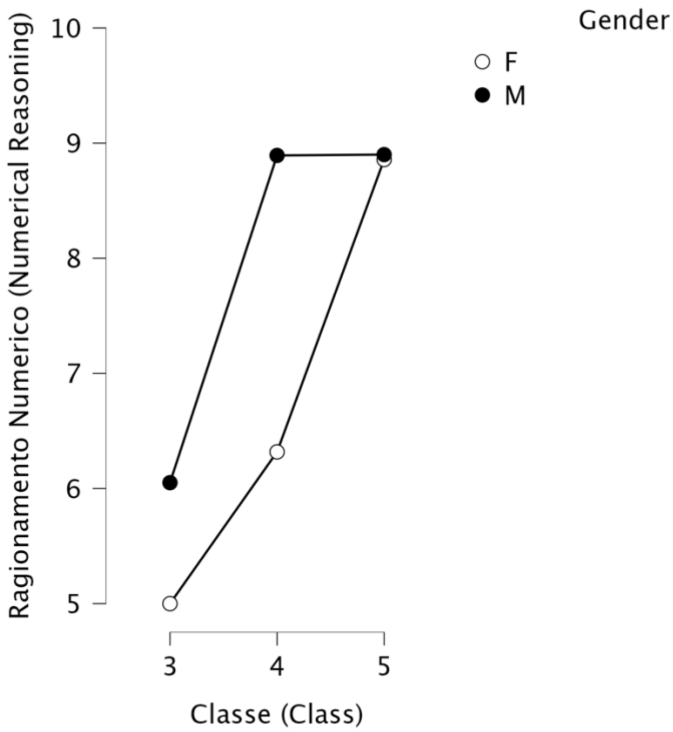
Table 4.2.8. *Factorial ANOVA for Numerical Reasoning*

	Mean Square	**Sum of Squares**	***F***	***P***
Nationality	27.48	27.48	4.40	**0.037**
Class	197.26	394.52	31.57	**<0.001**
Gender	63.47	63.47	10.16	**0.002**
*Nationality*Class*	5.10	10.19	0.816	0.44
*Nationality*Gender*	0.16	0.16	0.025	0.87
*Class*Gender*	21.10	42.21	3.38	**0.036**
*Nationality*Class*Gender*	5.24	10.49	0.84	0.43

Table 4.2.9. *Bonferroni Post Hoc Test for Numerical Reasoning*

		Mean Difference	**95% CI Lower**	**95% CI Upper**	**SE**	**T**	**PBONF**
International	*Italian*	-0.78	-1.52	-0.047	0.37	-2.10	0.037
3	*4*	-2.06	-2.88	-1.25	0.35	-5.97	<0.001
	5	-3.43	-4.60	-2.25	0.50	-2.68	<0.001
4	*5*	-1.36	-2.56	-0.16	0.50	-2.68	0.023
F	M	-1.19	-1.92	-0.45	0.37	-3.19	0.002

Graph 4.2.10. *Interaction* between *class and gender in Numerical Resasoning*



Approximate Calculation

A factorial ANOVA with approximate calculation as the dependent variable and school systems (Nationality: International school vs. Italian state school), class (3^{rd}, 4^{th} and 5^{th}) and gender (Male vs Female) as the independent variables was run. No difference was found in approximate calculation between international schools and Italian state school students (*Table 4.2.11.)*. However, a significant difference between classes was found. Thus, as the students advance grade their score increases. Additionally, a significant difference between gender was found, where males perform better than females in this task. Therefore, class and gender were found to have significant main effects and a significant interaction between school system and class was found. As depicted in *graph 4.2.13.*, the interaction between school system and class was found to be statistically signficant. In both 3rd and 5th grade international students have higher scores compare to the Italian state students. However, Italian state school students perfom signficantly better in 4th grade for approximate calculation compared to the international counterparts. Post-hoc tests were run to examine how the conditions differed from each other; these were corrected to Bonferroni Type-I error (*Table 4.2.12.)*. The difference between the conditions was found to be significant, hence males perform 1.8 points higher than females.

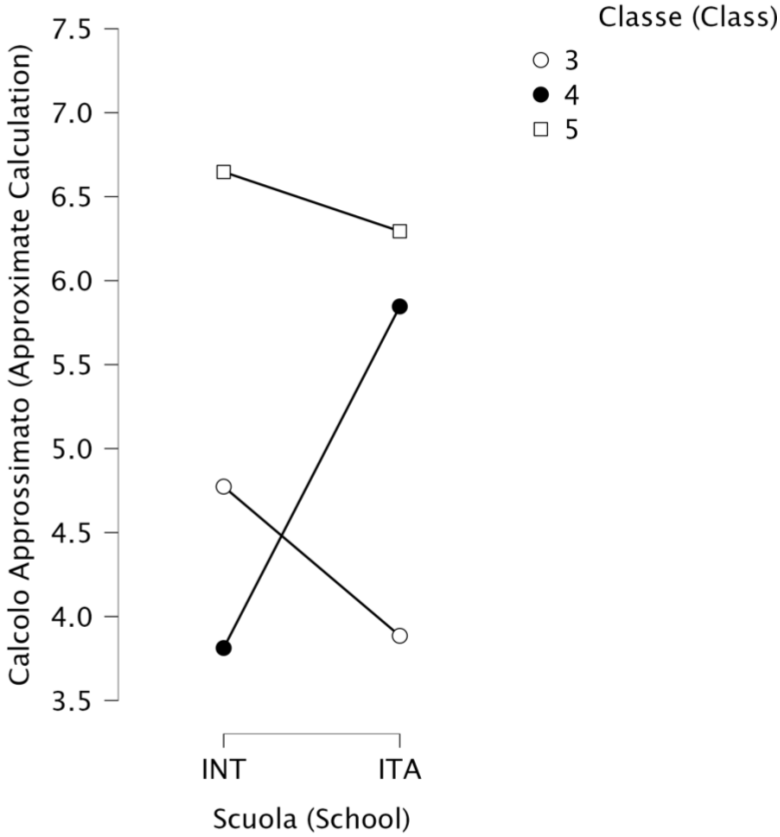
Table 4.2.11. *Factorial ANOVA for Approximate Calculation*

	Mean Square	**Sum of Squares**	***F***	***P***
Nationality	1.64	1.64	0.252	0.61
Class	59.50	119.01	9.140	**<0.001**
Gender	145.71	145.71	22.38	**<0.001**
*Nationality*Class*	38.77	77.55	5.96	**0.003**
*Nationality*Gender*	3.55	3.54	0.54	0.46
*Class*Gender*	16.63	33.26	2.55	0.080
*Nationality*Class*Gender*	19.23	38.45	2.95	0.054

Table 4.2.12. *Bonferroni Post Hoc Test for Approximate Calculation*

		Mean Difference	**95% CI Lower**	**95% CI Upper**	**SE**	**T**	**PBONF**
3	*4*	-0.32	-1.15	0.51	0.35	-0.90	1.00
	5	-2.16	-3.36	-0.96	0.51	-4.25	<0.001
4	*5*	-1.84	-3.06	-0.62	0.52	-3.57	0.001
F	M	-1.80	-2.55	-1.05	0.38	-4.73	<0.001

Graph 4.2.13. *Interaction* between *school system and class in Approximate Calculation*



4.2.2 Comparative Analysis of Generalized Anxiety

Before performing the comparisons between negative and positive math attitudes, no differences in general anxiety levels must be found between the school systems due to the overlap with math anxiety. A three-way ANOVA with generalized anxiety as the dependent variable and school systems (Nationality: International school vs. Italian state school), class (3^{rd}, 4^{th} and 5^{th}) and gender (Male vs Female) as the independent variables was conducted. No differences in generalized anxiety were found between school systems. Only gender was found to have a significant main effect. Post-hoc tests corrected to Bonferroni Type-I error, were run to examine how the gender conditions differed from each other (*Table 4.2.15.)*. The difference between the conditions was found to be significant, thus females overall have higher generalized anxiety than males.

Table 4.2.14. *Factorial ANOVA for Generalized Anxiety*

	Mean Square	**Sum of Squares**	***F***	***P***
Nationality	2.66	2.66	0.44	0.51
Class	4.60	9.20	0.76	0.48
Gender	35.47	35.47	5.90	**0.016**
*Nationality*Class*	14.61	29.21	2.43	0.090
*Nationality*Gender*	8.77	8.77	1.46	0.23
*Class*Gender*	11.57	23.14	1.92	0.15
*Nationality*Class*Gender*	1.76	3.53	0.29	0.75

Table 4.2.15. *Bonferroni Post Hoc Test for Generalized Anxiety*

		Mean Difference	**95% CI Lower**	**95% CI Upper**	**SE**	**T**	**PBONF**
F	*M*	0.89	0.17	1.61	0.37	2.43	0.016

4.2.3 Comparative Analysis of Math Anxiety

With regards to the second hypothesis, a three-way ANOVA was conducted to find differences in math anxiety between school systems (Nationality: International school vs. Italian state school), class (3^{rd}, 4^{th} and 5^{th}) and gender (Male vs Female). A statistically significant difference was found between international schools and Italian state school in math anxiety (*Table 4.2.16.*). International school students have lower math anxiety than their Italian state school counterparts. No statistically significant difference was found between classes and gender. Thus, only school system was found to have a significant main effect. Post-hoc tests were run to examine how the school systems differed from each other; these were corrected to Bonferroni Type-I error (*Table 4.2.17).* The difference between the conditions was found to be significant, hence international students display 5.50 points on average lower levels of math anxiety compared to Italian students.

Table 4.2.16. *Factorial ANOVA for Math Anxiety*

	Mean Square	**Sum of Squares**	***F***	***P***
Nationality	1363.56	1363.56	17.84	**<0.001**
Class	126.07	252.13	2.57	0.078
Gender	1.20	1.20	0.024	0.88
*Nationality*Class*	28.26	56.51	0.58	0.56
*Nationality*Gender*	3.65	3.65	0.074	0.78
*Class*Gender*	43.20	86.40	0.88	0.41
*Nationality*Class*Gender*	112.30	224.60	2.29	0.10

Table 4.2.17. *Bonferroni Post Hoc Test for Math Anxiety*

		Mean Difference	**95% CI Lower**	**95% CI Upper**	**SE**	**T**	**PBONF**
International	*Italian*	-5.50	-7.56	-3.45	1.04	-5.28	<0.001

4.2.4 Comparative Analysis of Perceived Control and Perceived Value

Subsequently, two separate factorial ANOVAs were conducted to explore any differences of perceived control and perceived value with relevance to the different school systems, class and gender.

Perceived control

A three-way ANOVA was conducted with perceived control as the dependent variable and school systems (Nationality: International school vs. Italian state school), class (3^{rd}, 4^{th} and 5^{th}) and gender (Male vs Female) as the independent variables. No statistically significant difference was found between school systems, class or gender. Thus, no main effects were found. However, the interaction between school system and class for perceived control was found to be statistically significant. As international school students advanced of grade so does their perceived control score. Whilst Italian state school students perceived control score remains constant though the different grade levels.

***Table 4.2.18**. Factorial ANOVA for Perceived Control*

	Mean Square	**Sum of Squares**	***F***	***P***
Nationality	28.90	28.90	3.30	0.070
Class	7.79	15.58	0.89	0.41
Gender	0.11	0.11	0.012	0.91
*Nationality*Class*	38.8	77.67	4.437	**0.013**
*Nationality*Gender*	0.056	0.056	0.006	0.94
*Class*Gender*	21.75	43.51	2.48	0.085
*Nationality*Class*Gender*	10.42	20.84	1.19	0.31

Perceived Value

A factorial ANOVA was conducted with perceived value as the dependent variable and school systems (Nationality: International school vs. Italian state school), class (3rd, 4th and 5th) and gender (Male vs Female) as the independent variables. A statistically significant difference between international schools and Italian state school in perceived value was found. Italian students have a higher perceived value score than international students (*Table 4.2.19.)*. Additionally, class differences in perceived value were found to be statistically significant. As students increase of grade level their perceived value decreases. Thus, school system and class were found to have significant main effects, however, no significant interaction was found. Furthermore, post-hoc tests corrected to Bonferroni Type-I error, were run to examine how the conditions differed from each other (*Table 4.2.20.)*. The difference between the conditions was found to be significant, hence Italian students display on average 4.12 points higher perceived value than international students.

***Table 4.2.19.** Factorial ANOVA for Perceived Value*

	Mean Square	**Sum of Squares**	***F***	***P***
Nationality	763.50	763.50	7.30	**0.007**
Class	772.85	1545.70	7.39	**<0.001**
Gender	2.02	2.02	0.019	0.89
*Nationality*Class*	13.40	26.80	0.13	0.88

*Nationality*Gender*	0.047	0.047	<0.001	0.98
*Class*Gender*	111.95	223.90	1.07	0.34
*Nationality*Class*Gender*	80.86	161.72	0.77	0.46

Table 4.2.20. *Bonferroni Post Hoc Test for Perceived Value*

		Mean Difference	95% CI Lower	95% CI Upper	SE	T	PBONF
International	*Italian*	-4.12	-7.12	-1.12	1.52	-2.70	0.007
3	*4*	4.40	1.06	7.73	1.41	3.12	0.006
	5	6.41	1.60	11.21	2.04	3.14	0.006
4	*5*	2.01	-2.88	6.90	2.07	0.970	1.00

4.3 Correlations

Lastly, to further investigate the third hypothesis, correlations between math achievement, math anxiety, perceived control, and perceived value for both school systems were conducted. Correlations are a statistical measure that describe the strength and direction of the relationship between two variables (Cohen, 2013). The most common type of correlation is the Pearson correlation coefficient, denoted as r, which ranges from -1 to 1. A correlation of r=1 indicates a perfect positive relationship, where when one variable increases the other also increases (Elliott & Woodward, 2014). Conversely, r = -1 indicates a perfect negative relationship, where increases in one variable are related with decreases in the other. A correlation of (r = 0) suggests no linear relationship between the variables (Elliott & Woodward, 2014). To interpret correlations, several indices and guidelines are commonly used such as the magnitude of correlation and significance testing (Cohen, 2013). The former refers to a series of thresholds that help to determine how strong a correlation is. Starting from 0.1 to 0.3 which is noted as weak correlation, then 0.4 to 0.6 would be a moderate correlation, followed by 0.7 to 0.9 which is a strong correlation and lastly, 0.9 to 1 which is a perfect correlation (Cohen, 2013). The latter is the significance of a correlation which is normally tested using p-value. A p-value less than 0.05 is considered to be statistically significant, indicating that the observed correlation is unlikely to have occurred by chance (Elliott & Woodward, 2014).

All math tasks were examined separately to observe the differences in correlation between math tasks and math anxiety, perceived control and perceived value. Thus, math competencies had statistically significant strong to moderate positive correlations between math fluency, written calculations, number reasoning and approximate calculations in both schools (Table 4.3). This signifies that if students performed batter in any of the math tasks their overall math competencies score would improve.

For both school systems, a weak statistically significant positive correlation was found between perceived control and mathematical competencies (r= 0.37; p<0.001; r= 0.33; p<0.001). Meaning that the higher the students perceived control the higher the mathematical competencies they display. Additionally, in both school systems, another weak statistically significant positive correlation was found between perceived control and math fluency (r= 0.36; p<0.001; r= 0.26; p<0.01). So, if students had a higher score in the math fluency task their perceived control would also be higher. However, for the written calculation task only two significantly weak correlations were found in the Italian sample; a positive one for perceived control (r= 0.35; p<0.001) and negative one for math anxiety (r= -0.20; p<0.05). The former, suggests as the Italian state school students written calculation score increases so those their perceived value. The latter, suggest that the lower the score in the written calculation task the higher the Italian state school student's maths anxiety. Moreover, in both school systems, an additional weak statistically significant positive correlation was found between perceived control and numerical reasoning (r= 0.25; p<0.01; r= 0.31; p<0.001). Therefore, the higher the numerical reasoning score the higher the students perceived control. Lastly, in both school systems, another weak statistically significant positive correlation was found between perceived control and approximate calculation (r= 0.28; p<0.01; r= 0.39; p<0.001). Therefore, the higher the students perceived control the higher the approximate calculation task. In only the Italian state school sample a weak statistically significant negative correlation was found between math anxiety and the approximate calculation task (*r*= -0.20; *p*<0.05). Meaning that the lower the score in the approximate calculation task the higher the Italian state school student's maths anxiety.

A weak statistically significant negative correlation was found between perceived control and math anxiety for international students (*r*= -0.37; *p*<0.001). Correspondingly, a moderate statistically significant negative corelation was found between perceived control and math anxiety for Italian students (*r*= -0.53; *p*<0.001). Thus, the lower the students perceived control the higher their math anxiety.

Similarly, a weak statistically significant negative correlation was found between perceived value and math anxiety for international students (*r*= -0.35; *p*<0.001). Also, a moderate statistically significant negative correlation was found between perceived value and math anxiety for Italian students (*r*= -0.46; *p*<0.001). Therefore, the lower the students perceived value score the higher the math anxiety.

In contrast, a moderate statistically significant positive correlation was found between perceived control and perceived value for both international (*r*=0.51; *p*<0.001) and Italian state school students (*r*=0.59; *p*<0.001). Meaning that as the students perceived control score increases so does their perceived value score.

Table 4.3 *Correlation table between Italian State school and international school students on math abilities*

	Mathematical Competencies	Math Fluency	Written Calculation	Numeric Reasoning	Approximate Calculation	Math Anxiety	Perceived Control	Perceived Value
Mathematical Competencies	--	*0.98****	*0.58****	*0.77****	*0.80****	-0.10	0.33***	0.10
Math Fluency	*0.97****	--	0.52***	*0.67****	*0.70****	-0.057	0.26**	0.083
Written Calculation	*0.62****	*0.54****	--	*0.43****	*0.41****	-0.20*	0.35***	0.029
Numeric Reasoning	*0.80****	*0.68****	*0.53****	--	*0.59****	*-0.10*	*0.31****	*0.13*
Approximate Calculation	*0.57****	*0.45****	*0.18*	*0.45****	--	*-0.20**	*0.39****	*0.108*
Math Anxiety	-0.083	*-0.062*	*-0.035*	*-0.051*	*-0.17*	--	*-0.53****	*-0.46****
Perceived Control	0.37***	*0.36****	*0.16*	*0.25***	*0.28***	-0.37***	--	*0.59****
Perceived Value	0.034	*0.029*	*-0.015*	*-0.006*	*0.10*	-0.35***	0.51***	--

Note: *Pearson's R correlation and P-value (*= P<0.05, ** = P<0.01, *** = P<0.001) are displayed for both international schools (Blue) and Italian State school (Red).*

Further interpretation of these results will be developed in the following chapter to draw meaningful conclusions and implications for future research.

Chapter 5 – Discussion

5.1 Math Abilities

As mentioned earlier, this research aims to understand the differences in the relationship between positive and negative emotions experienced during mathematical tasks and how these differences impact math attainment. The first hypothesis posits that international students will have higher math proficiency than Italian students. The results show that Italian students are better than the international students in all mathematical tasks. However, the difference in mathematical abilities between schools reduces as students advance grades. The reason for this is that international 3rd grade students' program is structured differently compared to Italian students. By the middle of the year, 3rd grade international students did not know how to solve multiplication with two digits. On top of that, long division was not yet covered in the program as it is normally introduced in 4th grade. This knowledge and attainment gap between the two schools reduces as the students advance grade levels. By the end of 5th grade, international school students will have covered all primary school math topics, thus catching up to the Italian state school program.

Furthermore, Italian state school students have higher math proficiency than international students. These results reflect the fact that Italian students are used to practicing and preforming these types of tasks more often than the international students. Especially as international students do not take as many tests as Italian students, and when they do, it is not always written out on pencil and paper. They have a work book provided to use jointly with the InnovaMat app. This explains why Italian students, in all three grade levels, performed much higher than international students on the written calculation task. However, as illustrated in the results for the approximate calculation task, international students in both 3rd and 5th grade, scored higher compared to the Italian state students. The reason behind this is that international students practice approximate calculations by learning how to break down operations into simple equations, thanks to the structure of the InnovaMat app. In some lessons, specifically when explaining 2-digit operations, InnovaMat breaks down the operation into simple terms for students. If the student does not understand how to do the operation correctly, even after explanation, the app will keep breaking it down for them into simple terms until the student completely grasps how to do it (InnovaMat Education, 2017). Overall students' math abilities vary between educational system; were a more traditional system in the early years of development achieves higher math performance compared to the modern teaching approaches. Though, by the end of primary school students' mathematical abilities are similar, suggesting that the modern teaching approaches, like using iPad, do help student performance in the long term.

5.1.1 Gender differences in mathematical abilities

In accordance with the literature found on gender differences in math performance, the results show that for both school's systems, females generally perform lower than males in mathematics. Countries with more gender-equal societies tend to have smaller gender gaps in math performance. Italy for instance is one of the countries with the greatest gender gap in math performance, (Matteucci & Mignani, 2011). Interestingly, the greatest gender difference in mathematics was found in the numerical reasoning task. 4th grade females scored signficantly lower than males. Cognitive development can vary significantly between individuals, and certain cognitive skills required for numerical reasoning may develop at different rates in boys and girls (Mammarella et al, 2017). Thus, female students might start to internalize gender stereotypes which would be affecting their confidence and performance.

By 5th grade, females' overall mathematical competencies are higher than that of males. Which goes to show, what many other studies have suggested, that females have the capability to do as good as, if not better than, males in maths but certain factors hinder them. Female students often have lower self-efficacy in mathematics compared to their male counterparts, which can affect their performance and willingness to engage with the subject (Xie & Liu, 2023).

5.2 Math Anxiety

The second hypothesis suggests that international students will have more positive math attitudes and lower negative attitudes towards math compared to Italian students. Findings show that math anxiety is lower in international students than Italian state school students. This can be attributed to several factors related to the educational environments and teaching methodologies prevalent in these different school systems. Firstly, the approach to teaching differs greatly as international schools often adopt progressive teaching methodologies that stimulate the apprehension of knowledge. Techniques such as project-based learning, collaborative group work, and the use of technology can make learning more engaging and less intimidating for students. The use of the iPad to learn and practice mathematics on a day-to-day basis drastically reduces students' negative perceptions of mathematics. Students learn thinking of it as more of a game which increases interest and decreases avoidance towards mathematics. Instead, the traditional teaching methods used in Italian state schools, which focus more on direct instruction and memorization, can sometimes lead to higher levels of anxiety, especially if students feel pressured to perform well on standardized tests.

Math anxiety can result in a poor performance on math-related tasks. However, as mentioned before, the Italian state students did significantly better in math tasks despite having higher math anxiety than international students. Hence, there is a possibility that the Italian state school students while preforming the math tasks, they were triggered and feelings such as failing a math test or making mistakes arose. These can lead to anxiety-like symptoms, nonetheless, it did not affect their performance but over time it could influence other areas of student's life.

5.2.1 Gender differences in math anxiety

In contrast with literature, no gender differences were found between both schools for math anxiety. As this study was conducted on primary school children, and most of the literature on the gender gap in math anxiety focuses on early to late adolescents, it suggests that the difference between females and males in math anxiety arise or become more prevalent after primary school (Tapia & Marsh, 2004). During primary school years, children do not feel the pressure to figure out who they are and what they excel at, they are able to enjoy learning freely. Math anxiety levels in middle school children should be explored to be able to determine when throughout development gender differences in math anxiety emerge. This could possibly help teachers determine how to best help students and reduce the gender gap, stimulating girls to undertake subjects in STEM.

5.3 Perceived Control and Perceived Value

After conducting an explorative analysis on perceived control and perceived value, interesting findings emerged. Firstly, it was found that Italian state school students perceived control score remined constant though different grade levels. Whilst, international school students perceived control increased as they advance grade. Perceived control is influenced by the involvement of the student in learning, therefore the fact the intentional students have iPads that help them work through problems and involve them in their own learning creates a greater feeling of interest towards math in them (Skinner, Wellborn & Connell, 1990). The fact that Italian state school students have to follow the state program very strictly, by using books, having to actively listen to teachers' explanation with little to no tactile work, does not allow them to be openminded or inspired learners.

Contrastingly, Italian students have a higher perceived value score than international students. Italian students assign a higher importance to maths a subject or related math tasks compared to international students. This is determined by their perceptions and emotions towards the subject. Normally, students with math anxiety will have lower perceived value as it is associated with feelings of stress, inadequacy or fear of the subject (Putwain, 2018). A possible explanation for this contrasting result is that international schools use a variety of assessment methods, including formative assessments, which provide ongoing feedback and help students improve continuously. This approach can reduce the fear of failure, build confidence and reduces the value students assign math. Italian state schools instead asses' students with, exams and oral tests, which can increase stress and anxiety among students, as their performance is often heavily judged and their grade is only based on a few high-stakes tests. Interestingly, 3rd grade international school students assigned more value to maths than other grade levels. This is perhaps due to developmental changes and teaching methods, as students grow older, they attribute less value to maths as they start to view maths as more of a game and less of daunting subject.

5.3.1 Gender differences in Perceived Control and Perceived Value

The findings show that international female students have a higher sense of control compared to their male counterparts. International schools often emphasize a supportive and inclusive educational environment. International schools implement strategies and practices aimed at reducing gender disparities (International Baccalaureate Organization, 2005). These can include encouraging female participation in STEM subjects, providing valuable role models, and offering mentorship programs. Such initiatives can enhance the perceived control of female students. In the early grades of primary school, positive reinforcement and encouragement can play a significant role in building their confidence. Female students in international schools might develop higher self-efficacy due to the positive feedback and recognition they receive. Female students who feel in control of their learning are likely to be more motivated, engaged, and persistent in their studies. The higher sense of control observed in international female students compared to their male counterparts can be attributed to a combination of educational environments and psychological factors. These elements collectively contribute to the building confidence and self-efficacy among female students, enabling them to feel more in control of their academic outcomes.

However, no gender differences were found for perceived value. International schools often strive to provide equal opportunities for all students, regardless of gender. This includes access to resources, encouragement from teachers, and participation in various academic and extracurricular activities. Such an environment can help ensure that both male and female students perceive the value of mathematics equally. In fact, the curriculum in international schools may be designed to be inclusive and engaging for all students. By presenting mathematics in a way that is relevant and interesting to both genders, schools can foster a similar level of perceived value among male and female students.

5.4 Correlations

To further investigate the third hypotheses various correlations were conducted. Results showed multiple statistically significant correlations for both samples and the various variables.

No significant correlations between math anxiety and any of the math tasks were found in the international sample. This finding despite not agreeing with literature, it concurs with the analysis conducted, as the international students have lower math anxiety score than Italian students. Meaning that the tasks presented to them did not arise any feelings of discomfort and stress. Contrastingly, in the Italian sample two tasks - written calculation and approximate calculation - were found to have a negative statically significant correlation with math anxiety. The lower the score in the tasks the higher the Italian state school student's maths anxiety (Hill et al, 2016). As mentioned previously, due to the strict nature of the Italian system students are expected to perform at a high level with minimum error thus preforming written calculations tasks can arise feelings of anxiousness in students. Not only that, but Italian students are not taught to approximate they are taught to always give the correct answer hence this task can cause negative attitudes in students or even enhance the pressure.

For both schools, all math tasks had a significant correlation with perceived control. Meaning that the higher the students perceived control the higher the mathematical competencies they display. So, if students had a higher score in either the math fluency, written calculation, numerical reasoning and approximate calculation task their perceived control would be higher. This is consistent with the findings reported, as helpful learning environment can foster enriched mathematical achievement over time (Tapia & Marsh, 2004).

Additionally, in both schools it was found that the lower the student's perceived control the higher their math anxiety. This finding is consistent with the literature reported on math anxiety and perceived control (Klee, Buehl, & Miller, 2021). As international school students' math anxiety is lower than Italian students their perceived control score is higher that their Italian counterparts.

Lastly, for both schools, as students perceived control score increased so did their perceived value score. Confirming the present literature on control-value theory which proposes that the two variables are related to higher math scores and are mediated by higher enjoyment and lower anxiety (Putwain, 2018). Overall, the positive environment and the use of technology has helped the international students reduce their negative feelings towards math tasks and positively adapt when facing a new challenge.

5.5 Limitations

One limitation of this study is that working memory tasks, such as forwards and backwards number recall, were not used to assess the difference in school systems and the effects on math attitudes. The mathematical tasks used (AC-FL and ACMT-3) are not comprehensively enough to capture the full range of cognitive processes involved in mathematical problem-solving. This could lead to an incomplete understanding of students' mathematical abilities; especially as different systems were examined. Mental math flexibility could differ between systems as Italian state school students are more used to doing oral expositions of mathematics than international students. While international school students are more prepared and engaged in mental maths thinking as they play a variety of games practicing these skills.

Longitudinal research is needed to better investigate the development of math anxiety and its effect on mathematics performance over time. This would provide a more dynamic view of how attitudes towards math evolve and influence academic outcomes. The study also selected a limited set of variables to investigate the hypotheses related to task value, control, math anxiety, and math ability tasks. This narrow focus may have overlooked other important factors that contribute to math performance, such as socio-economic status, parental involvement, and classroom environment. Including a broader range of variables in future research could provide a more rounded understanding of the factors influencing math performance. While the study provides valuable insights into the relationship between math attitudes and performance, its limitations highlight the need for more comprehensive and longitudinal research to fully understand the complexities of this relationship.

5.6 Further research

Future studies should look into exploring different variables related with negative and positive attitudes. Variables such as such as encouragement, improvement, avoidance should be measured to better understand how math performance can be affected by them. Additionally, more factors should be taken into account if comparing different school systems math performance, like difference economic status, parental involvement, and classroom environment and language of arrogation.

It would be interesting to further investigate the effect of teacher math anxiety on students. Based on the qualitative feedback given by the teachers that participated in this study, only one teacher seemed to the most engaged and motivated to teach mathematics, therefore having stronger protective factors. The rest either expressed directly they had anxiety regarding teaching maths or felt indifferent on the matter and preferred teaching other subjects. Teacher math anxiety can be indirectly conveyed to children, through the shared experience of not enjoying maths (Hadley & Dorward, 2011). This research should be expanded upon, due to the introduction of technology in schools. It would be interesting to see if this new technique reduces teachers' math anxiety and indirectly helps to reduce students' math anxiety.

The study underlines the importance of addressing math anxiety and fostering positive attitudes towards math to enhance students' mathematical abilities and overall academic achievement. It also highlights the need for comprehensive and longitudinal research to better understand the dynamic relationship between math attitudes and performance over time. Comparing international and Italian state school systems revealed that educational environments adopting a more open-minded and flexible approaches may better support positive math attitudes in mathematics. Schools should consider adopting more flexible and student-centred teaching methodologies to create a supportive learning environment. When students feel supported and engaged, they are more likely to develop a positive relationship with math, which can lead to improved performance and interest. Ultimately, a shift in education is needed to reduce the discrepancies between school systems in mathematics and promote a better learning environment for students.

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