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Psychological Determinants of Mathematical Performance in Palestinian Eighth-Graders: A Structural Equation Model

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Abstract: Objectives: This study investigates the combined influence of perceived self-efficacy, motivation, attitudes, anxiety, and enjoyment on mathematical performance using Structural Equation Modeling (SEM). **Methods:** A cross-sectional study of 439 eighth-grade students from Palestinian public schools was conducted using stratified random sampling. **Results:** The initial model displayed poor fit indices ($\chi^2 = 181.10$, RMSEA = .16), prompting modifications. Adding a significant path from anxiety to enjoyment and removing an insignificant path from attitudes to enjoyment improved the model's fit ($\chi^2 = 1.05$, RMSEA = .01). The revised model showed intrinsic motivation positively impacted attitudes ($\beta = .468$, $p < .001$) and enjoyment ($\beta = .116$, $p < .001$) while reducing anxiety ($\beta = -.304$, $p < .001$). Self-efficacy positively influenced attitudes ($\beta = .142$, $p = .003$) and enjoyment ($\beta = .268$, $p < .001$) while lowering anxiety ($\beta = -.367$, $p < .001$). Anxiety negatively affected both enjoyment ($\beta = -.557$, $p < .001$) and performance ($\beta = -.126$, $p = .004$). Attitudes ($\beta = .098$, $p = .002$) and enjoyment ($\beta = .121$, $p = .01$) positively affected performance. **Conclusions:** Motivation and self-efficacy also had significant positive effects on performance.

Keywords: Mathematical Performance, Perceived Self-Efficacy, Mathematics Motivation, Attitudes Towards Mathematics, Enjoyment in Mathematics, Anxiety in Mathematics, Structural Equation Modeling (SEM).

العوامل النفسية المحددة للأداء في الرياضيات لدى طلبة الصف الثامن الفلسطينيين: نمذجة العلاقات البنائية

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الملخص: الأهداف: تهدف هذه الدراسة إلى الكشف عن التأثير المشترك لكل من الكفاءة الذاتية المدركة والدافعية والاتجاهات والقلق والاستمتاع في الأداء في مادة الرياضيات باستخدام نمذجة العلاقات البنائية (SEM). **المنهجية:** أتبعت الدراسة المنهج الوصفي الارتباطي، وشملت عينة الدراسة (439) طالبًا من طلبة الصف الثامن في المدارس الحكومية الفلسطينية، وتمّ اختيار العينة بأسلوب العينة العشوائية الطبقية. **النتائج:** أظهر النموذج الأولي مؤشرات مطابقة ضعيفة ($\chi^2 = 181.10$, RMSEA = .16) مما استدعى إجراء تعديلات على النموذج النظري المقترح، وقد أدى إضافة مسار دال إحصائياً من القلق إلى الاستمتاع، وإزالة مسار غير دال إحصائياً من الاتجاهات إلى الاستمتاع، إلى تحسين مطابقة النموذج ($\chi^2 = 1.05$, RMSEA = .01)؛ إذ أظهر النموذج المعدل أن الدافعية الداخلية أثرت إيجابيًا على الاتجاهات ($\beta = .468$, $p < .001$) والاستمتاع ($\beta = .116$, $p < .001$)، وساهمت في تقليل القلق ($\beta = -.304$, $p < .001$) كما أثرت الكفاءة الذاتية المدركة إيجابيًا في الاتجاهات ($\beta = .142$, $p = .003$) والاستمتاع ($\beta = .268$, $p < .001$)، وساهمت في خفض القلق ($\beta = -.367$, $p < .001$) وقد أثر القلق سلبًا على كل من الاستمتاع ($\beta = -.557$, $p < .001$) والأداء في الرياضيات ($\beta = -.126$, $p = .004$) كما أثرت الاتجاهات ($\beta = .098$, $p = .002$) والاستمتاع ($\beta = .121$, $p = .01$) إيجابيًا في الأداء في الرياضيات. **الاستنتاجات:** أظهرت الدراسة أن الدافعية والكفاءة الذاتية المدركة لها تأثيرات إيجابية جوهرية في الأداء في الرياضيات.

الكلمات المفتاحية: الأداء في الرياضيات، الكفاءة الذاتية المدركة، دافعية تعلّم الرياضيات، الاتجاهات نحو الرياضيات، الاستمتاع بالرياضيات، القلق من الرياضيات، نمذجة العلاقات البنائية (SEM).

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Introduction

Mathematics plays a critical role in organizing thoughts and understanding the environment, helping individuals manage their surroundings effectively. In the information age, researchers emphasize the importance of mathematical thinking for its significant impact on enhancing human cognition, which is essential for social, economic, and technical advancement (Anderssen et al., 2016; Glazer & McConnell, 2002). This complex cognitive activity allows individuals to process symbols and concepts, applying them to solve various life problems (Schoenfeld & Sloane, 2016).

Mathematical thinking is essential for scientific and technological progress, highlighting the importance of effectively preparing students in mathematics. Teachers and educators should focus on developing students' problem-solving skills, understanding of mathematical concepts, and practical abilities (Anhalt & Cortez, 2016; English & Kirshner, 2002). Moreover, cultivating positive attitudes towards mathematics is vital (Aljodeh, 2016; Yelland et al., 2014). As a result, there is a growing interest in modernizing mathematics teaching methods to meet contemporary needs and foster a culture of thinking, creativity, and mathematical reasoning (Fiore & Lebar, 2017).

Developing mathematical thinking is a fundamental criterion in designing school mathematics curricula and is a primary goal across all educational stages. Modern trends in mathematics education stress that mathematical thinking should be deeply integrated into students' cognitive processes, rooted in understanding and logic (Cai & Howson, 2012; Schoenfeld & Sloane, 2016). The standards set by the National Council of Teachers of Mathematics (NCTM) in the U.S. aim to enhance both general and mathematical thinking strategies. These standards also emphasize the importance of effective mathematical communication and the interconnectedness within mathematics (Schoen, 2003).

Improving students' performance in mathematics is a major concern for teachers, educators, parents, and the broader community. This focus is driven by the critical importance of mathematics, making it one of the most important educational goals pursued by Ministries of Education globally (Bodovski et al., 2017). As a result, extensive efforts have been made over the past decades to enhance students' academic performance, particularly in mathematics (Growvs & Cebulla, 2000; Peteros et al., 2019; Saka, 2021).

In Palestine, mathematics is a core subject throughout all educational stages, where students learn arithmetic, algebra, probability, statistics, and geometry. The goal is to develop their skills in solving problems related to various mathematical concepts, including numbers, calculations, fractions, percentages, areas, volumes, algebraic equations, roots, exponents, integration, differentiation, geometry, trigonometry, and proofs. Despite efforts by the directorates of education in the Palestinian governorates, students' mathematical performance remains weak (Afaneh, 2014; Afana, 2021; Ramahi et al., 2016).

Since the establishment of the Palestinian National Authority in 1994, there have been significant advancements in various aspects of mathematics education in Palestine. Nevertheless, challenges persist in mathematics teaching, resulting in lower academic achievement compared to many countries. This is highlighted by Palestinian students' performance in international mathematics exams. For example, the 2011 Trends in International Mathematics and Science Study (TIMSS) results showed that about 40% of Palestinian students scored poorly in mathematics, placing Palestine 36th out of 42 participating countries (Mulkeen, 2013). Palestine has not participated in subsequent cycles of the TIMSS test.

Weak mathematical performance among Palestinian students may result from complex interactions of various factors, leading to difficulties in mathematics. Therefore, understanding the factors influencing mathematical performance is crucial for educators, policymakers, and researchers. Recent interest has focused on examining how psychological variables affect students' mathematical performance (Korem & Rubinsten, 2020; Semeraro et al., 2020). Despite extensive research in this area (Aktan & Budak, 2021; Espinoza & Taut, 2020; Onoshakpokaiye, 2024), there is still a gap in comprehensive studies that address these determinants within the specific context of Palestinian public schools.

The present study focuses on eighth-grade students, a crucial stage in their educational journey, to determine the psychological factors influencing mathematical performance. This stage is globally recognized as vital within education systems because students typically acquire fundamental mathematics and science concepts, forming a basis for assessing their comprehension and skills. Eighth grade is also used as a benchmark for evaluating educational attainment across various cultural and educational contexts and is often viewed as a preparatory phase for high school. Assessing students at this stage helps identify strengths and weaknesses early, which can guide educational policies and interventions. Additionally, the mathematical content taught in eighth grade aligns with foundational concepts necessary for higher-level learning, making this evaluation important for understanding the effectiveness of educational systems in preparing students for advanced studies (Jaffe, 2012; Wang & Goldschmidt, 2003).

This study aims to address the gap in research by investigating the psychological variables affecting mathematical performance among eighth-grade students in public schools in Palestine. It specifically examines perceived self-efficacy, motivation, attitudes, anxiety, and enjoyment in mathematical performance using Structural Equation Modelling (SEM).

SEM was chosen for its ability to analyze complex relationships among study variables while accounting for measurement error (Kline, 2023). This approach aligns with the study's objective of examining both direct and indirect pathways proposed by multiple theoretical frameworks (Schumacker & Lomax, 2004). Given the study's focus on interrelated psychological constructs; self-efficacy, motivation, attitudes, anxiety, enjoyment, and mathematical performance SEM was particularly suitable, as it enables the simultaneous assessment of multiple relationships (Kline, 2023). Unlike traditional methods such as regression, which analyze one dependent variable at a time, SEM allows for a more holistic understanding of how these variables interact (MacCallum & Austin, 2000).

Furthermore, psychological scales inherently contain measurement error, and SEM explicitly models these errors, leading to more precise and reliable estimates (Kline, 2023). A key advantage of SEM is its ability to quantify indirect effects (mediation analysis), which is essential for understanding the underlying mechanisms driving student performance (Koizumi, 2013). Additionally, SEM provides fit indices to assess how well the hypothesized model aligns with the observed data (Kline, 2023; Schumacker & Lomax, 2004) In summary, SEM was indispensable for disentangling the complex interplay of psychological factors influencing mathematical performance, offering a level of rigor and depth beyond that of simpler statistical techniques.

Prior to conducting SEM, researchers typically construct a path diagram or model that visually depicts the relationships between variables. A theoretical framework assists in determining which variables to incorporate into the model and how they are anticipated to interact. Moreover, when interpreting SEM results, a theoretical framework offers a basis for comprehending the significance and implications of estimated parameters, paths, and relationships within the model. It facilitates discussions on whether the findings align with or challenge existing theories (Civelek, 2018; Kline, 2023; Koizumi, 2013; Schumacker & Lomax, 2004).

In the present study, the researcher reviewed various frameworks to understand mathematical performance, acknowledging the complexity of learning and engagement in mathematics that cannot be fully explained by a single theory. Recognizing the difficulty in categorizing factors strictly as independent, mediating, or dependent variables, the research employed multiple theories: Social Cognitive Theory (SCT), Expectancy-Value Theory (EVT), Flow Theory (FT), Attribution Theory (AT), and Achievement Goal Theory (AGT). These theories were used to examine mathematical performance in relation to perceived self-efficacy, motivation, attitudes, anxiety, and enjoyment in learning mathematics.

Theoretical Frameworks and Mathematical Performance

In the realm of mathematics education, various theoretical frameworks elucidate the interplay between perceived self-efficacy, motivation, attitudes, anxiety, and enjoyment, which collectively influence mathematical performance.

Albert Bandura's Social Cognitive Theory (SCT) emphasizes that perceived self-efficacy (PSE) is crucial for academic success (Schunk & Mullen, 2012). PSE refers to an individual's confidence in their ability to successfully complete tasks and is influenced by personal achievements, vicarious experiences, verbal persuasion, and emotional states such as stress, anxiety, comfort, reassurance, or enthusiasm (Bandura, 1997, 2006).

Accurate self-perception helps students maintain consistent and effective behaviours (Schunk, 2023). Higher PSE fosters positive attitudes towards mathematics, as students who believe in their abilities are more likely to view challenges as opportunities rather than threats (Akin & Kurbanoglu, 2011; Ajayi et al., 2011; Kundu & Ghose, 2016; Ogundokun & Yinyinola, 2010). This confidence reduces anxiety, making mathematical tasks less daunting and more manageable (Akin & Kurbanoglu, 2011; Ding, 2016; Ogundokun & Yinyinola, 2010). Enhanced PSE also increases enjoyment in learning, as students who feel competent are more likely to engage with the subject matter enthusiastically (Getahun et al., 2016; Sağkal et al., 2022; Živković et al., 2023). Consequently, positive attitudes, reduced anxiety, and increased enjoyment directly impact mathematical performance. Motivated students with high PSE are more persistent, resilient, and willing to invest effort in their studies, leading to improved academic outcomes in mathematics (Lazarides et al., 2018; Stevens et al., 2004; Tait-McCutcheon, 2008).

Recent applications of SCT in mathematics education, such as Schunk & DiBenedetto’s (2020) work, demonstrate that mathematics self-efficacy directly predicts problem-solving persistence and achievement, particularly among adolescents. Contextually, Akin & Kurbanoglu (2011) linked higher self-efficacy to reduced math anxiety and improved attitudes, a relationship mirrored in this study’s structural model ($\beta = -.367$, $p < .001$). These findings underscore SCT’s relevance in explaining how confidence-driven behaviors mitigate anxiety and enhance engagement in resource-constrained settings like Palestine.

Expectancy-Value Theory (EVT), developed by Eccles and colleagues, complements Social Cognitive Theory (SCT) by focusing on students' expectations of success and the subjective value they place on mathematical tasks. EVT identifies four key components influencing mathematical performance: intrinsic value (enjoyment and interest), attainment value (importance of doing well), utility value (usefulness for future goals), and cost (perceived negative aspects like anxiety) (Ball et al., 2016; Rosenzweig et al., 2019).

Motivation and high perceived self-efficacy (PSE) enhance students' expectations of success, positively influencing their attitudes towards mathematics (Damrongpanit, 2019; Nicolaidou & Philippou, 2003; Schulz, 2005). When students value the subject and believe in their ability to succeed, they experience less anxiety and greater enjoyment in mathematical tasks (Daher, 2022). Motivated students who recognize the utility and importance of mathematics are more engaged and persistent in their learning activities. The positive interaction between high PSE, motivation, and favourable attitudes along with reduced anxiety and increased enjoyment—leads to higher levels of engagement and persistence, ultimately resulting in better mathematical performance (Rosenzweig et al., 2019; Wan, 2021; Wu et al., 2021).

Flow Theory (FT), introduced by Csikszentmihalyi, describes a mental state characterized by intense focus, enjoyment, and effortless action during activities. High perceived self-efficacy (PSE) is crucial for experiencing flow, as students need to feel confident in their abilities to fully engage in a task (dos Santos et al., 2018; Kurtuluş & Eryılmaz, 2021).

Students with high PSE and motivation are more likely to experience flow, which reduces anxiety and increases enjoyment. The state of flow enhances positive attitudes towards mathematics, as students associate the subject with pleasurable and engaging experiences. This optimal state of concentration and enjoyment during mathematical tasks leads to heightened focus, improved problem-solving skills, and overall better performance. Students who frequently achieve flow are more likely to develop a deep and lasting interest in mathematics, contributing to sustained academic success (Kim, 2021; Yunalis & Latifa, 2021).

Attribution Theory (AT), initially proposed by Heider and later expanded by Weiner, examines how individuals interpret their own and others' behaviours in relation to perceived self-efficacy. High perceived self-efficacy (PSE) leads students to attribute their successes to internal factors such as ability and effort, which reinforces their confidence and motivation (Schunk, 2023; van der Putten, 2017).

Students with high PSE and motivation are more likely to have positive attitudes towards mathematics, as they attribute their successes to controllable factors. This internal attribution reduces anxiety by making students feel more in control of their outcomes. Additionally, understanding their role in their success enhances their enjoyment of mathematical tasks. The combination of positive attitudes, reduced anxiety, and increased enjoyment contributes to better mathematical performance. Students with high PSE are also more likely to persist in challenging tasks and maintain high performance over time (Schunk, 2023; Shores & Smith, 2010).

Achievement Goal Theory (AGT), developed by Dweck and Elliot, differentiates between mastery goals (focused on learning and skill improvement) and performance goals (aimed at outperforming others). Higher perceived self-efficacy (PSE) supports mastery goals by boosting confidence in overcoming mathematical challenges (Christian, 2017; Elliot & Sommet, 2023).

Students with high PSE are more inclined to adopt mastery goals, which promote positive attitudes towards learning and reduce anxiety related to performance pressure. Motivated students with mastery goals enjoy the learning process and skill development rather than just focusing on outcomes. This emphasis on mastery goals leads to deeper engagement with mathematical content, sustained effort, and better long-term learning outcomes. Consequently, this approach enhances overall mathematical performance as students build a robust understanding and competence in mathematics (Anderman, 2020; Comegys, 2018).

Present Study

This study hypothesises that Perceived self-efficacy (PSE) and motivation are critical independent variables influencing students' engagement with mathematical tasks. Students confident in their abilities are more likely to be motivated to engage with and persist in their studies. Conversely, heightened motivation can bolster their perceived self-efficacy, establishing a mutually reinforcing relationship. This confidence nurtures a sense of assurance that promotes a state of flow during mathematical tasks, characterised by heightened concentration and improved overall performance.

Attitudes, anxiety, and enjoyment serve as mediating variables in the current study. Positive attitudes towards mathematics correlate with higher academic achievement, while negative attitudes hinder success (Ajayi et al., 2011; Ogundokun & Yinyinola, 2010; Şad et al., 2015). Additionally, motivated students with high PSE in mathematics exhibit lower anxiety levels, whereas those lacking self-confidence experience heightened anxiety, impeding their enjoyment and engagement with the subject (Zakaria & Nordin, 2008; Yeo, 2022).

In conclusion, integrating the insights from Social Cognitive Theory, Expectancy-Value Theory, Flow Theory, Attribution Theory, and Achievement Goal Theory provides a comprehensive framework for understanding the factors that influence mathematical performance. The proposed theoretical model diagram visually represents these intricate relationships, offering a structured framework for empirical testing in the present study. This integration underscores the importance of perceived self-efficacy, motivation, attitudes, anxiety, and enjoyment in shaping students' mathematical performance.

Thus, the discussed theoretical frameworks highlight both the direct and indirect impacts of these factors on mathematical performance, emphasising their roles in enhancing concentration, persistence, and efficient problem-solving all contributing to improved academic outcomes in mathematics. Based on this understanding, the following proposed theoretical model diagram aims to visually represent these intricate relationships, offering a structured framework for empirical testing in the present study. See figure 1.

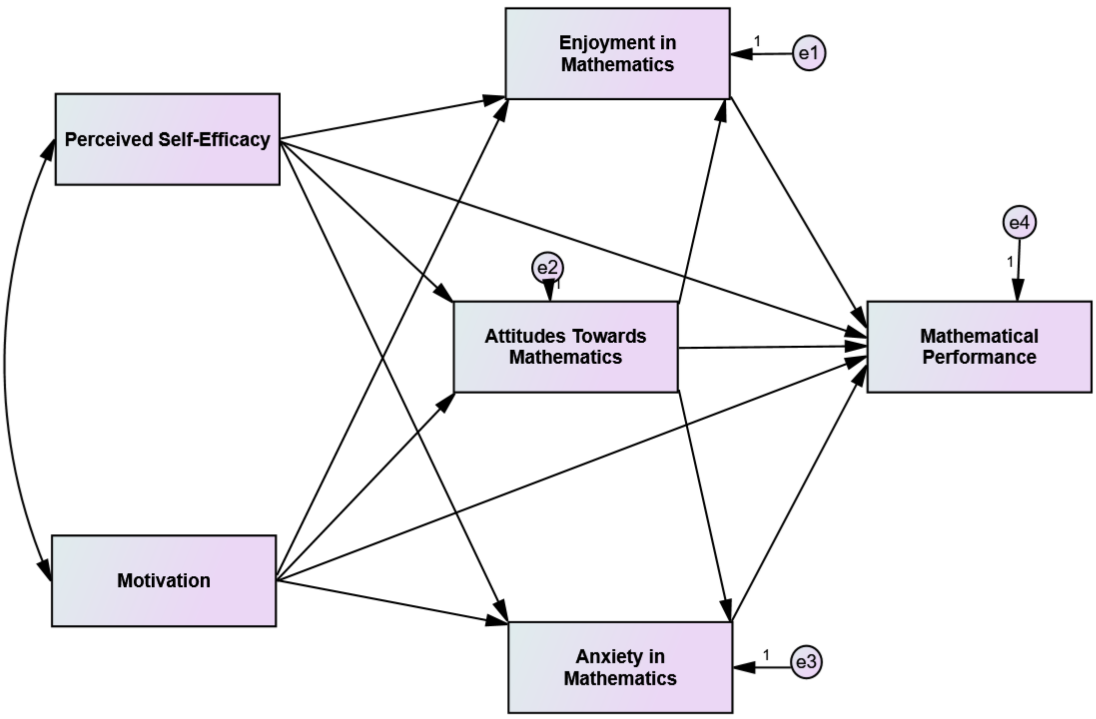

Figure (1): The hypothesised model examines both the direct and indirect effects of perceived self-efficacy and motivation on mathematical performance, mediated by attitudes, anxiety, and enjoyment.

Method

Participants

The study focused on eighth-grade students in Palestinian public schools within the West Bank, where accessing schools in the Gaza Strip was challenging due to ongoing conflict and blockade. To ensure a representative sample, the researcher employed a multi-stage sampling approach.

In the first stage, educational directorates were categorized geographically. The Northern West Bank included eight directorates, comprising 47% of all directorates and 41% of the student population, with 25,747 students. The Central West Bank included five directorates, representing 29% of all directorates and 32% of the student population, with 19,075 students. The Southern West Bank consisted of four directorates, accounting for 24% of all directorates and 27% of the student population, with 17,277 students.

In the second stage, the researcher used stratified random sampling to select seven directorates representing about 40% of all directorates. Three directorates were chosen from the Northern West Bank (Nablus, Tulkarm, and Jenin), two from the Central West Bank (Jericho and Jerusalem Suburbs), and two from the Southern West Bank (Hebron and South Hebron). Within each directorate, four schools were randomly chosen, totalling 28 schools (14 for males and 14 for females).

In the third stage, one eighth-grade class was randomly selected from each school, with 15 to 20 questionnaires distributed per class, totalling 500 questionnaires. Of these, 439 were retrieved, resulting in a non-response rate of approximately 12%. The final sample consisted of 224 females and 215 males, leading to a near-even gender distribution of 51% females and 49% males.

The study's findings, as presented in Table 1, show the distribution of participants across different categories. Geographically, the majority of participants were located in the Northern West Bank (47.0%), followed by the Central West Bank (29.0%) and the Southern West Bank (24.0%). The gender distribution was almost evenly split, with 51.0% female participants slightly outnumbering 49.0% male participants. Regarding mathematics achievement, the distribution indicated a wide range of scores: 25.1% of students achieved scores between 60 and less than 70, 21.0% scored between 80 and less than 90, and 16.9% scored 90 and above. On the lower end, 8.4% scored less than 50, and 13.7% scored between 50 and less than 60. This diverse range of achievement levels suggests that a significant portion of the study participants achieved moderate to high scores in mathematics. Informed consent was obtained from all students participating in the study.

Table (1): Distribution of Study Sample by Classificatory Study Variables.

Classificatory Variable	Variable Levels	Frequency	Percentage (%)
Directorate	Northern West Bank	206	47.0
	Central West Bank	127	29.0
	Southern West Bank	106	24.0
	Total	439	100
Gender	Male	215	49.0
	Female	224	51.0
	Total	439	100
Mathematics Achievement	Less than 50	37	8.4
	50 to less than 60	60	13.7
	60 to less than 70	110	25.1
	70 to less than 80	66	15.0
	80 to less than 90	92	21.0
	90 and above	74	16.9
	Total	439	100

Materials

Mathematical performance test

The researcher used TIMSS questions for eighth-grade students from a UAE Ministry of Education booklet (2011). The 2011 TIMSS booklet issued by the UAE Ministry of Education was selected for this study due to the absence of a complete, officially validated Arabic version of the TIMSS mathematics test within the Palestinian educational system. While the Palestinian Ministry of Education and its directorates possess fragmented TIMSS-based materials, they do not provide a fully standardized version of the exam. In contrast, the UAE-translated TIMSS test maintains the original structure and content as issued by the International Association for the Evaluation of Educational Achievement (IEA), the global governing body of TIMSS.

It is worth noting that some previous studies conducted in the Palestinian context have developed tests that simulate the original TIMSS exam. However, these adaptations lacked rigorous validation in terms of psychometric properties such as validity, reliability, discrimination, and difficulty when tested on representative samples of Palestinian students. For this reason, the current study utilized the TIMSS test in its original format, with the UAE Ministry of Education's role limited to translation, ensuring that the authenticity and integrity of the test questions were preserved. This approach upholds TIMSS as a globally recognized assessment, making it suitable for application across diverse educational contexts.

The TIMSS test measures proficiency in algebra, number and operations, geometry, and data and statistics, with questions distributed as follows: algebra (30%), number and operations (30%), geometry (20%), and data and statistics (20%) (National Centre for Measurement, 2019; Mullis et al., 2020). The current study's test (MPT) included 20 questions: 16 multiple-choice and 4 essay questions, distributed as follows: number and operations (30%), algebra (30%), geometry (20%), and data and statistics (20%). Three validity checks were used: Expert Validity, where five experts deemed the questions suitable, suggesting improvements for the essay questions; Construct Validity, where all 20 questions showed significant correlations ($\alpha < .01$) with the total score and their respective domains in a sample of 50 students; and Discriminant Validity, where significant score differences were found between high and low achievers (t-values ranging from 10.16 to 14.88, $\alpha < .01$). The test had a difficulty index of .61 and a KR-20 reliability coefficient of 0.79. Domain-specific reliability coefficients ranged from 0.64 to .75. Discrimination indices for the questions averaged .60, with domain indices from .55 to .67.

Perceived self-efficacy in mathematics scale

The mathematics self-efficacy scale (MSES) developed by Liu & Koirala (2009) consists of 5 items measuring perceived self-efficacy in mathematics, with participants rating their agreement on a 5-point Likert scale. An exploratory factor analysis (EFA) in the original study revealed a single factor accounting for 73.603% of the variance, with high factor loadings ranging from .835 to .875, and a Cronbach's alpha of .933. The current study adapted the MSES for the Palestinian context using Pan & De La Puente's (2005) five-step process for translating and adapting questionnaires. These steps include preparation, translation and back-translation, pretesting, revision, and documentation. The Arabic version, reviewed by four experts from An-Najah National University, was tested for clarity with 20 eighth-grade students. An EFA on a sample of 110 students (58 males, 52 females) confirmed data suitability for factor analysis, revealing a one-factor solution explaining 58.36% of the total variance with high factor loadings (.741 to .781) and communalities (.55 to .61). The KMO measure was .835, and Bartlett's test indicated significant sampling adequacy. The internal consistency reliability of the MSES was very good, with a Cronbach's alpha of .821.

Mathematics motivation scale

The mathematics motivation scale (MMS), developed by Zakariya and Massimiliano (2021), measures motivation in mathematics and originally revealed a five-factor structure: intrinsic motivation, extrinsic motivation, the utility of mathematics, the importance of mathematics, and self-efficacy for learning and performance. This study focuses on intrinsic motivation, emphasising internal satisfaction and self-directed engagement in mathematical tasks, rather than extrinsic rewards. The intrinsic motivation subscale (IMS) of the MMS, consisting of four items rated on a 5-point Likert scale, was used. The IMS showed acceptable internal consistency in the original study with a Cronbach's alpha of .61.

For the Palestinian context, the IMS was adapted using Pan & De La Puente's (2005) five-step translation process. An EFA conducted on a sample of 110 eighth-grade students (58 males, 52 females) confirmed data suitability for factor analysis. The KMO measure was .688, and Bartlett's test indicated significant sampling adequacy. The EFA revealed a one-factor solution explaining 49.84% of the total variance with factor loadings ranging from .592 to .794 and communalities from .35 to .63. The internal consistency reliability of the IMS in this study was .664, indicating good reliability.

Attitudes towards mathematics scale

Chapman (2003) developed the Mathematics Attitude Scale (MAS) for school students, consisting of 10 Likert-type items divided into three subscales: liking mathematics (affective component), valuing mathematics (cognitive component), and coping with mathematics (behavioural component). Initially validated with a sample of 774 Australian primary school students (grades 4-7), the scale showed good internal consistency with a Cronbach's alpha of .82. Students rated each item on a 5-point Likert scale, and scores were aggregated for a composite score.

In the current study, the MAS was adapted for the Palestinian context using Pan & De La Puente's (2005) method. An exploratory factor analysis (EFA) on a sample of 110 eighth-grade students (58 males, 52 females) confirmed data suitability, with a KMO measure of .748 and Bartlett's test indicating significant sampling adequacy. The EFA revealed a three-factor solution explaining 61.94% of the total variance, aligning with Chapman's original structure. Communalities ranged from .45 to .76, and factor loadings from .657 to .867. The internal consistency reliability of the MAS in this study was very good, with a Cronbach's alpha of .869 for the total score. Subscale reliabilities were .748 for liking mathematics, .759 for valuing mathematics, and .796 for coping with mathematics.

Mathematics anxiety scale

The mathematics anxiety scale, developed by Zakariya (2018), measures students' anxiety towards mathematics and originally revealed a two-factor structure: learning mathematics anxiety and perception of difficulty and motivation. This study focused on the learning mathematics anxiety subscale (LMA), consisting of 11 items rated on a 5-point Likert scale, which showed acceptable internal consistency (Cronbach's alpha of .86). The LMA was adapted for the Palestinian context using Pan & De La Puente's (2005) method. An exploratory factor analysis (EFA) on 110 eighth-grade students (58 males, 52 females) confirmed data suitability, with a KMO measure of .919 and Bartlett's test indicating significant sampling adequacy. The EFA revealed a one-factor solution explaining 54.49% of the total variance, with communalities from .45 to .70 and factor loadings from .670 to .834. The internal consistency reliability of the LMA in this study was excellent, with a Cronbach's alpha of .912.

Enjoyment in mathematics scale

The Enjoyment in Mathematics Scale (EMS), developed by Weinhandl et al. (2024), measures students' enjoyment in mathematics through 14 items rated on a 5-point Likert scale. The original study showed acceptable internal consistency with a Cronbach's alpha of .83. The EMS was adapted for the Palestinian context using Pan & De La Puente's (2005) method. An exploratory factor analysis (EFA) on a sample of 110 eighth-grade students (58 males, 52 females) retained 10 out of 14 items, eliminating four due to low factor loadings and communalities. The KMO measure for the 10 items was .908, and Bartlett's test indicated significant sampling adequacy. The EFA revealed a one-factor solution explaining 51.08% of the variance, with communalities from .31 to .72 and factor loadings from .550 to .848. The internal consistency reliability of the EMS in this study was very good, with a Cronbach's alpha of .89.

Procedure

The researcher secured approval from the Research and Development Center at the Palestinian Ministry of Education to conduct the study. Subsequently, the researcher contacted the principals of the participating schools and emailed them the study instruments. The principals coordinated with mathematics teachers to distribute the instruments and collect the responses from eighth-grade students. Once data collection was complete, the questionnaires were forwarded to the educational directorates responsible for these schools. The researcher then retrieved the completed questionnaires from the directorates and inputted the data into the SPSS-27 and AMOS-25. This entire process spanned two months, from late January 2024 to late March 2024.

Results

Descriptive statistics, one-sample t-test results, and correlation coefficients for all variables were calculated and reported in Table 2. As shown in this table, there is a significant difference between the sample mean ($\bar{x}$ = 9.00, S.D. = 4.62) and the hypothetical mean (μ = 10.50) in mathematical performance (t = -6.77, $p < .01$) in favour of the hypothetical mean, indicating that the mathematical performance among students is low. Similarly, mathematics self-efficacy ($\bar{x}$ = 3.42, S.D. = 0.87, t = 10.15, $p < .01$), mathematics attitude ($\bar{x}$ = 3.44, S.D. = 0.70, t = 13.32, $p < .01$), and enjoyment in mathematics ($\bar{x}$ = 3.48, S.D. = 1.10, t = 9.06, $p < .01$) showed significant differences from their respective hypothetical means (μ = 3.00), suggesting high levels in these variables. In contrast, intrinsic motivation ($\bar{x}$ = 3.07, S.D. = 0.80, t = 1.78) did not show a significant difference, and learning mathematics anxiety ($\bar{x}$ = 2.88, S.D. = 1.00, t = -2.63, $p < .01$) was significantly lower than the hypothetical mean, indicating lower anxiety levels among students.

Table (2): Descriptive Statistics, One Sample t-Test, and Correlation Coefficients Results (n = 439).

Variables	Mean	S.D.	Min.	Max.	t-value	1.	2.	3.	4.	5.
1. MPT	9.00	4.62	1	20	-6.77**	1				
2. MSES	3.42	0.87	1	5	10.15**	.717**	1			
3. IMS	3.07	0.80	1	5	1.78	.734**	.575**	1		
4. MAS	3.44	0.70	1	5	13.32**	.536**	.412**	.550**	1	
5. LMA	2.88	1.00	1	5	-2.63**	-.669**	-.605**	-.599**	-.472**	1
6. EMS	3.48	1.10	1	5	9.06**	.690**	.672**	.604**	.459**	-.789**

Note. MPT: mathematical performance test, MSES: mathematics self-efficacy scale, IMS: intrinsic motivation scale, MAS: mathematics attitude scale, LMA: learning mathematics anxiety scale, and EMS: enjoyment in mathematics scale.

** p < .01

Additionally, there is a significant positive correlation between mathematical performance and perceived self-efficacy (r = .717, p < .01), suggesting that an improvement in mathematical performance is associated with an increase in perceived self-efficacy among the students and vice versa. Similarly, mathematical performance is positively correlated with intrinsic motivation (r = .734, p < .01), mathematics attitude (r = .536, p < .01), and enjoyment in mathematics (r = .690, p < .01). This indicates that higher performance is linked with higher motivation, a more positive attitude, and greater enjoyment in mathematics. Conversely, there is a significant negative correlation between mathematical performance and learning mathematics anxiety (r = -.669, p < .01), indicating that higher performance is associated with lower anxiety levels.

Furthermore, there is a significant negative correlation between anxiety and perceived self-efficacy (r = -.605, p < .01), indicating that higher levels of anxiety are associated with lower self-efficacy in mathematics. Similarly, anxiety is negatively correlated with intrinsic motivation (r = -.599, p < .01), mathematics attitude (r = -.472, p < .01), and enjoyment in mathematics (r = -.789, p < .01). This suggests that higher anxiety levels are linked to lower motivation, less positive attitudes, and reduced enjoyment in mathematics. Overall, reducing anxiety can lead to improvements in self-efficacy, motivation, attitude, and enjoyment, thereby enhancing overall mathematical performance.

Since the correlations between the variables of interest resulted statistically significant, the present study proceeded by testing the hypothesised model, as the primary objective of this study is to highlight both the direct and indirect impacts of self-efficacy, motivation, attitude, enjoyment, and anxiety on mathematical performance. By employing path analysis using SEM, the current study aimed to test the proposed model and provide a comprehensive understanding of how these factors interrelate and contribute to students' success in mathematics.

A preliminary exploratory data analysis was conducted to verify that the essential assumptions were satisfied for suitable statistical tests in Structural Equation Modelling (SEM) (Tabachnick et al., 2007). This process involved evaluating data precision, missing data, univariate and multivariate normality, and outliers. Regarding data accuracy, values out of range and implausible values were checked using frequencies and descriptive statistics, including range, mean, and standard deviation. Missing data accounted for less than 3% (13 cases) of the responses within all constructs. These missing values were replaced with the mean response across all items contributing to their respective constructs.

SEM procedures rely on the assumption of multivariate normality, which involves the normality of univariate distributions, normal joint bivariate distributions, and the normality of linear combinations of variables (Kline, 2023). While it is impractical to test all aspects of multivariate normality, many instances of non-normality can be detected by inspecting univariate distributions (Kline, 2023). In the present study, univariate normality was the basis for inspecting multivariate normality. Skewness and kurtosis were used to assess univariate normality (Kline, 2023). Skewness refers to the asymmetry of a unimodal distribution around its mean, while kurtosis measures the peakedness of the distribution. Positive skewness and kurtosis indicate a higher concentration of scores below the mean and a higher peak with heavier tails, respectively, while negative values indicate the opposite (Wulder, 2005).

Variable distributions may exhibit significant skewness, kurtosis, or both. Researchers can assess whether a variable has significant skewness or kurtosis by dividing the unstandardized skewness or kurtosis index by its corresponding standard error; this ratio is interpreted as a z-test of skewness or kurtosis (Kline, 2023). Ratios exceeding 1.96 indicate a p-value below 0.05, while ratios exceeding 2.58 indicate a p-value below 0.01, signifying significant skewness or kurtosis in the data.

In this study, as shown in Table 3 the skewness and kurtosis indices for the various scales were examined, revealing that several constructs exhibited significant skewness and/or kurtosis, indicating deviations from normality. For example, the Mathematics Performance Test (MPT) showed a skewness ratio of 0.75, indicating no significant skewness, and a kurtosis ratio of -3.00, indicating significant negative kurtosis (p < 0.01). Similar patterns were observed across other scales, such as the Mathematics Self-Efficacy Scale (MSES) and the Intrinsic Motivation Scale (IMS), highlighting the presence of non-normality in the data.

Table (3): Skewness and kurtosis indices for MPT, MSES, IMS, MAS, LMA and EMS (n = 439).

Scales	Skewness	Standard error	Ratio	Kurtosis	Standard error	Ratio
MPT	0.088	0.117	0.75	-0.698	0.233	-3.00
MSES	-0.697	0.117	-5.96	-0.594	0.233	-2.55
IMS	-0.033	0.117	-0.28	-1.20	0.233	-5.15
MAS	-0.521	0.117	-4.45	-0.603	0.233	-2.59
LMA	0.218	0.117	1.86	-1.13	0.233	-4.85
EMS	-0.787	0.117	-6.73	-0.737	0.233	-3.16

Regarding outliers, these are extreme or highly unusual cases that may bias estimators (Yuan & Bentler, 2001). Outliers can be either univariate or multivariate. Univariate outliers exhibit extreme scores on a single variable and can be identified by examining z-scores; cases with z-scores greater than 3.0 in absolute value are considered unusual and may indicate outliers (Kline, 2023). Based on this threshold and as shown in Table 4 no univariate outliers were identified for the variables within the sample.

Table (4)*:* Z-scores of MPT, MSES, IMS, MAS, LMA and EMS (n = 439).

Scale	Minimum value	Maximum value
MPT z-score	-1.94	2.38
MSES z-score	-2.64	1.68
IMS z-score	-2.12	1.96
MAS z-score	-2.50	1.98
LMA z-score	-1.55	1.88
EMS z-score	-2.24	1.38

On the other hand, multivariate outliers may feature extreme scores on multiple variables or an unusual combination of values, without any single variable exhibiting extreme scores (Mishra & Chakraborty, 2022). Mahalanobis distance was employed to identify multivariate outliers, as it represents the distance of a case from the centroid (the sample mean) of all cases (Kline, 2023). A significance level of $p < 0.001$ is typically recommended for identifying statistical significance in this multivariate outlier test (Kline, 2023). Using SPSS-27, the analysis identified 15 outliers in the sample ($p < 0.001$, Kline, 2023), which represents 3.4% of the cases. This percentage is considered small.

The researcher decided to retain all cases, including the outliers, to ensure realistic results. However, given that some study scales violated the assumptions of univariate and multivariate normality, a suitable estimation method, such as the Robust Maximum Likelihood (RML) estimation, was employed. RML is more appropriate for handling non-normal data distributions and outliers, providing more accurate parameter estimates in such cases (Wilcox, 2011). Consequently, the RML method was applied in this study.

The fit between the hypothetical model and the observed data was evaluated using several indices: relative chi-square (CMIN/df), Bollen-Stine bootstrap p-value, Bentler-Bonnett or normed fit index (NFI), non-normed (Tucker-Lewis) fit index (TLI), comparative fit index (CFI), goodness of fit index (GFI), adjusted goodness of fit index (AGFI), and the root mean square error of approximation (RMSEA) (Byrne, 2013; MacCallum & Austin, 2000). RMSEA is a crucial indicator that shows how well the estimated parameters of an SEM model represent the entire population from which the sample was drawn.

The hypothesised model showed poor fit indices, with χ^2 (181.10/1 = 181.10), Bollen-Stine bootstrap p-value $< .001$, NFI = .892, TLI = .630, CFI = .891, GFI = .899, AGFI = .871, and RMSEA = .16. To improve the hypothesised model, one significant path from mathematics anxiety to enjoyment in mathematics was added, and one insignificant path from attitudes towards mathematics to enjoyment in mathematics was dropped. This revised model showed very good fit indices with χ^2 (1.05/1 = 1.05), Bollen-Stine bootstrap p-value = .346, NFI = .999, TLI = .989, CFI = .997, GFI = .999, AGFI = .983, and RMSEA = .01.

According to the results in Table 5, all coefficients were significant and show the parameter estimates for the direct effects of psychological variables on mathematical performance among eighth-grade students in Palestinian public schools. The results reveal several significant relationships. Intrinsic motivation (IMS) positively influences mathematics attitude (MAS) with a strong effect ($\beta = .468$, $p < .001$), and similarly affects enjoyment in mathematics (EMS) ($\beta = .116$, $p < .001$). On the other hand, IMS has a negative impact on learning mathematics anxiety (LMA) ($\beta = -.304$, $p < .001$). Mathematics self-efficacy (MSES) also positively affects MAS ($\beta = .142$, $p = .003$) and EMS ($\beta = .268$, $p < .001$), while negatively impacting LMA ($\beta = -.367$, $p < .001$).

Table (5): Parameter Estimates of Standardised Direct Effects of Psychological Variables on Mathematical Performance Among eighth-grade students in Palestinian public schools (n = 439).

Parameter description	β	S.E.	C.R.	P-value
MAS <--- IMS	.468	.042	9.69	< .001**
MAS <--- MSES	.142	.039	2.95	.003**
LMA <--- IMS	-.304	.058	-6.52	< .001**
LMA <--- MAS	-.153	.060	-3.67	< .001**
LMA <--- MSES	-.367	.049	-8.59	< .001**
EMS <--- IMS	.116	.049	3.30	< .001**
EMS <--- MSES	.268	.045	7.56	< .001**
EMS <--- LMA	-.557	.040	-15.37	< .001**
MPT <--- IMS	.348	.011	9.37	< .001**
MPT <--- MSES	.319	.010	8.65	< .001**
MPT <--- MAS	.098	.011	3.07	.002**
MPT <--- EMS	.121	.010	2.59	.010*
MPT <--- LMA	-.126	.010	-2.85	.004**
Correlation between MSES and IMS	.575	.038	10.44	< .001**
R^2 of MAS	.316			
R^2 of LMA	.476			
R^2 of EMS	.689			
R^2 of MPT	.704			

MPT: mathematical performance test, MSES: mathematics self-efficacy scale, IMS: intrinsic motivation scale, MAS: mathematics attitude scale, LMA: learning mathematics anxiety scale, and EMS: enjoyment in mathematics scale.
S.E.: standard error and C.R.: critical ratio; a value greater than 1.96 (in absolute terms) suggests that the parameter is significant.
** $p < .01$, * $p < .05$

LMA shows a strong negative effect on EMS ($\beta = -.557$, $p < .001$) and affects mathematical performance (MPT) negatively ($\beta = -.126$, $p = .004$). In contrast, MAS has a positive effect on MPT ($\beta = .098$, $p = .002$). EMS also positively affects MPT ($\beta = .121$, $p = .01$), while IMS ($\beta = .348$, $p < .001$) and MSES ($\beta = .319$, $p < .001$) have strong positive influences on MPT. The correlations between MSES and IMS ($r = .575$, $p < .001$) indicate a significant positive relationship. The R^2 values show that the models account for a substantial proportion of variance in each dependent variable, with MPT having the highest (R2 = .704).

Table 6 shows the standardised indirect effects of psychological variables on mathematical performance (MPT) among eighth-grade students in Palestinian public schools. Focusing on the indirect effects from MSES to MPT, the influence of MSES on MPT through enjoyment in mathematics (EMS) is .032, through mathematics anxiety (MAS) is .014, through learning mathematics attitudes (LMA) is 0.046, and through a combination of MAS and LMA is .003. Summing these pathways, the total indirect effect of MSES on MPT is .095. In comparison, the indirect effects from IMS to MPT show that IMS influences MPT through EMS by .014, through MAS by .046, through LMA by .038, and through the combination of MAS and LMA by .009. The total indirect effect of IMS on MPT is .107.

Table (6): Parameter Estimates of Standardised Indirect Effects of Psychological Variables on Mathematical Performance Among eighth-grade students in Palestinian public schools (n = 439).

Indirect effect	B
From MSES To MPT	
MSES → EMS → MPT	.032
MSES → MAS → MPT	.014
MSES → LMA → MPT	.046
MSES → MAS → LMA → MPT	.003
Total indirect effect of MSES on MPT	.095
From IMS To MPT	
IMS → EMS → MPT	.014
IMS → MAS → MPT	.046
IMS → LMA → MPT	.038
IMS → MAS → LMA → MPT	.009
Total indirect effect of IMS on MPT	.107

When comparing these indirect effects, it is evident that the total indirect effect of IMS on MPT (.107) is higher than that of MSES (.095), indicating that intrinsic motivation (IMS) has a stronger overall indirect influence on mathematical performance compared to self-efficacy (MSES). Specifically, MSES exhibits a stronger indirect effect through enjoyment in mathematics (EMS) compared to IMS (.032 vs. .014), while IMS has a much stronger indirect effect through mathematics anxiety (MAS) compared to MSES (.046 vs. .014). For the pathway through learning mathematics attitudes (LMA), MSES shows a slightly stronger indirect effect compared to IMS (.046 vs. .038). Additionally, IMS has a stronger indirect effect through the combined pathway of MAS and LMA compared to MSES (.009 vs. .003).

These findings suggest that intrinsic motivation is a more influential factor in improving mathematical performance through its impact on enjoyment, anxiety, and attitudes towards learning mathematics. While self-efficacy remains significant, intrinsic motivation's impact appears to be more substantial overall. Therefore, educators might focus more on enhancing intrinsic motivation to improve students' mathematical performance effectively. See Figure 2.

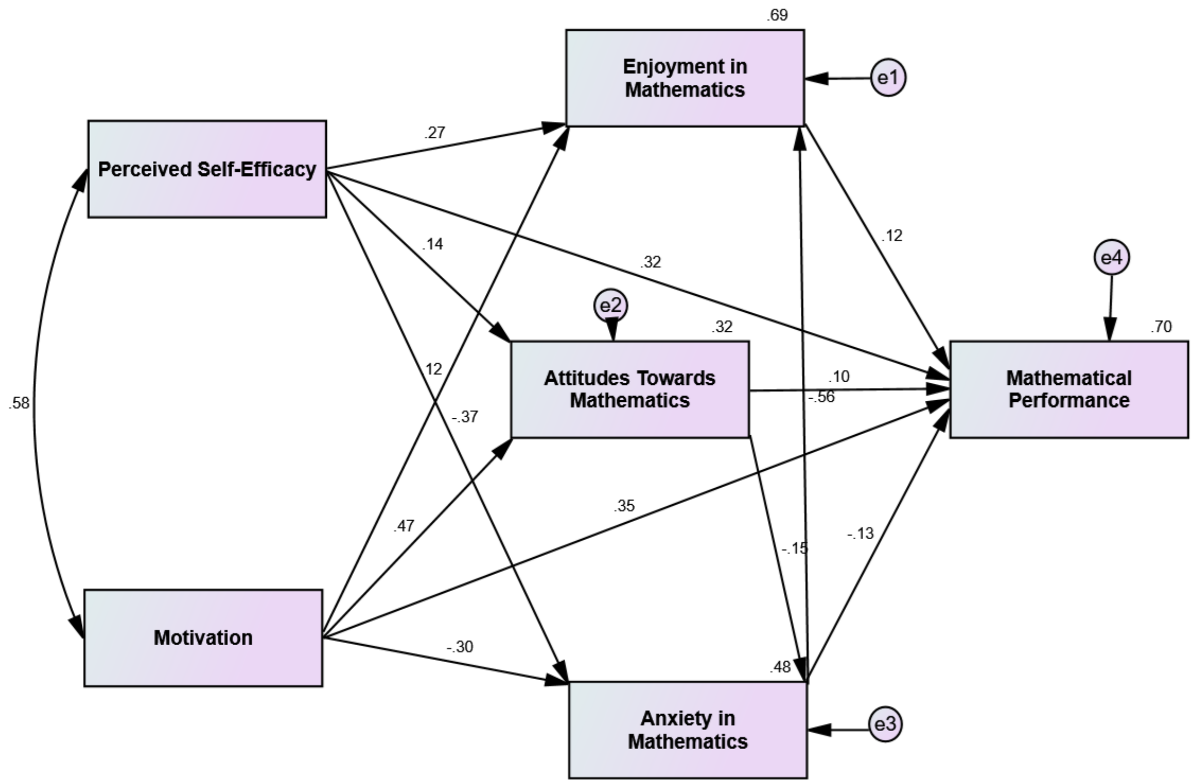

Figure (2): The results of the modified model of the direct and indirect effects of perceived self-efficacy and motivation on mathematical performance, mediated by attitudes, anxiety, and enjoyment.

Discussion

The study of 8th-grade students in public schools in the West Bank, Palestine, reveals a complex paradox where high self-efficacy, positive attitudes, and enjoyment in mathematics do not align with actual performance. According to Social Cognitive Theory (SCT), high self-efficacy should correlate with better performance (Bandura, 1997; Schunk, 2023). The study confirms that students exhibit high self-efficacy and positive attitudes, but their performance remains significantly below expectations. This discrepancy suggests that factors such as inadequate resources or ineffective teaching methods may be influencing their outcomes. EVT further explains that while students place significant intrinsic value on mathematics, their motivation does not exceed expected levels (Ball et al., 2016; Rosenzweig et al., 2019). This indicates a potential disconnect between their perceived value of the subject and practical aspects of their education, such as curriculum relevance or instructional quality. FT suggests that high self-efficacy should facilitate flow, a state of deep engagement that enhances performance (dos Santos et al., 2018; Kurtuluş & Eryılmaz, 2021). Despite students enjoying mathematics and having positive attitudes, inconsistent performance indicates that sustained flow experiences might be hindered by systemic issues, such as inadequate resources or outdated teaching methods.

AT supports the idea that high self-efficacy leads to internal attributions of success, reducing anxiety and potentially improving performance (Schunk, 2023; van der Putten, 2017). The study's finding of low learning anxiety aligns with AT, but the persistent low performance suggests external constraints might be affecting students' ability to convert self-efficacy into academic success. AGT differentiates between mastery goals and performance goals, with students' positive attitudes indicating a potential focus on mastery (Christian, 2017; Elliot & Sommet, 2023). However, average intrinsic motivation levels suggest challenges or an emphasis on performance goals might be detracting from effective learning and engagement. Additionally, family values and response biases may play a crucial role; if families emphasise success in mathematics without adequate support, students may overestimate their abilities or inflate self-assessment responses (Schunk, 2023). This overestimation can lead to a disconnect between perceived and actual performance. Integrating these theories and factors indicates that while Palestinian students exhibit high self-efficacy, positive attitudes, and enjoyment in mathematics, systemic improvements are needed.

On the other hand, correlation analysis shows that better mathematical performance is associated with higher self-efficacy, increased intrinsic motivation, more positive attitudes, and greater enjoyment in mathematics. Conversely, higher anxiety levels are linked to lower performance, self-efficacy, motivation, attitudes, and enjoyment. This suggests that reducing anxiety could improve students' self-efficacy, motivation, attitudes, and enjoyment, leading to better overall mathematical performance.

In addition, the initial model exhibited poor fit indices ($\chi^2 = 181.10$, RMSEA = .16), leading to modifications: adding a significant path from mathematics anxiety to enjoyment and removing an insignificant path from attitudes to enjoyment. The results from the revised model, which showed excellent fit indices ($\chi^2 = 1.05$, RMSEA = .01), provide valuable insights into the relationships among psychological variables and mathematical performance. This improved model allows for a nuanced understanding of how intrinsic motivation (IMS) and mathematics self-efficacy (MSES) influence mathematical performance (MPT) through various mediating factors, such as attitudes towards mathematics (MAS), enjoyment in mathematics (EMS), and learning mathematics anxiety (LMA).

The fit indices confirm that the model's structure aligns closely with the observed data, validating the theorized relationships between variables. The strong fit suggests that anxiety, enjoyment, and motivation are central to explaining performance in the Palestinian context.

Intrinsic motivation (IMS) was found to positively influence both attitudes towards mathematics (MAS) ($\beta = .468$, $p < .001$) and enjoyment in mathematics (EMS) ($\beta = .116$, $p < .001$). This supports EVT, which emphasises that intrinsic value, such as enjoyment and interest in the subject, enhances students' attitudes and performance (Eccles et al., 1983). Furthermore, IMS negatively affected learning mathematics anxiety (LMA) ($\beta = -.304$, $p < .001$), which is consistent with research indicating that higher intrinsic motivation can reduce anxiety by creating a more engaging and less threatening learning environment (Schunk, 2023).

Mathematics self-efficacy (MSES) also had a positive impact on MAS ($\beta = .142$, $p = .003$) and EMS ($\beta = .268$, $p < .001$), while negatively influencing LMA ($\beta = -.367$, $p < .001$). According to Social Cognitive Theory (SCT), high self-efficacy enhances students' confidence, which positively affects their attitudes and enjoyment while reducing anxiety (Bandura, 1997; Schunk, 2023). The significant influence of MSES on MAS and EMS demonstrates the role of perceived competence in fostering positive mathematical experiences and alleviating anxiety (Akin & Kurbanoglu, 2011).

Mathematics anxiety (LMA) had a strong negative effect on both EMS ($\beta = -.557$, $p < .001$) and mathematical performance (MPT) ($\beta = -.126$, $p = .004$). This finding underscores the detrimental impact of high anxiety on students' enjoyment and performance in mathematics (Ding, 2016). The pronounced negative effect of LMA on EMS indicates that reducing anxiety is crucial for enhancing students' enjoyment and engagement with mathematics (Getahun et al., 2016).

The strong fit of the modified model confirms that anxiety's negative effect on enjoyment ($\beta = -.557$) is a critical pathway. For instance, a one-unit increase in intrinsic motivation corresponds to a .468-unit rise in positive attitudes, which is substantial compared to prior studies (e.g., Damrongpanit, 2019: $\beta = .32$). The high R^2 for performance (70.4%) underscores the combined explanatory power of the variables, suggesting that holistic interventions targeting multiple psychological factors are essential.

Both MAS ($\beta = .098$, $p = .002$) and EMS ($\beta = .121$, $p = .01$) positively influenced MPT, suggesting that positive attitudes and enjoyment contribute to better mathematical performance. This is consistent with FT, which posits that enjoyable and engaging experiences enhance performance by fostering deep concentration and problem-solving skills (Csikszentmihalyi, 1990; Kim, 2021). The positive effects of IMS ($\beta = .348$, $p < .001$) and MSES ($\beta = .319$, $p < .001$) on MPT further emphasise the importance of intrinsic motivation and self-efficacy in achieving higher performance outcomes (Lazarides et al., 2018; Wan, 2021).

The indirect effects analysis revealed that IMS had a total indirect effect of .107 on MPT, which was greater than MSES's total indirect effect of .095. IMS exhibited a stronger indirect effect through MAS (effect = .046 vs. .014 for MSES) and the combined pathway of MAS and LMA (effect = .009 vs. .003 for MSES). Conversely, MSES had a stronger indirect effect through EMS (effect = .032 vs. .014 for IMS). These results suggest that while both intrinsic motivation and self-efficacy are vital for mathematical performance, intrinsic motivation has a more substantial overall impact. This highlights the potential benefits of focusing on enhancing intrinsic motivation to improve students' mathematical outcomes (Rosenzweig et al., 2019).

The current finding that intrinsic motivation mediates performance more strongly than self-efficacy diverges from Lazarides et al. (2018), who attributed 65% of variance to self-efficacy in German samples. This may reflect cultural differences in educational values; Palestinian students, facing systemic barriers, may rely more on internal drive. Conversely, our anxiety-performance correlation ($r = -.669$) aligns with Ding (2016), validating cross-cultural consistency in anxiety's detrimental role.

The SEM analysis reveals that intrinsic motivation and self-efficacy operate synergistically, with anxiety acting as a critical barrier. The high explanatory power ($R^2 = 70.4\%$) validates the need for integrated psychological interventions in mathematics education, particularly in contexts like Palestine where systemic challenges amplify the role of internal drive.

While prior studies (e.g., Rosenzweig et al., 2019; Schunk, 2023) emphasize self-efficacy as the primary driver of mathematical performance, the present study findings highlight intrinsic motivation as having a stronger indirect effect ($\beta = .107$ vs. MSES: $\beta = .095$). This contrasts with Ajayi et al. (2011), who found self-efficacy to be the dominant mediator. This discrepancy may stem from contextual factors unique to Palestinian students, such as systemic educational challenges (e.g., resource limitations), which may amplify the role of intrinsic drive over perceived competence. Additionally, unlike Zakariya & Nordin (2008), who reported anxiety as the strongest negative predictor, our model identifies anxiety's effect ($\beta = -.126$) as secondary to the positive impacts of motivation and self-efficacy, suggesting that interventions targeting engagement may be more impactful in the Palestinian context.

Implications

The study reveals a paradox in Palestinian public schools: despite eighth-grade students exhibiting high self-efficacy, positive attitudes, and enjoyment in mathematics, their performance remains low. This suggests systemic issues, such as inadequate resources, outdated teaching methods, or a misaligned curriculum. Addressing these challenges requires improving resources, aligning the curriculum with students' interests and future goals, and enhancing instructional quality to bridge the gap between perceived value and motivation.

Flow Theory highlights the need to create conditions for deep engagement, such as appropriate challenge levels and effective feedback, which are currently lacking. Professional development for teachers is essential to foster these conditions. Additionally, Attribution Theory suggests that high self-efficacy should reduce anxiety and improve performance, but external constraints may be hindering students' success. Addressing these constraints and developing support structures is crucial.

Achievement Goal Theory indicates that focusing on mastery goals over performance goals could create a more positive learning environment and improve outcomes. Involving families in the educational process and educating parents about realistic expectations can help align students' self-assessments with their actual performance.

Intrinsic motivation has a significant impact on performance, highlighting the importance of fostering students' interest in mathematics through real-world applications and curiosity-driven learning. By addressing curriculum relevance, teaching methods, professional development, parental involvement, and support structures, educators can close the gap between students' self-efficacy and their actual performance, leading to improved educational outcomes in mathematics.

Incorporating real-world applications, such as budgeting exercises or problem-solving in engineering contexts, can enhance students' intrinsic motivation by highlighting the practical value of mathematics, as emphasized by Expectancy-Value Theory (EVT). Structuring learning tasks in progressive stages can help reduce anxiety by ensuring early successes, which in turn fosters self-efficacy. To support mastery-oriented learning, workshops should focus on collaborative problem-solving rather than competitive grading, aligning with Achievement Goal Theory (AGT). Additionally, training teachers in effective feedback techniques; such as linking student efforts to specific improvements (e.g., "Your practice has strengthened your problem-solving approach") can reinforce internal attributions, as suggested by Attribution Theory (AT), further boosting students' confidence and engagement in mathematics.

To sustain student engagement, teachers can implement "flow triggers" as proposed by Csikszentmihalyi (1990). This involves designing differentiated tasks that align with students' individual skill levels, ensuring that challenges remain neither too difficult nor too easy. By maintaining an optimal balance, students are more likely to stay focused, experience deep learning, and develop a sense of enjoyment in mathematics.

Organizing community seminars can help align family expectations with mastery-oriented learning goals. Often, parental pressure to achieve high grades can lead to inflated self-efficacy misperceptions, where students overestimate their abilities without a corresponding improvement in performance. Educating parents on the importance of fostering resilience, effort, and conceptual understanding rather than just focusing on grades can create a supportive home environment that reinforces healthy academic development.

To bridge systemic educational gaps identified in international assessments such as TIMSS (Mulkeen, 2013), policymakers should advocate for better resource allocation. Expanding access to technology, such as interactive learning tools and digital simulations, can enhance hands-on learning experiences, making abstract mathematical concepts more tangible and engaging. Investing in these resources can help create an equitable learning environment that supports student success across diverse educational settings.

Limitations and future directions

The study's results are limited by several factors. The focus on 8th-grade students in West Bank public schools may not be generalisable to other regions or contexts due to cultural and socio-economic differences. Self-reported data may introduce biases, as students might overestimate their abilities due to social desirability or family expectations. The initial model's poor fit, which only improved with modifications, raises concerns about its robustness and potential overfitting.

The cross-sectional design of the study limits causal inferences, suggesting a need for longitudinal research to better understand the interactions between variables over time. Future research should include broader and diverse samples to enhance generalisability, use mixed methods to gain deeper insights, and incorporate longitudinal studies to establish causality.

Future studies could also test specific interventions to improve intrinsic motivation and mathematical performance, and evaluate teaching methods, curriculum relevance, and resources. Refining theoretical models to address discrepancies between self-reported and actual performance, and exploring the role of family and community involvement, could provide a more comprehensive understanding of factors influencing mathematical performance in the West Bank.

Conclusions

Despite high self-efficacy, positive attitudes, and enjoyment in mathematics among 8th-grade students in the West Bank, their performance is below expectations. This discrepancy suggests that systemic factors, such as inadequate resources or ineffective teaching methods, might be affecting their academic outcomes. Social Cognitive Theory (SCT) and Expectancy-Value Theory (EVT) highlight that these systemic issues may hinder the translation of high self-efficacy into better performance, indicating a need for broader educational reforms.

Intrinsic motivation significantly influences students' attitudes towards mathematics, enjoyment, and anxiety reduction, aligning with EVT's emphasis on the importance of intrinsic value in enhancing engagement and reducing anxiety. However, moderate levels of intrinsic motivation suggest a gap between students' perceived value of mathematics and their actual engagement, possibly due to curriculum relevance or instructional quality.

SCT shows that high self-efficacy positively impacts attitudes and enjoyment but has limited effects on performance due to other factors. High mathematics anxiety negatively affects enjoyment and performance, indicating that reducing anxiety is crucial for improving student engagement and outcomes.

Pathway analysis reveals that intrinsic motivation has a stronger indirect effect on performance through attitudes and anxiety than self-efficacy, suggesting that enhancing intrinsic motivation may be more effective for improving performance.

The study underscores the need for systemic and instructional improvements. Addressing issues such as resource constraints and outdated teaching methods, alongside fostering intrinsic motivation, could help bridge the gap between high self-efficacy and actual performance. Additionally, family values and response biases might lead to overestimation of abilities, affecting self-assessments and performance. Overall, while psychological attributes are important, systemic changes and a focus on intrinsic motivation are key to improving educational outcomes.

Disclosure data

- **Participants' Consent:** Prior to data collection, written informed consent was obtained from all participants and their legal guardians after providing a full explanation of the study's purpose, procedures, potential risks, and benefits**.**
- **Availability of data and materials:** The dataset supporting the findings of this study is openly available at Figshare via the following DOI: https://doi.org/10.6084/m9.figshare.28836191.
- **Author contribution:** Mayada Ameen Sammar conceptualized and designed the study, conducted data collection and analysis, interpreted the results, and prepared the manuscript.
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