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How can the mathematics anxiety rating scale be modified for Indonesian elementary students (aged 10-12)? A psychometric analysis

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Abstract

Mathematics anxiety is a well-documented affective factor that negatively influences students' learning processes and academic achievement. While the Mathematics Anxiety Rating Scale (MARS) is among the most established instruments for assessing this construct, it was originally developed for adolescents and adults, thereby limiting its applicability for younger learners. Despite increasing recognition of the early onset of mathematics anxiety, few validated instruments exist for measuring this phenomenon in elementary school students, particularly within non-Western contexts. Addressing this gap, the present study introduces a culturally and developmentally appropriate adaptation of the MARS for Indonesian elementary students aged 10–12 years. Employing a quantitative psychometric approach with a cross-sectional survey design, data were collected from 324 students via an online questionnaire. The MARS-30 was linguistically simplified and contextually adapted to suit the cognitive and emotional characteristics of younger learners. Exploratory Factor Analysis (EFA) revealed a two-factor solution—Mathematics Test Anxiety and Numerical Anxiety—accounting for 57.62% of the total variance. Confirmatory Factor Analysis (CFA) further supported this structure, yielding satisfactory model fit indices (CFI = 0.94, TLI = 0.92, RMSEA = 0.06, and SRMR = 0.05). Internal consistency reliability was high for the overall scale ($\alpha = 0.87$) and its subscales (Mathematics Test Anxiety: $\alpha = 0.85$; Numerical Anxiety: $\alpha = 0.84$). These results provide robust empirical evidence for the multidimensional nature of mathematics anxiety in children and validate the adapted MARS as a psychometrically sound instrument for use in Indonesian elementary educational settings. The findings underscore the importance of early detection and culturally responsive assessment of mathematics anxiety, informing future research and intervention strategies aimed at mitigating its long-term educational impact.

Keywords: Elementary Students, Mathematics Anxiety Rating Scale, Numerical Anxiety, Psychometric Validation, Test Anxiety

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Mathematics anxiety is a pervasive psychological construct known to adversely affect students' academic performance and their attitudes toward mathematics. It is typically defined as a state of tension, apprehension, or fear that disrupts engagement with mathematical tasks and impairs problem-solving and learning (Suresh, 2023). High levels of mathematics anxiety have been consistently linked to avoidance behaviors, reduced motivation, and lower achievement in mathematics-related domains (Kyttälä & Björn, 2022). Notably, this form of anxiety can emerge as early as elementary school, highlighting the importance of early detection and intervention strategies (Maclean & Law, 2022).

Despite the growing recognition of its significance, research examining mathematics anxiety among elementary students in Indonesia remains limited. Moreover, existing instruments employed to assess this phenomenon often lack developmental suitability and cultural relevance for young learners. In Indonesia, national assessments have revealed widespread difficulties in mathematics performance and the emergence of negative attitudes toward the subject (Diponegoro et al., 2024). However, these assessments do not explicitly attribute such difficulties to mathematics anxiety, underscoring a critical gap in localized, validated tools capable of isolating and quantifying anxiety specific to mathematics among children. Addressing this gap necessitates the development of a reliable and valid instrument tailored to the Indonesian educational and cultural context.

One of the most widely used instruments for assessing mathematics anxiety is the Mathematics Anxiety Rating Scale (MARS), originally developed by Richardson and Suinn (1972). MARS has been adopted extensively across diverse populations due to its comprehensive coverage of both cognitive and affective components of anxiety, including worry, fear, and physiological arousal. Initially designed for adolescents and adults in Western educational contexts, MARS has since been adapted into shorter versions such as MARS-30 and MARS-E (Elementary version) to enhance usability (Suinn & Winston, 2003). The MARS-30 condenses the original 98-item scale while preserving its core constructs, and the MARS-E is designed specifically for younger students. Nevertheless, these adaptations were developed within Western sociocultural frameworks and include context-specific references—such as "taking a college entrance exam" or "calculating income tax"—that may not resonate with or be developmentally appropriate for elementary students in Indonesia. Additionally, the emphasis on formalized mathematical scenarios may not align with the everyday mathematical experiences of children in Indonesian classrooms, increasing the likelihood of misinterpreting anxiety-related responses. Therefore, adapting and validating a modified version of MARS for Indonesian elementary students aged 10–12 is essential to ensure both linguistic comprehensibility and contextual relevance.

Although the psychometric properties of MARS have been rigorously examined in various settings, applying the instrument across cultures requires thoughtful modifications to accommodate linguistic, educational, and cultural differences (Balluerka et al., 2024). In the Indonesian context, classroom environments are often characterized by teacher-centered pedagogy, high-stakes assessments, and elevated parental expectations—all of which may uniquely shape students' experiences and expressions of mathematics anxiety (Ghaleb, 2024). Furthermore, many students speak local languages at home while receiving instruction in Indonesian, adding a layer of linguistic complexity that may hinder comprehension and affect the reliability of measurement instruments.

To date, research on mathematics anxiety measurement in Indonesia has primarily focused on secondary and postsecondary students (Prahmana et al., 2021). Given that mathematics anxiety often originates in early educational experiences, it is imperative to develop an instrument that reflects young learners' cognitive development, linguistic proficiency, and cultural context (Hamamcı, 2025). Prior studies have demonstrated that early exposure to mathematics significantly influences students' long-term attitudes toward STEM disciplines (Quintana & Saatcioglu, 2022). Without appropriate tools for early identification, efforts to mitigate the adverse effects of mathematics anxiety will remain fragmented and less effective. A modified version of MARS tailored to the needs of Indonesian elementary students would enable more accurate diagnosis and timely intervention, thereby promoting more positive mathematical dispositions from an early age.

The modification process requires several critical adjustments. First, language simplification is necessary to ensure that students aged 10–12 can comprehend the items without ambiguity. Second,

the scenarios presented should reflect typical school experiences in Indonesia, such as classroom quizzes, group activities, and everyday arithmetic tasks (Ruslan Mahfuz et al., 2024). Third, items referencing advanced mathematical concepts should be either removed or replaced with age-appropriate content, as students at this level may not yet engage with topics like algebra or statistics (Boyer et al., 2008; Powell & Nelson, 2021). These adjustments are particularly pertinent in Indonesia, where the diversity of regional languages and variations in educational quality present challenges to the implementation of standardized instruments (Umeh, 2025). Although the psychometric properties of the modified tool will require empirical validation, similar adaptations in other countries have yielded promising results (Mishu et al., 2023). Thus, an appropriately adapted instrument may offer a robust framework for assessing mathematics anxiety in this age group.

This study seeks to modify and validate the Mathematics Anxiety Rating Scale (MARS) for Indonesian elementary students aged 10–12. This age range marks a critical developmental stage where learners are introduced to more abstract mathematical concepts—such as fractions, decimals, and basic geometry—that are frequently associated with heightened anxiety. The need for modification is supported by evidence indicating that standardized instruments often fail to account for the cultural, linguistic, and developmental characteristics of non-Western primary school students (Kanth et al., 2024; Waschl & Chen, 2022). Inaccurate or culturally inappropriate measurement may lead to misdiagnosis and ultimately to ineffective interventions (Hilz et al., 2023; Pizzie & Kraemer, 2023). In contrast to prior studies that rely primarily on translation, this research adopts a comprehensive approach to scale adaptation, incorporating linguistic, cultural, and developmental considerations. It responds to the lack of psychometrically validated tools for early identification of mathematics anxiety in Southeast Asia, particularly at the elementary level.

The anticipated outcomes of this study hold implications for multiple stakeholders in elementary education. A culturally and developmentally appropriate mathematics anxiety scale would allow educators to identify students at risk and implement targeted interventions to enhance mathematical confidence and reduce avoidance behaviors (Petronzi et al., 2021). Policymakers could leverage such data to design mathematics curricula that mitigate anxiety-inducing elements while fostering supportive classroom environments. As global emphasis on STEM education continues to grow, addressing mathematics anxiety in the foundational years becomes increasingly critical for preparing students to pursue math-intensive fields in the future (Furner & Duffy, 2022).

Beyond its educational significance, this study contributes to the field of psychometric assessment by extending the applicability of MARS to younger, non-Western populations. Much of the existing literature on mathematics anxiety measurement has centered on Western countries, with limited research focusing on Southeast Asia and Indonesia in particular (Yuan et al., 2023). By developing and validating a culturally adapted instrument, this study addresses a notable gap and lays the groundwork for further inquiry in diverse educational contexts. The modified MARS is expected to offer a psychometrically sound, contextually grounded tool for the early detection of mathematics anxiety among Indonesian learners and may serve as a model for similar adaptations in other multilingual and multicultural settings.

METHODS

Research Design

This study employed a quantitative research design utilizing a psychometric approach to modify and validate the MARS for Indonesian elementary students aged 10–12 years. To ensure methodological rigor and

transparency, the research was conducted in three systematic stages, as summarized in Table 1.

Table 1. Research design overview

Stage	Description
Stage 1	Modification and adaptation of MARS-30, including item simplification and contextual adjustments to fit the 10–12 age group.
Stage 2	Data collection via an online survey (Google Forms) with adult guidance and ethical approval.
Stage 3	Psychometric analysis, including Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and reliability testing.

EFA was conducted to identify the underlying factor structure of the modified scale by examining the interrelationships among items without imposing a preconceived structure (Costello & Osborne, 2005). EFA is appropriate in early instrument development stages to explore dimensionality and item grouping (Fabrigar et al., 1999). CFA was then used to test whether the factor structure identified through EFA adequately fits the data collected. CFA provides statistical evidence of construct validity by assessing model fit indices and factor loadings (Brown et al., 2017). Together, EFA and CFA help ensure that the modified MARS measures mathematics anxiety accurately and consistently for Indonesian elementary students. The aim was to develop a valid and reliable instrument to measure mathematics anxiety in Indonesian elementary students, allowing for early identification and intervention. To ensure rigorous instrument modification, the procedure included a systematic review of each original MARS-30 item. Items with contexts unsuitable for elementary students, such as references to university-level exams or adult life situations, were replaced with contexts relevant to daily experiences of students aged 10–12 years (e.g., “taking a college placement test” was modified to “doing a school math quiz”). Language was simplified to match the reading and comprehension abilities typical of Indonesian elementary students, following guidelines for developing child-friendly scales (Maisaroh et al., 2024). Three elementary school teachers and two educational psychologists reviewed and validated the content for theoretical relevance and developmental appropriateness, contributing to content (internal) validity.

Participants and Procedures

This study was conducted between October and November 2024. It involved 324 elementary school students aged 10 to 12 years from 11 cities and regencies across five provinces in Indonesia, including both urban and rural areas such as Jakarta, Surabaya, Sleman, Lumajang, and Tana Toraja. A convenience sampling method was used to recruit participants. While this method has limitations regarding representativeness, efforts were made to enhance diversity by involving schools from various socio-economic and geographical contexts public and private schools, urban and rural areas, and regions with differing levels of digital access (as recommended in socio-demographic sampling strategies; (Omweri, 2024). The sample size of 324 was determined based on psychometric testing guidelines, which recommend a minimum of 300 participants for robust factor analysis (Costello & Osborne, 2005). Parental consent was obtained through a digital consent form embedded at the beginning of the online survey. Parents or guardians were required to read and approve the participation of their children before the students could proceed. The study adhered to ethical standards for research involving minors, including confidentiality, anonymity, and voluntary participation (Tigges, 2004).

The data collection was conducted through an online survey using Google Forms. The survey link was distributed via school networks, teacher WhatsApp groups, and parent communities. It was not

publicly posted but rather shared in closed groups where participant identity and school affiliation could be reasonably verified by the distributing teachers. To reduce bias, only one response was accepted per device and students were required to input their school's name and grade level, allowing researchers to confirm age appropriateness and institutional affiliation. To address concerns about children's comprehension and device access, the following steps were taken:

1. Students completed the survey at home under the guidance of their parents or teachers.
2. Instructions were delivered both in writing and through a short, embedded video to explain how to fill out the form step-by-step.
3. Schools involved in the dissemination confirmed that participating students had access to digital devices at home or were supported through school-owned devices provided temporarily for participation. Although some Indonesian schools restrict phones during regular class time, this data collection was conducted outside classroom hours with parental coordination.

To ensure data quality, only responses from students aged 10–12 years were retained. Age, grade level, and school name were cross-checked to validate eligibility. Responses that appeared to be completed unusually quickly were flagged for review, and a sensitivity analysis was conducted to examine response patterns. This approach is aligned with quality control standards in child response studies (Tigges, 2004).

Assessment Instrument: Modified MARS

The MARS-30 was originally developed by Suinn and Winston (2003) as a shortened version of the full MARS scale by Richardson and Suinn (1972). The original MARS-30 consists of 30 items measuring mathematics anxiety across two dimensions:

1. Mathematics Test Anxiety – Fear or nervousness related to math exams and quizzes.
2. Numerical Anxiety – Anxiety associated with handling numbers in everyday life.

For this study, the MARS-30 was modified to better suit elementary students aged 10-12 years. The modifications included:

1. Simplifying language to ensure that all questions were understandable for young students, avoiding complex or abstract phrasing.
2. Revising context by adjusting items related to real-life mathematical situations relevant to elementary students (e.g., replacing "college entrance exams" with "school math tests" or "homework assignments").
3. Removing or replacing items related to advanced mathematical operations that exceed elementary-level curricula, substituting them with contexts such as basic arithmetic, multiplication tables, or daily math tasks like counting money.
4. Maintaining the 5-point Likert scale format: 1 = Not at all, 2 = Slightly, 3 = Moderately, 4 = Quite a bit, and 5 = Very much

To ensure content validity and theoretical appropriateness, the modified items were reviewed by a panel of five experts, including two educational psychologists and three elementary school teachers. This step served as an internal validation process to ensure that the scale aligns with the developmental stage and mathematical experiences of Indonesian students. The panel provided feedback regarding language clarity, age-appropriate context, and construct coverage, which was incorporated into the final version of

the instrument before empirical testing.

Data Analysis

The collected data were analyzed using IBM SPSS 26 and AMOS 24 software. The analysis involved multiple steps to ensure the validity, reliability, and psychometric accuracy of the modified MARS for Indonesian elementary students. The primary purpose of this study was not only to modify the MARS but also to test the validity and reliability of the modified instrument to ensure its appropriateness for the target age group. Basic descriptive statistics were calculated, including mean, standard deviation, skewness, and kurtosis, to assess data distribution and identify potential outliers. Skewness and kurtosis values were examined to determine whether the data followed a normal distribution, which is an essential assumption for subsequent analyses. If extreme skewness or kurtosis was detected, data transformations or adjustments were considered to improve normality.

Validity Testing

In addition to the expert review during the item modification phase (serving as a form of internal or content validity), the construct validity of the modified MARS was assessed using two types of factor analyses: EFA and CFA.

1. Content Validation by Experts
   Prior to the statistical validation, the initial draft of the modified MARS items was reviewed by a panel consisting of three elementary school teachers and two educational psychologists. This expert panel evaluated each item for age-appropriateness, linguistic clarity, and cultural relevance. Items containing unfamiliar or developmentally inappropriate contexts (e.g., college-level exams, bank loans) were revised or replaced with scenarios grounded in the daily experiences of 10–12-year-old Indonesian students (e.g., math quizzes, class savings, shopping). The qualitative feedback was used to refine wording and contextual alignment, ensuring that each item reflected the cognitive and emotional experiences relevant to the target group. This process strengthened the content validity of the scale before empirical testing.
2. Construct Validation
   Following the expert review, EFA was conducted using Principal Component Analysis (PCA) with Varimax rotation to examine the underlying factor structure without assuming a predefined model. Items with factor loadings below 0.4 were considered for removal to improve the scale's psychometric strength. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity confirmed the suitability of the data for factor analysis. Subsequently, CFA was performed using maximum likelihood estimation in AMOS 24 to test the model fit identified through EFA. Model fit was evaluated using the following widely accepted indices:
   a. Comparative Fit Index (CFI): Acceptable if ≥ 0.90
   b. Root Mean Square Error of Approximation (RMSEA): Acceptable if ≤ 0.08
   c. Standardized Root Mean Square Residual (SRMR): Acceptable if ≤ 0.08
   d. Chi-square/df ratio (χ^2/df): Acceptable if ≤ 3

These combined steps expert review and statistical factor analysis ensured both theoretical and empirical validation of the modified MARS (see Figure 1).

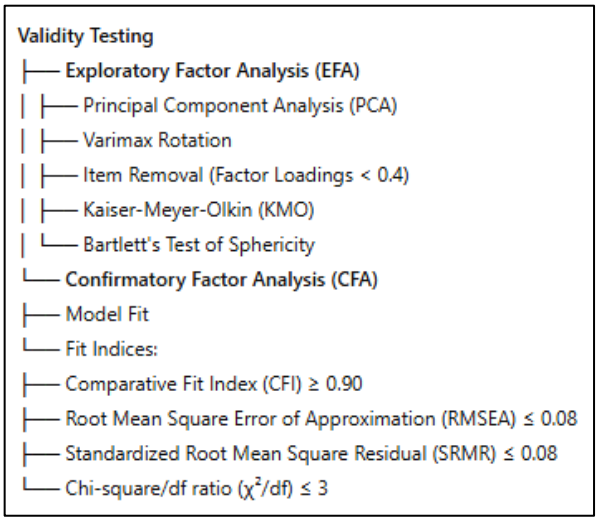

Figure 1. Validity testing

Reliability Testing

To assess the internal consistency of the modified MARS, Cronbach's Alpha (α) was calculated for each identified factor and for the total scale. A Cronbach's Alpha coefficient above 0.7 was considered acceptable, while values above 0.8 indicated strong reliability (George & Mallery, 2018). Additionally, corrected item-total correlations were examined to ensure that each item contributed meaningfully to the overall scale. If an item had a weak correlation with the total score, it was considered for removal to enhance reliability (see Figure 2).

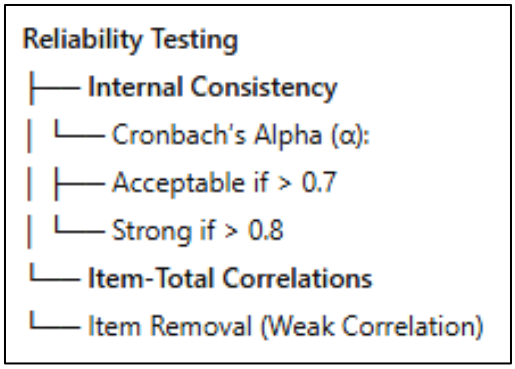

Figure 2. Reliability testing

Results from CFA

In this study, CFA was primarily used instead of EFA, since the original MARS-30 already groups items into two theoretical dimensions: Mathematics Test Anxiety and Numerical Anxiety (Richardson & Suinn, 1972; Suinn & Winston, 2003). CFA is appropriate when the factor structure is predetermined and the goal is to test whether the collected data fit the hypothesized model (Kyriazos & Poga-Kyriazou, 2023). Table 2 presents the standardized factor loadings from the CFA, showing that 16 items were confirmed to load significantly (≥ 0.40) on their intended dimensions, while 14 items were removed due to weak or cross loadings.

Table 2. Factor loadings from CFA

Item Number	Factor Loading	Retained (✓) / Removed (✗)
Item 1	0.72	✓
Item 2	0.65	✓
Item 3	0.78	✓
Item 4	0.69	✓
Item 5	0.62	✓
Item 6	0.55	✗
Item 7	0.58	✗
Item 8	0.75	✓
Item 9	0.71	✓
Item 10	0.67	✓
Item 11	0.45	✗
Item 12	0.79	✓
Item 13	0.60	✗
Item 14	0.52	✗
Item 15	0.66	✓
Item 16	0.73	✓
Item 17	0.41	✗
Item 18	0.48	✗
Item 19	0.51	✗
Item 20	0.44	✗
Item 21	0.70	✓
Item 22	0.59	✗
Item 23	0.61	✗
Item 24	0.79	✓
Item 25	0.77	✓
Item 26	0.50	✗
Item 27	0.42	✗
Item 28	0.74	✓
Item 29	0.76	✓
Item 30	0.72	✓

A total of 16 items were retained (✓) with satisfactory factor loadings (≥ 0.40), confirming their contribution to the Mathematics Anxiety construct within the two hypothesized dimensions. This refinement ensured that only the most relevant and reliable items were included in the final version of the modified MARS for elementary students.

Reliability Analysis

Reliability testing was conducted using Cronbach's Alpha (α) to examine the internal consistency of the retained items. The reliability coefficient for the final 16-item instrument was α = 0.87, indicating strong internal consistency. In addition to Cronbach's Alpha, Composite Reliability (CR) was also calculated for each dimension during the CFA phase. A CR value above 0.70 confirmed that the items consistently measured the intended constructs. This study employed a quantitative psychometric approach to modify,

confirm the factor structure (via CFA), and test the reliability of the MARS for Indonesian elementary students. A total of 324 students aged 10-12 years participated by completing the Google Forms survey. The psychometric analysis confirmed a robust two-factor structure and high reliability (α = 0.87; CR values > 0.70 for both dimensions). These findings indicate that the modified MARS is a valid and reliable instrument for assessing mathematics anxiety in Indonesian elementary students.

RESULTS AND DISCUSSION

Descriptive Statistics of Participants

A total of 324 elementary school students aged 10-12 years participated in this study. The demographic distribution of the sample is presented in Table 3.

Table 3. Demographic characteristics of participants

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	156	48.15%
	Female	168	51.85%
Age	10 years	102	31.48%
	11 years	120	37.04%
	12 years	102	31.48%
School Type	Public School	214	66.05%
	Private School	110	33.95%

The sample consisted of 156 male students (48.15%) and 168 female students (51.85%). The participants were evenly distributed across the 10-year-old (31.48%), 11-year-old (37.04%), and 12-year-old (31.48%) groups. The majority of students were from public schools (66.05%), while 33.95% attended private schools.

Descriptive Statistics of the Modified MARS Scores

The modified MARS consisted of 16 valid items after factor analysis. The descriptive statistics of the modified MARS scores are summarized in Table 4.

Table 4. Descriptive statistics of modified MARS scores

Statistic	Mean	SD	Skewness	Kurtosis
Total MARS Score	48.76	12.34	0.45	-0.12
Mathematics Test Anxiety (8 items)	26.42	6.85	0.38	-0.25
Numerical Anxiety (8 items)	22.34	5.92	0.52	0.03

The mean total score for the modified MARS was 48.76 (SD = 12.34), indicating a moderate level of mathematics anxiety among elementary school students. The Mathematics Test Anxiety subscale had a mean of 26.42 (SD = 6.85), while the Numerical Anxiety subscale had a mean of 22.34 (SD = 5.92). The skewness and kurtosis values indicated that the data were approximately normally distributed.

Instrument Refinement and Item Reduction

Before proceeding to factor analysis, the original 30-item version of the MARS-30 was reviewed and modified to fit the developmental and contextual characteristics of Indonesian elementary school students

aged 10–12 years. The adaptation process involved language simplification, context adjustment, and expert validation to ensure the content was age-appropriate and culturally relevant. A total of 16 items were retained in the final version based on both empirical evidence and expert review. Items were excluded if they (a) had factor loadings below 0.40, (b) were considered too complex or irrelevant for the target age group (e.g., references to taxation, calculator use, or budget management), or (c) overlapped in meaning with other items.

The refinement process included feedback from three elementary school teachers and two educational psychologists and aligned with child-appropriate scale development principles (DeVellis, 2017). The comparison of the original and modified scale versions is summarized in Table 5.

Table 5. Comparison of the original and modified MARS instruments

Instrument Version	Number of Items	Scale Format	Subscales	Notes
Original MARS-30	30	4-point Likert	Mathematics Test Anxiety, Numerical Anxiety	Adapted from Suinn and Winston (2003); developed for adolescents and adults
Modified MARS-16	16	4-point Likert	Mathematics Test Anxiety, Numerical Anxiety	Validated for Indonesian elementary school students aged 10–12

This revision ensured that the scale was both psychometrically sound and ecologically valid for the intended population. The following section presents the results of the EFA used to verify the factor structure of the 16-item instrument.

Qualitative Development of Indicators

Before conducting the psychometric analysis, a qualitative content review of the original MARS-30 items was undertaken to ensure age-appropriateness and cultural relevance for Indonesian elementary students. This review was conducted by a panel comprising three elementary school teachers and two educational psychologists, who evaluated each item for linguistic clarity, developmental suitability, and contextual alignment with the lived experiences of students aged 10–12. Items containing adult-oriented content—such as references to “taking a college entrance exam” or “calculating loan interest”—were either eliminated or revised to reflect scenarios familiar to elementary students (e.g., “doing a school math quiz” or “counting class savings”).

The language simplification process adhered to established guidelines for the development of child-friendly instruments, ensuring that all items were comprehensible without the need for adult interpretation or support. Based on expert feedback and theoretical congruence with the constructs of mathematics test anxiety and numerical anxiety, a total of 16 items were selected for inclusion in the final version of the instrument. These included items retained with minor wording revisions, as well as others that were significantly adapted or replaced to better reflect the target population's experiences. This qualitative stage played a critical role in establishing the content validity of the modified instrument and ensured that subsequent quantitative validation through EFA and CFA would be based on items that were both developmentally appropriate and culturally meaningful.

Exploratory Factor Analysis (EFA)

To examine the factor structure of the modified MARS, EFA was conducted using PCA with Varimax

rotation. The KMO measure of sampling adequacy was 0.86, and Bartlett's test of sphericity was significant ($\chi^2 = 1354.67$, $p < 0.001$), indicating that the data were suitable for factor analysis, as shown in Table 6. The two-factor structure was confirmed, explaining 57.62% of the total variance. Items 1 to 10 loaded onto the Mathematics Test Anxiety factor, while items 12 to 29 loaded onto the Numerical Anxiety factor.

Table 6. Factor loadings of the modified MARS (EFA)

Item	Mathematics Test Anxiety	Numerical Anxiety	Communality
Item 1	0.72	-	0.65
Item 2	0.65	-	0.61
Item 3	0.78	-	0.69
Item 4	0.69	-	0.63
Item 5	0.62	-	0.59
Item 8	0.75	-	0.70
Item 9	0.71	-	0.68
Item 10	0.67	-	0.64
Item 12	-	0.79	0.72
Item 15	-	0.66	0.63
Item 16	-	0.73	0.68
Item 21	-	0.70	0.65
Item 24	-	0.79	0.74
Item 25	-	0.77	0.72
Item 28	-	0.74	0.70
Item 29	-	0.76	0.71

Confirmatory Factor Analysis (CFA)

To validate the factor structure, CFA was performed using AMOS 24. The model fit indices are presented in Table 7. The CFA results confirmed that the two-factor model provided a good fit to the data. The Comparative Fit Index (CFI) = 0.94, the Tucker-Lewis Index (TLI) = 0.92, the Root Mean Square Error of Approximation (RMSEA) = 0.06, and the Standardized Root Mean Square Residual (SRMR) = 0.05 all met the recommended thresholds, supporting the construct validity of the modified MARS.

Table 7. CFA model fit indices

Fit Index	Recommended Value	Model Value	Interpretation
χ^2/df	≤ 3.00	2.34	Acceptable
CFI	≥ 0.90	0.94	Good
TLI	≥ 0.90	0.92	Good
RMSEA	≤ 0.08	0.06	Good
SRMR	≤ 0.08	0.05	Good

Reliability Analysis

Reliability was assessed using Cronbach's Alpha (α) for internal consistency. The overall reliability of the modified MARS was excellent (α = 0.87). The two subscales also demonstrated good reliability (Mathematics Test Anxiety: α = 0.85, Numerical Anxiety: α = 0.84), indicating that the instrument was internally consistent, as presented in Table 8.

Table 8. Reliability coefficients (Cronbach's Alpha)

Scale	Cronbach's Alpha (α)	Interpretation
Total MARS (16 items)	0.87	Excellent
Mathematics Test Anxiety (8 items)	0.85	Good
Numerical Anxiety (8 items)	0.84	Good

The findings of this study indicate that the modified version of the MARS possesses strong psychometric properties (a valid and reliable instrument), supporting its suitability for use among Indonesian elementary school students aged 10 to 12 years. EFA and CFA both affirmed the construct validity of the instrument, revealing a clear and theoretically coherent two-factor structure. Furthermore, the scale demonstrated excellent internal consistency, as evidenced by a high Cronbach's alpha coefficient (α = 0.87), indicating that the items reliably measure the underlying construct of mathematics anxiety. The results from the CFA also showed that the model exhibited a good overall fit, further supporting its appropriateness for assessing mathematics anxiety in this age group. Collectively, these results suggest that the modified MARS is a valid and reliable tool for evaluating mathematics anxiety among Indonesian elementary students.

Discussion

Mathematics anxiety is a well-established psychological construct that has been shown to significantly impair students' academic performance, cognitive functioning, and participation in mathematics-related learning activities (Ashcraft & Ridley, 2005). The present study aimed to modify and validate the MARS for Indonesian elementary students aged 10–12 years. The results provide strong psychometric support for the modified instrument, which demonstrated a robust two-factor structure, high internal consistency, and acceptable model fit indices. These findings suggest that mathematics anxiety among young learners can be effectively assessed through a culturally and developmentally tailored measure (Suinn & Winston, 2003) that captures the emotional and cognitive components relevant to their age group.

The EFA revealed a clear two-factor structure distinguishing Mathematics Test Anxiety and Numerical Anxiety. This bifactorial model aligns with prior literature emphasizing the multidimensional nature of mathematics anxiety (Harris, 2022). Specifically, Mathematics Test Anxiety encompasses anxiety-provoking experiences related to assessments, such as exams, quizzes, and grading. In contrast, Numerical Anxiety pertains to apprehension associated with performing arithmetic operations and solving everyday mathematical problems. These results corroborate theoretical frameworks suggesting that affective responses to mathematics are not homogeneous but instead arise from distinct domains of experience (Hembree, 1990).

The results from the CFA further substantiated the proposed structure, with model fit indices falling within acceptable thresholds, thereby supporting the construct validity of the instrument. These findings are consistent with existing research that underscores the multidimensionality of mathematics anxiety and validates its decomposition into discrete, yet interrelated, components (Talić et al., 2024). The internal consistency analysis indicated high reliability across both subscales, affirming that the modified MARS measures mathematics anxiety consistently and accurately. This reliability aligns with previous validations of the original and adapted versions of MARS in various educational contexts (Kul et al., 2024). Collectively, these psychometric outcomes demonstrate that the modified instrument is suitable for assessing mathematics anxiety in younger populations and can serve as a reliable diagnostic tool in educational and psychological assessments.

An important empirical observation in this study was the moderate level of mathematics anxiety reported by Indonesian elementary students. This finding aligns with evidence indicating that mathematics anxiety can emerge in early schooling and exert long-term effects on students' engagement with mathematical content (Johnston & Bull, 2022). The presence of anxiety at this developmental stage is particularly concerning, as it may lead to reduced participation in mathematics-related tasks, avoidance of STEM-related pathways, and diminished academic achievement (Daker et al., 2021). Early identification, therefore, is imperative for designing timely interventions aimed at fostering positive mathematical dispositions and mitigating future disengagement.

The Indonesian socio-educational context may contribute to the observed levels of anxiety. Structural features of the education system—such as high-stakes examinations, performance-oriented pedagogy, and rigid classroom hierarchies—may inadvertently exacerbate anxiety among young learners (Rabbi & Islam, 2024). Furthermore, societal and familial pressures to perform well in mathematics can influence students' emotional experiences and self-perceptions in the subject. Prior studies have indicated that both parental attitudes and teacher expectations play a significant role in shaping students' confidence and emotional regulation in mathematics learning (Gün et al., 2023). Future investigations should examine how environmental, pedagogical, and sociocultural variables interact to influence the development and expression of mathematics anxiety in the Indonesian context.

Despite its contributions, this study is subject to several limitations. First, the reliance on self-report data introduces the potential for social desirability bias and subjective response tendencies (Lavidas et al., 2022). Future research could incorporate mixed-method approaches, such as behavioral observations, qualitative interviews, or physiological measures, to triangulate and enrich the findings. Second, the sample was restricted to Indonesian elementary students, which may limit the generalizability of results across different cultural or educational contexts. Cross-cultural validation studies are recommended to determine the applicability of the instrument in diverse international settings.

Another limitation is the cross-sectional design, which precludes analysis of how mathematics anxiety evolves over time. Longitudinal research is needed to explore the developmental trajectory of mathematics anxiety and its interaction with academic transitions, curricular complexity, and individual coping mechanisms (Victor-Edema, 2024). Furthermore, experimental studies are warranted to evaluate the efficacy of targeted interventions—such as growth mindset training, mindfulness techniques, and adaptive curriculum design—in reducing anxiety and improving mathematical outcomes (Samuel & Warner, 2021).

In addition, future research should examine the relationship between mathematics anxiety and related psychological constructs, such as working memory capacity, self-efficacy, and intrinsic motivation. Prior studies have established that students with elevated mathematics anxiety often exhibit lower working memory efficiency, which may hinder their ability to solve complex problems (Ashcraft & Krause, 2007). Investigating these interrelationships will enhance the design of multi-component interventions that address both affective and cognitive barriers to mathematical learning.

Finally, this study offers compelling empirical support for the validity and reliability of a modified MARS instrument tailored for Indonesian elementary school students. The two-factor structure, satisfactory model fit, and high internal consistency demonstrate the instrument's psychometric soundness. Importantly, the adaptation process incorporated cultural, linguistic, and developmental considerations, thereby enhancing the instrument's relevance and utility in local educational contexts. Given the detrimental impact of mathematics anxiety on academic success and student well-being, early and accurate assessment is essential. Educators, psychologists, and policymakers must work

collaboratively to recognize mathematics anxiety as a legitimate educational concern and to implement proactive strategies for its reduction. Future research should continue to refine anxiety measurement tools, investigate developmental and contextual influences, and evaluate the effectiveness of intervention models aimed at supporting mathematics learners from an early age.

CONCLUSION

This study successfully adapted and validated the MARS for use with Indonesian elementary school students aged 10–12 years. The adaptation process entailed linguistic simplification and contextual modifications to ensure developmental and cultural relevance, including the substitution of college-level items with scenarios reflective of elementary-level mathematical experiences. Psychometric refinement led to the removal of poorly performing items, resulting in a 16-item instrument with strong construct validity, as confirmed through CFA. The model yielded two distinct factors—Mathematics Test Anxiety and Numerical Anxiety—both demonstrating substantial factor loadings and excellent internal consistency (Cronbach's $\alpha = 0.87$). These findings highlight that mathematics anxiety manifests early in students' educational trajectories and substantiate the importance of employing developmentally appropriate measures for its assessment. The validated instrument presents a valuable diagnostic tool for educators and researchers to identify and monitor mathematics anxiety in Indonesian primary education contexts, supporting timely and targeted intervention efforts.

The cross-sectional design constrains inferences regarding the developmental progression of mathematics anxiety over time. Additionally, the sample was limited to specific geographic and socio-economic contexts, which may affect the generalizability of the results across Indonesia's diverse educational landscape. Future research should pursue longitudinal analyses to explore the evolution of mathematics anxiety across developmental stages and examine its interactions with cognitive, affective, and motivational variables. Furthermore, intervention-based studies grounded in the adapted MARS framework are recommended to evaluate the efficacy of context-sensitive strategies for anxiety reduction. Broadly, this research emphasizes the necessity of culturally and developmentally calibrated measurement instruments in mathematics education and psychological assessment. By leveraging such tools, stakeholders can better understand and address mathematics anxiety, fostering more equitable and empowering mathematics learning environments for young learners.

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Appendix

Modified Mathematics Anxiety Rating Scale (MARS-16) – English Version
Target Group: Indonesian Elementary School Students (Aged 10–12 Years)

Instructions:

Read each statement carefully. Please choose the option that best describes how anxious you would feel in each situation. Mark one option (✓) for each item.

Scale:

1 = Not anxious at all

2 = Slightly anxious

3 = Anxious

4 = Very anxious

No.	Statement	1	2	3	4
1	Taking a final exam in a math subject.				
2	Thinking about a math test that will happen in one week.				
3	Thinking about a math test that will happen tomorrow.				
4	Thinking about a math test that will start in one hour.				
5	Thinking about a math test that will start in five minutes.				
6	Realizing that you have to take several math classes at school.				
7	Getting a surprise quiz in math class.				
8	Studying to prepare for a math test.				
9	Taking a quiz in math class.				
10	Getting ready to study for a math test.				
11	Dividing a five-digit number by a two-digit number on paper.				
12	Solving an addition problem on paper.				
13	Being responsible for collecting class money and recording the total amount.				
14	Solving a division problem on paper.				
15	Solving a subtraction problem on paper.				
16	Solving a multiplication problem on paper.				

Optional Notes:

Please write here if there are any feelings or experiences you would like to share:

.....
.....
.....