MEDIATING ROLES OF MATHEMATICAL CREATIVITY AND ANXIETY ON THE RELATIONSHIP BETWEEN PSYCHOLOGICAL FACTORS AND MATHEMATICS ACHIEVEMENT AMONG 14 YEARS OLD SECONDARY SCHOOL STUDENTS

By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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Malaysia is a country that strives to provide quality education for all its citizens, fostering national identity and equipping students with 21st-century skills. Mathematics is a vital subject that develops students' logical thinking, problem-solving, and creativity skills. However, many students struggle with mathematics due to various psychological and emotional factors that affect their achievement and performance. This study aims to to determine the mediating role of mathematical creativity and anxiety on the relationship between psychological factors and mathematical achievement among 14 years old secondary school respondents in Selangor, Malaysia. Descriptive and correlational research design with mediation analysis were employed in this study. The sample of this study consist of 132 respondents aged 14 years old from public secondary schools in Selangor, Malaysia, selected through stratified random sampling. The instruments used for data collection are

questionnaire, Test of Mathematical Creativity, and Test of Mathematical Achievement. The reliability and validity if the instruments are between 0.732 to 0.977. Data were analyzed using SPSS v25 for descriptive statistics and SmartPLS v3.3.2 for Structural Equation Modelling (SEM). The results in this study demonstrated that students were reported to have higher level, intrinsic motivation, self-efficacy, mathematical belief and anxiety. On the other hand, mathematical achievement and mathematical creativity were found to be moderate. The major finding of the current study is that mathematical creativity significantly impacts mathematical achievement ($\beta=0.410$, $p < 0.001$) and has the biggest contribution towards mathematical achievement followed by self-efficacy ($\beta=0.288$, $p<0.05$) and anxiety ($\beta=-0.267$, $p<0.001$). Mathematical creativity also acts as a mediator in the relationship between anxiety and mathematical achievement ($\beta=-0.120$, $p<0.05$), introducing a novel theoretical perspective. Further analysis revealed that anxiety mediated the relationship between intrinsic motivation ($\beta=0.074$, $p<0.05$), self-efficacy ($\beta=0.162$, $p<0.05$) and belief ($\beta=-0.064$, $p<0.05$). It is evident that students' educational outcomes can be maximized through the development of effective interventions that target mathematical creativity and these psychological and emotional factors. Based on the study's findings, it was concluded that the influence of the selected variables in this study for 14 years old students' academic performance needed to be addressed for successful educational practice. This study provides a comprehensive understanding of the influences of these variables on mathematical achievement. This approach could shed light on how these variables collectively impact students' mathematics achievement. This study shows that enhancing self-efficacy can be highly effective in

improving mathematical achievement. It encourages students to believe in their own capabilities and empowers them to excel in their mathematical pursuits through dedicated effort and continuous learning. Conversely, anxiety emerges as a significant barrier, hindering mathematical achievement and underlining the urgency of addressing it in mathematics education. Moreover, the study suggests that fostering creative problem-solving skills and innovative thinking can counteract the detrimental effects of anxiety on achievement. Thus, rather than focusing solely on reducing anxiety, educational strategies could also concentrate on enhancing creativity as a pathway to improved achievement. This study recommends that educational institutions and stakeholders collaborate closely to create a holistic approach to Mathematics education that integrates these strategies. By doing so, students can be empowered to not only excel in mathematics but also to foster a generation of learners who are resilient, innovative, and capable of navigating the complexities of the future.

Keywords: Mathematics Achievement, Anxiety, Mathematical Creativity, Psychological Factor

SDG: Goal 4: Quality Education

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PERANAN PENGANTARA KREATIVITI MATEMATIK DAN KEBIMBANGAN TERHADAP PENCAPAIAN MATEMATIK DI KALANGAN PELAJAR BERUMUR 14 TAHUN SEKOLAH MENENGAH DI SELANGOR

Oleh

MARDIAH HAFIZAH BINTI MUHAMMAD HAFIZI

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Malaysia adalah sebuah negara yang berusaha untuk menyediakan pendidikan berkualiti bagi semua rakyatnya, memupuk identiti kebangsaan dan melengkapkan pelajar dengan kemahiran abad ke-21. Matematik adalah subjek penting yang membangunkan pemikiran logik, penyelesaian masalah, dan kreativiti pelajar. Namun, ramai pelajar menghadapi kesukaran dalam matematik disebabkan oleh kreativiti matematik serta pelbagai faktor psikologi dan emosi yang mempengaruhi pencapaian prestasi mereka. Kajian ini bertujuan untuk menentukan peranan pengantara kreativiti dan matematik kebimbangan dalam hubungan antara faktor psikologi dan pencapaian matematik di kalangan responden sekolah menengah berumur 14 tahun di Selangor, Malaysia. Rekabentuk penyelidikan deskriptif dan korelasi dengan analisis pengantaraan digunakan dalam kajian ini. Sampel kajian ini terdiri daripada 132 responden berumur 14 tahun dari sekolah menengah awam di Selangor, Malaysia, dipilih melalui persampelan rawak berstrata. Instrumen

yang digunakan untuk pengumpulan data adalah soal selidik, Ujian Kreativiti Matematik, dan Ujian Pencapaian Matematik. Kebolehpercayaan dan kesahan instrumen adalah antara 0.732 hingga 0.977. Data dianalisis menggunakan SPSS v25 untuk statistik deskriptif dan SmartPLS v3.3.2 untuk Pemodelan Persamaan Struktur (SEM). Dapatan kajian ini menunjukkan bahawa pelajar dilaporkan mempunyai tahap yang tinggi bagi motivasi intrinsik, efikasi kendiri, kepercayaan matematik dan kebimbangan. Sebaliknya, pencapaian matematik dan kreativiti matematik didapati sederhana. Kajian ini juga mendedahkan bahawa kreativiti matematik ($\beta=0.410$, $p < 0.001$) memberikan sumbangan terbesar terhadap pencapaian matematik diikuti efikasi kendiri ($\beta=0.288$, $p<0.05$) dan kebimbangan ($\beta=-0.267$, $p<0.001$). Analisis lanjut menunjukkan bahawa kebimbangan menjadi pengantara dalam hubungan antara motivasi intrinsik ($\beta=0.074$, $p<0.05$), efikasi kendiri ($\beta=0.162$, $p<0.05$) dan kepercayaan ($\beta=-0.064$, $p<0.05$). Kreativiti matematik ($\beta=-0.120$, $p<0.05$) juga menjadi pengantara dalam hubungan antara kebimbangan dan pencapaian matematik. Adalah jelas bahawa hasil pendidikan pelajar boleh dimaksimumkan melalui pembangunan intervensi yang berkesan yang menumpukan kepada kreativiti matematik serta faktor-faktor psikologi dan emosi ini. Berdasarkan dapatan kajian, dapat disimpulkan bahawa pengaruh pemboleh ubah yang dipilih dalam kajian ini terhadap prestasi akademik pelajar perlu ditangani bagi amalan pendidikan yang berjaya. Kajian ini memberikan pemahaman yang menyeluruh tentang pengaruh pembolehubah ini terhadap pencapaian matematik. Pendekatan ini dapat memberi penjelasan tentang bagaimana pembolehubah ini secara kolektif memberi kesan kepada pencapaian matematik pelajar. Kajian ini

menunjukkan bahawa meningkatkan efikasi kendiri boleh menjadi sangat berkesan dalam meningkatkan pencapaian matematik. Ia menggalakkan pelajar untuk mempercayai keupayaan mereka sendiri dan memperkasakan mereka untuk cemerlang dalam proses pembelajaran matematik mereka melalui usaha yang tekun dan pembelajaran berterusan. Sebaliknya, kebimbangan muncul sebagai penghalang utama, menghalang pencapaian matematik dan harus diberi penekanan dalam pendidikan matematik. Selain itu, kajian mencadangkan bahawa memupuk kreativiti matematik boleh menjadi strategi yang berkesan untuk mengurangkan kesan negatif kegelisahan terhadap prestasi matematik pelajar. Oleh itu, selain daripada hanya memberi tumpuan kepada mengurangkan kebimbangan, strategi pendidikan juga boleh memberi tumpuan kepada meningkatkan kreativiti dalam menigkatkan pencapaian akademik. Kajian ini mengesyorkan agar institusi pendidikan dan pihak berkepentingan bekerjasama rapat untuk mewujudkan pendekatan holistik kepada pendidikan Matematik yang mengintegrasikan strategi-strategi ini. Dengan melakukan demikian, pelajar dapat diperkasakan tidak hanya untuk cemerlang dalam matematik tetapi juga untuk memupuk generasi pelajar yang bersifat daya tahan, inovatif, dan mampu mengemudi kerumitan masa hadapan.

Kata Kunci: Pencapaian Matematik, Kebimbangan, Kreativiti Matematik, Faktor Psikologi

SDG: MATLAMAT 4: Pendidikan Berkualiti

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In the name of Allah, the Most Gracious, the Most Merciful,

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

KBSM	Integrated Secondary School Curriculum
KSSM	Standard Curriculum for Secondary Schools
TIMSS	Trends in International Mathematics and Science Study
STEM	Science, Technology, Engineering and Mathematics
PISA	Programme for International Students Assessment
SEM	Structural Equation Modelling
PLS-SEM	Partial Least Squares Structural Equation Modelling
SDT	Self Determination Theory
SCT	Social Cognitive Theory
IM	Intrinsic Motivation
SE	Self-Efficacy
MB	Mathematical Belief
AN	Anxiety
MAc	Mathematical Achievement
MCr	Mathematical Creativity
UPSR	*Ujian Pencapaian Sekolah Rendah*

remained unsatisfactory (OECD, 2016). Also, the disposition of eighth-grade (14 years old) Malaysian students towards mathematics underwent a notable change between TIMSS 2011 and TIMSS 2015. There was a significant decrease in the percentage of students who expressed a strong liking for learning mathematics, dropping from 39% to 28% during this period. Furthermore, there was a modest increase in the percentage of students who indicated that they did not like learning mathematics, rising from 15% in 2011 to 16% in 2015 (Martin et al., 2017). These students are at a critical stage of their mathematical development and learning. They are also exposed to a variety of mathematical topics that cover different strands of the mathematics curriculum.

Table 1.1: Mean performance score of Programme for International Student Assessment (PISA) (MOE, 2021)

Year	Mathematics
2012	421
2015	446
2018	440
OECD Average (2018)	489

This pivotal stage in their education not only sets the foundation for advanced mathematical concepts but also influences their future academic and career choices. While some students demonstrate strong mathematical competencies, others struggle with foundational mathematical concepts and problem-solving skills. Students face difficulties in applying existing knowledge to non-routine and complex problems (Abdullah, 2018). Structure of questions demand students to interpret and reflect along with real-life assessments are

among the factors contributing to the unsatisfactory performance demonstrated by Malaysian students (Abdullah et al., 2014).

Considering these challenges, fostering mathematical creativity has emerged as an emerging priority in Malaysian mathematics education. The inclusion of mathematical creativity as a distinct variable in this study reflects the recognition of its unique role in shaping students' performance and success in mathematics (Ayvaz & Durmus, 2021). Moreover, it has also become one of the most discussed skills in this 21st century because of the important role in determining students' educational status (Valverde et al., 2020). Research suggests that fostering creativity in mathematics education can lead to improved learning outcomes and problem-solving abilities(Csikszentmihalyi, 1996). Creativity is the essence of growth and can be counted as part of the pillar in the current educational pedagogy.

Integrating opportunities for creative exploration and discovery in mathematics classrooms can enhance students' engagement, motivation, and confidence in their mathematical abilities. Creativity is related to Mathematics since it is vital when students try to solve unfamiliar mathematical problems (Leikin et al., 2013). It goes beyond conventional problem-solving techniques and encourages students to think outside the box, make connections between concepts, and approach mathematical tasks with originality (Liljedahl & Sriraman, 2006). Creative problem-solving skills are essential for navigating real-world challenges and fostering innovation in various fields. Investigating

the impact of mathematical creativity is an essential step toward a more holistic understanding of education in today's dynamic world.

Students' achievement is determined by how well they meet established learning objectives, typically evaluated through test scores and continuous assessments. However, the traditional measures of student achievement, primarily based on test scores and ongoing assessments, offer only a partial understanding of the complex factors that contribute to student success. When students struggle to see the relevance and applicability of their mathematical skills to real-world situations, their belief in their own abilities to tackle such challenges may wane. This can lead to anxiety, as students feel ill-equipped to handle the demands of these assessments, which, in turn, negatively impacts their mathematical achievement (Abdullah, 2018). In addition to mathematics achievement, TIMSS and PISA assessments shed light on students' psychological factors towards mathematics learning in Malaysia. While some students exhibit enthusiasm and confidence in their mathematical abilities, others experience anxiety and negative emotions when engaging with mathematical tasks. Negative emotion such as mathematical anxiety is a common issue among students and has been found to negatively impact mathematical achievement (Du et al., 2021).

Addressing mathematics anxiety is crucial for creating inclusive and supportive learning environments that empower all students to succeed in mathematics. Anxiety is defined as a negative emotional state that is associated with feelings of nervousness, worry, and fear (Ashcraft & Moore, 20091). This emotional

state can impair students' cognitive processes, including memory, attention, and problem-solving, while also diminishing their motivation and self-confidence (Ma, 19992). When students experience high levels of anxiety related to mathematics, it can significantly impede their cognitive functioning and problem-solving abilities. According to Ashcraft & Kirk (2001), anxiety consumes cognitive resources, impair working memory, and create a negative cycle that affects performance (Ashcraft & Kirk, 2001). Therefore, addressing anxiety and creating a supportive learning environment that reduces anxiety can positively impact students' engagement, participation, and performance in mathematics.

In general, educators and researchers agree that Mathematics learning is not limited to the understanding and applying mathematical concepts and procedures but also require the growth of a student's psychological aspects towards Mathematics (Zhang et al., 2020). Research has indicated that non-cognitive factors, particularly psychological ones, significantly affect student behavior, especially in the fields of science and, more specifically, mathematics (Dianabasi et al., 2017). These factors encompass aspects such as intrinsic motivation, self-efficacy, and belief in the subject matter. Numerous studies have been conducted to investigate the factors that influence academic achievement in Mathematics (Herges et al., 2017; Tee et al., 2019).

According to McLeod (1992), when students engage as active learners in mathematics and enthusiastically tackle non-routine problems, their affective responses toward mathematics become significantly more pronounced

compared to situations where they are simply required to attain acceptable levels of proficiency in basic computational skills (McLeod, 1992). Psychological factors are internal factors that influence students' attitudes, emotions, and behaviors in learning mathematics. A number of studies revealed that psychological and emotional variables such as intrinsic motivation , self-efficacy (Pajares & Miller, 1994), mathematical belief , anxiety are influential on students' mathematical achievement.

Intrinsic motivation, recognized as crucial factor in shaping students' attitudes and behaviors towards mathematics (Ryan & Deci, 2000a). drives students to engage in mathematical tasks for the inherent satisfaction and enjoyment they experience, rather than external rewards or pressures. Students who are intrinsically motivated tend to approach mathematical tasks with curiosity, persistence, and a desire for mastery. They are more likely to invest effort and exhibit a positive attitude towards mathematics, leading to better learning outcomes and improved mathematical achievement.

Self-efficacy, which known as the belief in one's own ability to perform mathematical tasks successfully plays a pivotal role in students' approach to mathematical challenges. Students with higher levels of self-efficacy tend to approach mathematical challenges with confidence and are more likely to persist in their efforts to overcome difficulties. Mathematical belief is the set of assumptions, values, and expectations that students hold about mathematics and themselves as mathematics learners. Students' beliefs about mathematics significantly influence their problem-solving approaches, the selection of

strategies, and their persistence levels when engaging with mathematical challenges (Schoenfeld, 1985a). Research conducted by previous scholars has reported that students' belief on mathematics could predict mathematics achievement (Bakar et al., 2019). Students who maintain positive beliefs about mathematics are likely to enhance their problem solving strategies and solve mathematics problem accurately (Mason & Scrivani, 2004).

Kamalimoghaddam (2016) proposed that strong self efficacy and mathematical belief will influence mathematics achievement positively. Given that solving problem in mathematics require students' perseverance and confidence, fostering self-efficacy and mathematics belief becomes particularly very important (Ozturk & Guven, 2016). Therefore, fostering and enhancing students' mathematical beliefs and self-efficacy can be key components of effective mathematics education strategies, ultimately contributing to improved mathematics achievement. These psychological factors can either enhance or hinder students' mathematics achievement. Recognizing the impact of these psychological factors is essential for developing holistic approaches to education that support students in reaching their full potential and achieving meaningful learning outcomes beyond mere performance on standardized tests. By understanding and addressing these underlying influences, educators can create more inclusive and efficient learning environments tailored to the diverse needs and strengths of students.

Against the backdrop of Malaysia's mathematics education landscape, the current research aims to explore the mediating roles of anxiety and

mathematical creativity in shaping students' mathematics learning experiences and outcomes. By contextualizing findings within the Malaysian educational context, the study seeks to identify effective strategies and interventions to support students' mathematics achievement and well-being. Moreover, by examining the interplay between psychological factors, such as intrinsic motivation, self-efficacy, and mathematical beliefs, and students' mathematics achievement, the research aims to inform evidence-based practices that promote positive attitudes and engagement in mathematics among Malaysian students. Addressing the effect of mathematical anxiety and nurturing mathematical creativity can empower students to develop critical thinking skills and become confident problem solvers in an increasingly complex and interconnected world. However, there is a lack of research on how anxiety and mathematical creativity may mediate this relationship, especially among 14 years old secondary school students. Therefore, this research aims to fill this gap by examining the mediating roles of anxiety and mathematical creativity on the relationship between psychological factors and mathematics achievement among this group of students.

1.2 Problem Statement

Globally, many researchers have shown poor mathematics achievement among students and have explored various factors contributing to ineffective comprehension and justification for the inadequate mathematical achievement among learners. Mathematics is a fundamental subject that forms the basis for many other disciplines, including science, technology, engineering, and

economics. Poor mathematics achievement is a significant problem with wide-ranging implications. Apart from limiting educational and career opportunities, it impedes the cultivation of crucial skills like critical thinking and problem-solving, which are indispensable for addressing contemporary challenges. As mentioned earlier, according to TIMSS and PISA, mathematics performance among 14 years old students is declining. This trend underscores the urgency of understanding the factors influencing mathematics achievement among students in this age group.

In Malaysia, fostering mathematical creativity has emerged as a critical priority in mathematics education. Students often struggle with reasoning skills, especially when it comes to applying their existing knowledge to non-routine and complex problems that require them to interpret, reflect upon, and apply their existing knowledge to real-life situations (Abdullah, 2018). It is important to note that all these activities require a certain level of creativity. Mathematical creativity refers to the ability to approach mathematical problems from novel perspectives, make connections between diverse mathematical concepts, and generate innovative solutions. Lack of creativity can significantly impact their mathematical achievement (Grégoire, 2016) as creativity is a valuable asset in the realm of mathematics (Kozlowski & Si, 2019; Liljedahl & Sriraman, 2006). Leikin (2009) suggests that mathematical creativity plays a pivotal role in promoting deeper conceptual understanding, enhancing problem-solving skills, and fostering intrinsic motivation among students. Furthermore, Sternberg and Lubart (1999) argue that nurturing mathematical creativity can cultivate students' curiosity, resilience, and perseverance in the face of

mathematical challenges, thereby promoting positive attitudes towards mathematics and increasing students' overall engagement with the subject.

However, its integration into Malaysian mathematics education practices is limited, with traditional methods emphasizing memorization and standardized assessments potentially stifling creativity. Moreover, the intricate interplay between mathematical creativity, anxiety, and other psychological factors in the Malaysian context remains underexplored. This research seeks to address these gaps by investigating the role of mathematical creativity in shaping students' attitudes, motivation, and performance in mathematics within the Malaysian secondary school context. Through a comprehensive exploration of mathematical creativity, educators and policymakers can develop innovative instructional strategies, curricular approaches, and assessment practices that prioritize creativity in mathematics education. By embracing creativity as a cornerstone of mathematics learning, Malaysian secondary schools can empower students to approach mathematical challenges with confidence, curiosity, and ingenuity, thereby cultivating a new generation of mathematically literate and innovative thinkers poised to thrive in the 21st century.

Another factors that can affects mathematical achievement is anxiety, which is defined as a negative emotional state triggered by situations involving mathematics (Ashcraft, 2002). Despite concerted efforts to enhance mathematics instruction and curriculum design, many Malaysian students continue to struggle with mathematics anxiety, hindering their ability to engage effectively with mathematical concepts and tasks (Gopal et al., 2020). Anxiety

can impair cognitive processes, such as working memory and attention, that are essential for mathematical reasoning and problem-solving (Ashcraft & Kirk, 2001; Ashcraft & Moore, 2009). Mathematics anxiety presents a pervasive challenge that significantly impacts students' academic experiences and outcomes (Cargnelutti et al., 2017; Szczygieł, 2020). It can be characterized by heightened levels of fear, apprehension, and discomfort when engaging with mathematical tasks, concepts, and assessments.

For many students, the mere thought of solving mathematical problems or participating in math-related activities can evoke feelings of dread and insecurity, leading to avoidance behaviors and diminished performance (Ashcraft & Moore, 2009). The existence of mathematics anxiety among Malaysian secondary school students underscores the urgency of understanding its underlying causes and implications within the educational context (Zakaria et al., 2012). Mathematics anxiety not only impedes students' ability to effectively engage with mathematical content but also erodes their confidence and self-efficacy in the subject.

Furthermore, mathematics anxiety can have far-reaching consequences beyond academic performance, affecting students' overall well-being and psychological health. Rozek et al. (2015) underscored that those who encounter difficulties with Mathematics are at higher risk of dropping out of school or avoid career related to mathematics (Rozek et al., 2015). This correlation between mathematical challenges and career decisions is particularly concerning given the current landscape in Malaysia, which reflects

a discouraging trend in the pursuit of science-based disciplines among Malaysian youths. As shown in Figure 1.1 below, the present situation in Malaysia illustrates that the number of Malaysian youths who choose to pursue science-based subject is far less encouraging (MOE, 2021). The number of students enrolled in science stream subjects (including science, mathematics, physic, biology) and technology subjects in Malaysia decreased from 2019 to 2021. This trend underscores the urgency of addressing mathematics anxiety and its broader implications, as persistent experiences of anxiety may not only undermine academic performance but also deter students from pursuing advanced coursework and careers in science related fields.

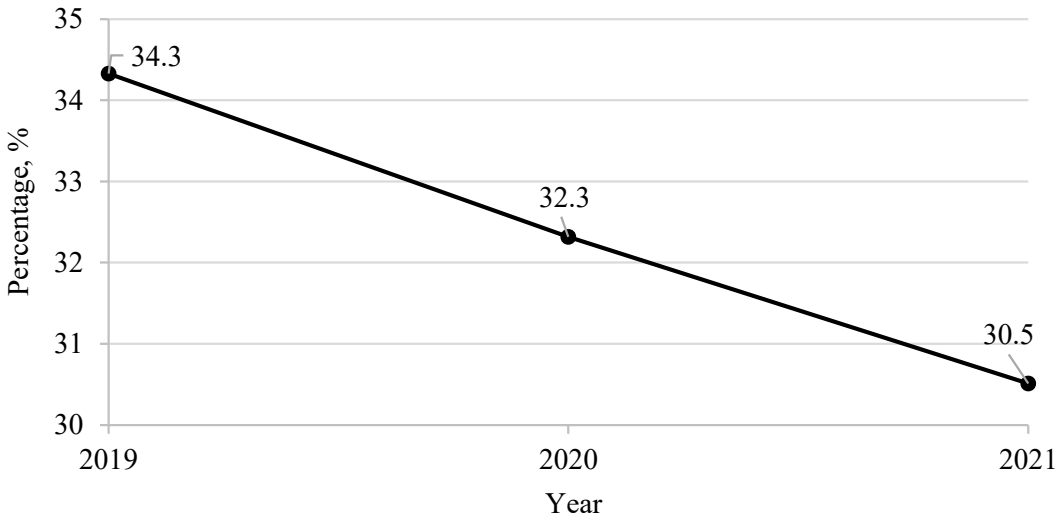

Figure 1.1: Form 5 (Grade 11) Enrolment for Science and Technology Subjects in Malaysia (MOE, 2021).

Despite the recognition of mathematics anxiety as a significant barrier to learning, there remains a gap in understanding how it interacts with other psychological factors and influences students' mathematics achievement. This research seeks to address this gap by investigating the mediating roles of

anxiety and its impact on students' attitudes, motivation, and performance in mathematics within the Malaysian secondary school context.

Research findings also consistently underscore the critical role of psychological factors such as intrinsic motivation, self-efficacy, and mathematical belief in shaping students' mathematical achievement (Bandura, 2001; Du et al., 2021; Ryan & Deci, 2000a). However, despite their significance, many students struggle with intrinsic motivation, self-efficacy, and mathematical belief, leading to suboptimal mathematical achievement levels. This issue is critical to address as it not only hampers individual academic success but also undermines the broader goals of mathematics education and students' long-term prospects in science-related fields. These factors can influence how students' approach, engage, and perform mathematics tasks.

Students who possess strong intrinsic motivation to learn mathematics demonstrate a natural curiosity and enthusiasm for the subject (Deci & Ryan, 2015; OECD, 2013). They actively seek opportunities to explore mathematical concepts and persevere through challenges. The impact of intrinsic motivation on students' mathematical achievement extends beyond the immediate academic context; it serves as an internal engine that propels them towards higher levels of mathematical achievement (Habók et al., 2020; Herges et al., 2017). As student progress through their educational journey and into adulthood, intrinsic motivation empowers them to become self-directed learners. They take initiative in seeking out mathematical challenges, exploring

new areas of mathematics, and furthering their mathematical knowledge independently (Deci & Ryan, 1985).

Similarly, it was suggested that students with high self-efficacy and positive belief about mathematics perform better in mathematics (Pajares & Miller, 1994). Self-efficacy, or an individual's belief in their own ability to accomplish specific tasks, plays a fundamental role in determining their approach to mathematics. When students possess a strong sense of self-efficacy in mathematics, they are more likely to approach mathematical challenges with confidence and determination.

Mathematical belief or sometimes refer to belief about the nature of mathematics, is especially important in mathematics learning because they affect students' participation in the learning activities and their performance in mathematics (Bakar et al., 2019). These beliefs encompass students' attitudes towards mathematics, their perceptions of its utility, and their confidence in their mathematical abilities. Positive mathematical beliefs can inspire greater engagement in mathematics, leading to improved learning outcomes. Thus, it is thus essential to understand and explore how students learn Mathematics, interact with their surrounding and build certain positive or negative beliefs, attitudes and values which will lead to success or failure in achieving Mathematics.

As a conclusion, the existing research landscape concerning mathematics achievement among secondary students has extensively explored the

influence of various psychological factors, including such as intrinsic motivation, self-efficacy, and mathematical beliefs. However, a critical gap persists in our understanding of the nuanced interactions between these psychological factors and academic performance, particularly among 14-year-old secondary students. Despite extensive research on psychological factors influencing mathematics achievement among secondary students, there remains a critical gap in understanding the mediating roles of mathematical creativity and anxiety in this relationship, particularly among 14-year-olds. Mathematical creativity positively impacts mathematics learning while anxiety lessen it, yet empirical evidence on their mediating roles is lacking. Understanding how mathematical creativity and anxiety interact is crucial for developing effective interventions to support students' mathematics achievement and well-being.

Therefore, this study intends to provide a comprehensive understanding on the direct and indirect relationship between, intrinsic motivation, self-efficacy, mathematical belief, anxiety, mathematical creativity, and mathematical achievement. This study also addresses the lack of empirical evidence on how mathematical creativity and anxiety mediate the effect of these variables on mathematical achievement among 14 years old students in Selangor.

1.3 Research Objectives

The general objective of this study is to determine the mediating role of anxiety and mathematical creativity on the relationship between psychological factors

and mathematical achievement among 14 years old secondary school students.

Specifically, there are five objectives of the current research which are:

1. To identify the students' level of mathematical creativity, intrinsic motivation, self-efficacy, mathematical belief, anxiety, and mathematical achievement
2. To determine the influence of intrinsic motivation, self-efficacy, mathematical belief, and anxiety on mathematical achievement.
3. To determine the influence of mathematical creativity on mathematical achievement.
4. To determine if mathematical creativity mediates the relationship between intrinsic motivation, mathematical beliefs, self-efficacy, anxiety, and mathematical achievement.
5. To determine if anxiety mediates the relationship between intrinsic motivation, mathematical beliefs, self-efficacy, and mathematical achievement.

1.4 Research Hypotheses

Based on the relevant related literature, the major hypotheses of this study include the following:

H_1: There is positive relationship between intrinsic motivation towards mathematical achievement.

H_2: There is positive relationship between self-efficacy towards mathematical achievement.

H_3: There is positive relationship between mathematical beliefs towards mathematical achievement.

H_4: There is negative relationship between anxiety towards mathematical achievement.

H_5: There is positive relationship between mathematical creativity towards mathematical achievement.

H_6: Mathematical creativity mediates the relationship between intrinsic motivation and mathematical achievement.

H_7: Mathematical creativity mediates the relationship between self-efficacy and mathematical achievement.

H_8: Mathematical creativity mediates the relationship between mathematical beliefs and mathematical achievement.

H_9: Mathematical creativity mediates the relationship between anxiety and mathematical achievement.

H_{10}: Anxiety mediates the relationship between intrinsic motivation and mathematical achievement.

H_{11}: Anxiety mediates the relationship between self-efficacy and mathematical achievement.

H_{12}: Anxiety mediates the relationship between mathematical beliefs and mathematical achievement.

1.5 Research Questions

Based on the research objectives, the research questions of this study include the following:

1. What are the levels of students' mathematical creativity, intrinsic motivation, self-efficacy, mathematical belief, anxiety and mathematical achievement?
2. To what extent intrinsic motivation influence mathematical achievement?
3. To what extent self-efficacy influence mathematical achievement?
4. To what extent mathematical belief influence mathematical achievement?
5. To what extent anxiety influence mathematical achievement?
6. Does mathematical creativity influence mathematical achievement?
7. Does mathematical creativity mediate the relationship between intrinsic motivation, self-efficacy, mathematical belief and anxiety and mathematical achievement?
8. Does anxiety mediate the relationship between intrinsic motivation, self-efficacy, mathematical belief and mathematical achievement?

1.6 Significance of the Study

In the 21st-century worldwide economy, it is essential for students to have a good working knowledge of Mathematics in order to be success in education as well as competing for jobs later. The outcomes from this study could have important implications for the teaching profession and the education sector. The outcomes of the study will support towards the advancement of new educational framework that encompasses 21st-century skills especially in the

field of Mathematics. Several key variables have been identified and their correlations with Mathematics academic achievement have been established. This framework expands the current literature on various factors associated with mathematical creativity, intrinsic motivation, self-efficacy, mathematical belief, anxiety and mathematical achievement. This study also intends to verify mathematical creativity and anxiety as a possible mediator to extend the body of knowledge of in the study related to mathematical achievement. The findings of this study could promote a greater understanding of various determinants or factors influencing Mathematics achievement. The examination of these factors involved the analysis of the link among various variables. The findings may have implications for developing interventions and strategies that promote positive attitudes, reduce anxiety, nurture mathematical creativity, and ultimately enhance mathematics achievement among 14 years old secondary school students.

Also, this study includes the impact of mathematical creativity on students' mathematical achievement. The study on students' creativity in Mathematics is necessary as we can help future generation of students and educators to apply their mathematical skills in many ways and produce numerous solutions by expanding their understanding of mathematical ideas not just based on memorization of facts, drills and practices but by thinking creatively.

The priority of this study is not to generalize the study findings, but rather to provide a background for future studies to further explore this topic from different contexts and using different approaches. It also explores a potential

expansion to the body of knowledge due to the limited previous studies on the applicability of the Partial Least Square Structural Equation Modelling (PLS-SEM) in Mathematics educational context especially in Malaysia. Thus, this study can provide a significant contribution to the development of a new framework to enhance Malaysian students' mathematical achievement.

1.7 Limitation of the Study

This study has several limitations, and these should be considered by readers carefully as they interpret the results. First, the study will only be limited and focused on 14 years old students in Selangor. In this case, the results may not be applicable to other disciplines and different age groups. Therefore, the results may not be directly applicable to students in other regions or age groups, potentially limiting the generalizability of the findings.

Second, this study only covers two learning areas of Mathematics which are numbers and algebra; measurement and geometry for 14 years old mainly from mathematics KSSM syllabus. This narrow scope may not account for the full range of mathematical topics and concepts that students encounter in their curriculum.

Third, the study primarily investigates the influence of students' mathematical creativity, intrinsic motivation, self-efficacy, mathematical belief, and anxiety on mathematical achievement. While these factors are important, there are other variables that could impact mathematical achievement, including gender, socioeconomic status, prior mathematics achievement, and school

experiences. The omission of these potential influencers may limit the comprehensiveness of the study's conclusions.

Fourth, the sample size used in this study, consisting of 132 participants, falls within the recommended range for structural equation modeling. However, it is important to acknowledge that the sample size may have played a role in the failure of some model parameters to reach statistical significance.

Fifth, data collection was done in 2021 the midst of pandemic Covid 19 which introduced additional challenges. School closures, uncertainty about the opening of schools, inconsistent student attendance due to health concerns, and difficulties in accessing schools due to quarantine measures may have affected the data collection process. Long quarantine periods have delayed a lot of time and sometimes outsiders were not allowed in the schools which make it more difficult to collect more data.

Lastly, the study acknowledges the possibility of variations in students' interpretations of survey questions, potentially influenced by their temporary feelings during data collection. These variations in interpretation could introduce some degree of response bias and impact the study's conclusions. Overall, while this study offers valuable insights, readers should be cautious of these limitations when interpreting and applying the findings to wider educational contexts.

1.8 Conceptual and Operational Definition

In the context of this study, the following key terms are defined theoretically and operationally as follows:

1.8.1 Intrinsic Motivation

In this study, intrinsic motivation refers to a situation in which a person performs an activity solely for the enjoyment of doing it, in which the activity itself is the motivation and not for any reward (Deci & Ryan, 1985). Intrinsic motivation is measured through self-reports of interest and enjoyment of the activity during the study is administered.

1.8.2 Self-efficacy

In this study, self-efficacy is a person's belief of their capability to act in a specific way to achieve a particular goal (Bandura, 1994). Within the context of this study, self-efficacy refers to students' belief of their capability to successfully perform or accomplish a particular mathematical task or problem.

1.8.3 Mathematical Belief

Mathematical belief in this study refers to students' beliefs about the nature of Mathematics. Beliefs are typically shaped via personal experience or through learning about the experiences of others (Bandura, 1971) and, accordingly,

mathematical beliefs are formed from personal experience, or other people experiences with Mathematics.

1.8.4 Anxiety

Anxiety in this study refer to anxiety in which students feel when dealing with Mathematics. Anxiety can be defined as tension, nervousness or fear that can affect mathematical achievement (Ashcraft, 2002).

1.8.5 Mathematical Achievement

In this research context, mathematical achievement refers to the score from pen and pencil test called Mathematics Achievement Test. The score from the test will be used to measure the students' mathematical knowledge and skills on the stated learning areas in Mathematics. In this study, it covers two learning areas which are: numbers and algebra; measurement and geometry.

1.8.6 Mathematical Creativity

The degree to which a person can produce several solutions to mathematical problems; used for mathematical creative problem solving (Sriraman, 2004). It is described as the process leading to uncommon or insightful solutions to a particular problem or analogy, and the formulation of different problems and alternatives that enable an existing problem to be considered from a different perspective that requires imagination equivalent to those for creativity in professional. Mathematical creativity in this study will be described based on

these three components which are Fluency, Flexibility, Originality (Leikin & Lev, 2013; Mann, 2005; Sitorus & Masrayati, 2016).

1.9 Summary

This chapter presented the study with a short description of the background and context. It was supported by related literature to identify the research gaps. This was then presented in the problem statement which led to the development of research questions, hypotheses and objectives. Subsequently, the significances of the study were elaborated and linked to the next section which provides the limitations of the study. The last part of this chapter outlines the operational definition of the key terms used in the study. In Chapter 2, literature review on factors related to mathematical achievement are discussed.

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