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Mathematics Anxiety Profiles and Dominant Predictors of Students' Mathematical Problem-Solving Ability for SDG 4: Quality Mathematics Education

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ABSTRACT

Objective: *To identify mathematics anxiety profiles among junior high school students and examine the dominant psychological predictors influencing students' mathematical problem-solving ability. The study addresses the limitation of previous research that often treats mathematics anxiety as a single emotional barrier by examining variations in students' anxiety characteristics and their associated predictors.* ***Method:*** *A mixed-methods sequential explanatory design was employed involving 183 seventh-grade students from two public junior high schools in West Surabaya, Indonesia. Quantitative data were collected using a mathematics anxiety questionnaire and a mathematical problem-solving ability test. Descriptive statistics and multiple regression analysis were conducted to identify anxiety profiles and determine dominant predictors within each profile. Qualitative data from interviews were analyzed to provide deeper explanations of quantitative findings.* ***Results:*** *The findings revealed that students demonstrated different mathematics anxiety characteristics associated with variations in problem-solving ability. Regression analysis showed that dominant predictors differed across anxiety profiles. Psychological factors emerged as the strongest predictor in Cluster 1 ($B = 1.692$, $p < 0.001$), while personality factors became the dominant predictor in Cluster 2 ($B = 1.899$, $p = 0.021$).* ***Novelty:*** *The study contributes to mathematics education research by demonstrating that mathematics anxiety should not be viewed as a homogeneous construct. Instead, different anxiety profiles are associated with different dominant predictors, providing implications for developing differentiated learning strategies that support inclusive and quality mathematics education aligned with Sustainable Development Goal 4.*

INTRODUCTION

Mathematical problem-solving ability is a fundamental competency in mathematics education because it reflects students' capacity to understand mathematical problems, develop appropriate strategies, apply procedures, and evaluate solutions (Gravameijer et al., 2017). In the context of 21st-century education, mathematical problem solving extends beyond computational skills and involves critical thinking, reasoning, and decision-making abilities. Therefore, improving students' mathematical problem-solving ability has become an important objective in achieving quality education (Kim, Lee, & Cho, 2022). This objective is closely aligned with Sustainable Development Goal 4 (SDG 4), which emphasizes inclusive and equitable quality education and the improvement of learning outcomes for all learners (Kioupi & Voulvoulis, 2019).

Despite its importance, many students continue to experience difficulties in solving mathematical problems. These difficulties are not only related to limited conceptual understanding or procedural knowledge but are also influenced by affective factors (Dwivedi et al., 2019). One of the most frequently reported affective barriers in mathematics learning is mathematics anxiety. Mathematics anxiety refers to negative emotional responses experienced when individuals encounter mathematical tasks,

learning activities, or evaluation situations (Halverson & Graham, 2019). Students experiencing mathematics anxiety may feel nervous, confused, afraid of making mistakes, and unable to effectively utilize their cognitive resources during mathematical problem-solving activities (Edina & D., 2026).

However, mathematics anxiety should not be considered a single and homogeneous construct. Students may experience different anxiety characteristics due to variations in psychological conditions, personality characteristics, and self-efficacy beliefs. These internal factors influence how students perceive mathematical challenges, regulate emotional responses, and maintain confidence when engaging in problem-solving activities. Therefore, identifying mathematics anxiety profiles provides a more comprehensive understanding of why students demonstrate different levels of mathematical performance (Caviola et al., 2021).

Some preliminary studies state that math anxiety can affect students' math performance. The classic finding suggests that students are already starting to get anxious when they see numbers, so high number anxiety is associated with lower math scores (Baumert et al., 2017; Yeager et al., 2022). Correspondingly, recent meta-analyses and empirical studies have also confirmed a consistent negative correlation between math anxiety and math achievement at various levels of education (Nazareth et al., 2019; Tang et al., 2022; Živković et al., 2023). As a result, limited evidence is available regarding which factors become dominant predictors of students' mathematical problem solving ability within different mathematics anxienty profiles.

Although previous studies have confirmed the negative relationship between mathematics anxiety and mathematical achievement, limited attention has been given to identifying dominant predictors within different mathematics anxiety profiles (Roos et al., 2022). Previous research has generally focused on the overall effect of mathematics anxiety on achievement, without considering that students with different anxiety characteristics may require different forms of academic support. Therefore, examining dominant predictors across anxiety profiles may provide deeper insights into improving students' mathematical problem-solving ability (Gkintoni et al., 2025).

Furthermore, students experiencing mathematics anxienty cannot be considered a homogeneous group because they may demonstrate different anxienty profiles with distinct psycological charactheristic and learning experiences. Identifying dominant predictors within different mathematics anxienty profiles is therefore essensial to provide a deeper understanding of variations in students' problem solving performance, this approach extends previous research by moving beyond measuring the level of mathematics anxienty and examining which factors contribute most strongly to students' mathematical problem solving ability across different anxienty profiles (Orbach & Fritz, 2021).

To address there gaps, the present study investigates mathematics anxienty profiles and identifies dominant predictos of students' mathematical problem solving ability. Unlike previous studies that focus on the general relationship between mathematics anxienty and achievement, this study analyze the contribution of multiple psycological and social factors across different anxienty profiles. By identifying dominant predictors, this research provides a more comprehensive understanding of why students with different anxienty characteristics demonstrate different problem solving performances (Chan & Liem, 2023).

Therefore, this study aims to identify mathematics anxiety profiles among junior high school students and examine the dominant psychological predictors influencing their mathematical problem-solving ability. Specifically, this study addresses three research

questions: (1) What mathematics anxiety profiles can be identified among junior high school students? (2) Which psychological factors significantly predict students' mathematical problem-solving ability within each profile? and (3) Which factors become the dominant predictors across different mathematics anxiety profiles?

The finding of this study are expected to contribute theoretically by expanding the understanding of mathematics anxienty as a multidimensional construct and practically by supporting teachers in developing differentiated mathematics learning strategies. Furthermore, this study contributes to SDG 4 by promoting quality and inclusive mathematics education through learning approaches that consider students' psycological and social characteristics.

RESEARCH METHOD

Research design

This study employed a mixed-methods sequential explanatory design consisting of quantitative and qualitative phases (Busetto et al., 2020). The quantitative phase was conducted to identify mathematics anxiety profiles and determine dominant predictors of students' mathematical problem-solving ability through statistical analysis (Macaro et al., 2017). Subsequently, the qualitative phase was conducted to explore students' experiences and provide contextual explanations of the quantitative findings. The integration of both approaches enabled a more comprehensive understanding of how mathematics anxiety characteristics influence mathematical problem-solving performance (Bubeck et al., 2023).

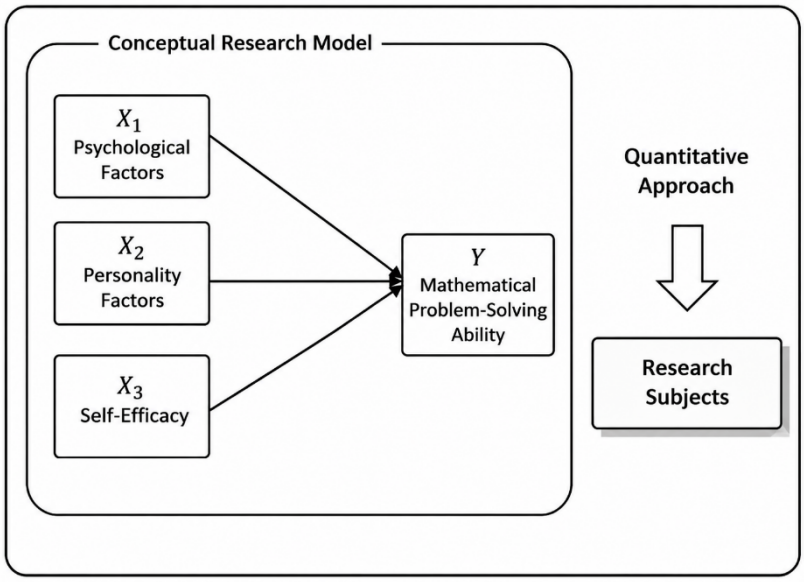

Figure 1. Conceptual research model

The conceptual model illustrates the relationship between mathematics anxiety profiles, psychological characteristics, and students' mathematical problem-solving ability. Three main predictor variables were examined, including psychological factors (X_1), personality factors (X_2), and self-efficacy (X_3). These factors were analyzed to determine their contribution and dominant influence on students' mathematical problem-solving ability across different mathematics anxiety profiles (Leithwood et al., 2021).

Participants

The participants of this study were 183 seventh-grade students from two public junior high schools in West Surabaya, Indonesia. Participation was voluntary, and ethical considerations regarding confidentiality and participant anonymity were maintained throughout the research process. The selection of seventh-grade students was based on their transitional stage in mathematics learning, where students begin to encounter more abstract mathematical concepts and increasingly complex problem-solving tasks. The research setting was selected to represent the context of junior high school mathematics learning, where students are expected to develop mathematical reasoning and problem-solving abilities while facing various psychological challenges, including mathematics anxiety. The participants were involved in completing the mathematics anxiety questionnaire and mathematical problem-solving ability test as part of the quantitative phase of the study.

Research instruments

1. Mathematics anxienty questionnaire
   The Mathematics Anxiety Questionnaire (MAQ) was used to measure students' mathematics anxiety and its associated psychological and social factors. The instrument was developed to capture the multidimensional characteristics of mathematics anxiety, consisting of six factors: psychological factors, personality characteristics, self-efficacy, teacher-related factors, peer-related factors, and parental-related factors. These factors represent internal and external conditions that may influence students' emotional responses, confidence, and learning experiences when engaging with mathematical tasks. The questionnaire was used to identify students' mathematics anxiety profiles and examine the contribution of each factor in predicting mathematical problem-solving ability (Holmes et al., 2018).
2. Mathematical problem-solving ability test
   The Mathematical Problem-Solving Ability Test (MPSAT) was used to assess students' ability to solve mathematical problems. The instrument was designed based on problem-solving stages, including understanding the problem, devising a plan, carrying out the plan, and looking back. The test evaluated students' ability to interpret mathematical information, select appropriate strategies, perform mathematical procedures, and evaluate the correctness of their solutions. The obtained scores represented students' mathematical problem-solving ability as the dependent variable in this study (Alzubaidi et al., 2021).

Data collection procedure

Data collection was conducted in two sequential phases following the mixed-methods explanatory design. In the first phase, quantitative data were collected by administering the Mathematics Anxiety Questionnaire and the Mathematical Problem-Solving Ability Test to junior high school students. The questionnaire was used to identify students' mathematics anxiety characteristics based on psychological and social factors, while the problem-solving test was used to measure students' mathematical problem-solving ability (Kasneci et al., 2023).

After the quantitative data were collected, statistical analyses were conducted to identify mathematics anxiety profiles and determine the dominant predictors influencing students' mathematical problem-solving ability. Based on the quantitative findings, selected participants were involved in the qualitative phase through interviews and problem-solving process analysis (Macaro et al., 2017).

The qualitative phase was conducted to provide deeper explanations regarding students' experiences, difficulties, and cognitive processes when solving mathematical problems. The integration of quantitative and qualitative findings enabled the researchers to obtain a more comprehensive understanding of how mathematics anxiety profiles and their associated factors influence students' mathematical problem-solving ability (Thornhill et al., 2023).

Data analysis

Quantitative data were analyzed using descriptive statistics and multiple regression analysis. Descriptive statistics were used to identify students' mathematics anxiety characteristics and mathematical problem-solving ability levels (Pascual et al., 2019). Multiple regression analysis was conducted separately across anxiety profiles to determine the contribution and dominant predictors influencing mathematical problem-solving ability. The dominant predictor was identified based on regression coefficients, significance values, and explanatory power of the regression model. Qualitative interview data were analyzed descriptively to explain students' experiences related to mathematics anxiety and problem-solving processes (Kennedy et al., 2021).

RESULTS AND DISCUSSION

Results

Students' mathematical problem-solving ability

The initial analysis was conducted to describe students' mathematical problem-solving ability levels. The results showed that students were distributed into three categories: low, moderate, and high problem-solving ability. The distribution of students' problem-solving ability levels is presented in Table 1.

Table 1. Distribution of students' mathematical problem-solving ability levels

Problem-Solving Ability Level	Frequency	Percentage (%)
Low	4	2.2
Moderate	93	50.8
High	86	47.0
Total	183	100

As presented in Table 1, most students were categorized as having moderate mathematical problem-solving ability (50.8%), followed by high ability (47.0%), while only a small proportion were categorized as having low ability (2.2%). These results indicate that students demonstrated varied levels of mathematical problem-solving performance.

Mathematics anxienty profiles

The analysis of mathematics anxiety was conducted to identify students' emotional characteristics when engaging with mathematics learning activities. Mathematics anxiety was measured through six dimensions, including psychological factors, personality factors, self-efficacy, teacher-related factors, peer-related factors, and parental factors is presented in Table 2.

Table 2. Distribution of students' mathematics anxienty levels

Mathematics Anxiety Level	Frequency	Percentage (%)
Low	4	2.19
Moderate	142	77.60
High	37	20.21
Total	183	100

As presented in Table 2, the analysis revealed variations in students' mathematics anxiety characteristics. Most students experienced moderate mathematics anxiety (77.60%), followed by high anxiety (20.21%) and low anxiety (2.19%). These findings indicate that mathematics anxiety represents a common affective experience among junior high school students.

Dominant predictors across mathematics anxienty profiles

Multiple regression analysis was conducted separately for each mathematics anxiety profile to identify dominant predictors influencing students' mathematical problem-solving ability. The regression results are presented in Table 3.

Table 3. Regression result and dominant predictors across mathematics anxienty profiles

Mathematics Anxiety Profile	Predictor	B	Sig.	R^2
Cluster 1 (Confused, Panic, Tense, Stress)	Psychological Factors	1.692	0.000	0.934
Cluster 2 (Pessimistic)	Personality Factors	1.899	0.021	0.747

As presented in Table 3, the regression analysis demonstrated that dominant predictors differed across mathematics anxiety profiles. Psychological factors emerged as the strongest predictor in Cluster 1 ($B = 1.692$, $p < 0.001$), while personality factors became the dominant predictor in Cluster 2 ($B = 1.899$, $p = 0.021$). These findings indicate that students with different anxiety characteristics are influenced by different psychological conditions when solving mathematical problems.

Qualitative explanation of mathematics anxiety and problem-solving processes

The qualitative findings were used to explain the quantitative results regarding the influence of anxiety-related factors on students' mathematical problem-solving processes. Analysis of students' written responses and interviews showed that students with higher problem-solving ability tended to demonstrate confidence in understanding problems, selecting strategies, performing calculations, and verifying their answers.

Students with lower problem-solving ability showed greater difficulty, particularly in executing mathematical procedures and checking the accuracy of solutions. These difficulties were often accompanied by emotional responses such as hesitation, uncertainty, and lack of confidence when facing mathematical tasks. The interview findings also indicated that students' experiences with teachers and peers influenced their emotional responses toward mathematics. Supportive teacher explanations and positive peer interactions helped students feel more comfortable when encountering difficult mathematical problems. Conversely, fear of negative evaluation and lack of confidence could intensify mathematics anxiety.

These findings provide further evidence that mathematical problem-solving ability is influenced by cognitive and affective factors simultaneously. Improving mathematics

learning outcomes therefore requires attention not only to students' mathematical knowledge but also to psychological and social conditions that shape their learning experiences.

Discussion

Mathematics anxiety as a multidimensional construct

The finding that most students experienced moderate mathematics anxiety indicates that anxiety is a common phenomenon in mathematics learning rather than an issue limited to a small number of learners. This finding supports the perspective that mathematics anxiety represents a multidimensional construct influenced by students' psychological characteristics, beliefs, and learning experiences (Rahman et al., 2024).

Dominant role of psychological and personality factors

1. Psycological factors as dominant predictors
   The dominance of psychological factors among Cluster 1 students suggests that emotional regulation and internal psychological conditions play an important role in mathematical problem solving. Students experiencing confusion, tension, or stress may face difficulties in allocating cognitive resources effectively when processing mathematical information. Therefore, improving students' emotional regulation and reducing negative psychological responses may support better engagement in mathematical problem-solving activities (Morosanova et al., 2019).
2. Personality factors as dominant predictors
   Personality factors became the strongest predictor among Cluster 2 students. This finding indicates that individual characteristics, such as persistence, confidence, and attitudes toward challenges, influence how students approach mathematical tasks. Students with stronger adaptive personality characteristics may demonstrate greater willingness to explore strategies, overcome difficulties, and evaluate their solutions (Janssen et al., 2022).

Qualitative findings integrations

The qualitative findings further supported the quantitative results by showing that students' emotional experiences influenced their problem-solving processes. Students with higher anxiety characteristics tended to demonstrate hesitation, uncertainty, and reduced confidence when facing mathematical tasks. Conversely, students with better problem-solving performance showed greater confidence in understanding problems, selecting strategies, and evaluating solutions (Živković et al., 2023).

Implications for quality mathematics education

The findings provide important implications for achieving SDG 4 by emphasizing the importance of inclusive mathematics education that considers students' cognitive and emotional diversity. Mathematics instruction should not only focus on improving mathematical knowledge but also address psychological factors that influence students' engagement and confidence. Differentiated learning strategies that consider students' anxiety characteristics may contribute to more equitable and effective mathematics education (Llanos et al., 2025).

CONCLUSION

Fundamental Finding: This study demonstrates that mathematics anxiety among junior high school students represents a multidimensional construct influenced by different

psychological characteristics. The findings reveal that students' mathematical problem-solving ability varies across mathematics anxiety profiles. The regression analysis indicates that dominant predictors differ between profiles, where psychological factors become the strongest predictor in Cluster 1, while personality factors emerge as the dominant predictor in Cluster 2. These findings highlight that students with different anxiety characteristics experience different psychological conditions that influence their mathematical problem-solving performance. **Implication:** The findings emphasize the importance of implementing differentiated mathematics learning strategies that consider students' psychological characteristics and emotional experiences. Mathematics educators should not only focus on improving students' mathematical knowledge and problem-solving strategies but also provide learning environments that strengthen students' psychological readiness, confidence, and positive attitudes toward mathematics. These efforts contribute to Sustainable Development Goal 4 (SDG 4) by supporting inclusive and equitable quality mathematics education that accommodates diverse student needs. **Limitation:** This study has several limitations. First, the participants were limited to 183 seventh-grade students from two public junior high schools in West Surabaya, Indonesia; therefore, the findings may not fully represent students from different educational levels, regions, or cultural backgrounds. Second, mathematics anxiety was examined through selected psychological dimensions, while other contextual factors may also influence students' mathematical problem-solving ability. **Future Research:** Future research may investigate mathematics anxiety profiles across broader educational contexts and involve participants from different school levels and regions. Longitudinal studies are also recommended to examine changes in students' mathematics anxiety characteristics over time. Furthermore, intervention-based research may explore effective learning strategies designed to reduce mathematics anxiety and enhance students' mathematical problem-solving ability.

AUTHOR CONTRIBUTIONS

Herfa Maulina Dewi Soewardini contributed to the conceptualisation, and data curation. **Yusuf Fuad** contributed to the formal analysis, investigation, and methodology. **Rooselyna Ekawati** contributed to the preparation of the original manuscript.

CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest regarding the publication of this research. The research was conducted independently, and there were no financial, institutional, or personal relationships that could influence the findings and interpretation presented in this article.

ETHICAL COMPLIANCE STATEMENT

This research complied with ethical principles in qualitative research. The identities of participants and organizations were anonymized to maintain confidentiality. Data collection was conducted through voluntary participation, and participants provided informed consent before interviews and observations were conducted.

STATEMENT ON THE USE OF AI OR DIGITAL TOOLS IN WRITING

The authors declare that artificial intelligence (AI)-based tools were not used to generate research data, conduct analysis, or replace academic judgment in the research process. AI tools, if utilized, were only applied as supporting instruments for language

improvement, proofreading, and enhancing manuscript readability. The authors remain fully responsible for the accuracy, originality, and integrity of the research content.

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