



RECONSTRUCTION OF A THREE-FACTOR MATHEMATICAL RESILIENCE SCALE (MRS) FOR ELEMENTARY SCHOOL TEACHERS: A PSYCHOMETRIC STUDY

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Abstract

This study aims to reconstruct and validate a three-factor Mathematical Resilience Scale (MRS) comprising value, growth, and struggle dimensions to better suit the context of prospective elementary school teachers in Indonesia. The reconstruction process was conducted through two stages: Confirmatory Factor Analysis (CFA) and Exploratory Factor Analysis (EFA), to evaluate the validity and reliability of the revised instrument. The findings indicate that the initial MRS model did not fully fit the participant data, particularly in the struggle factor, which exhibited a low Average Variance Extracted (AVE). Through EFA, several items were removed, and the factor structure was refined. In the second CFA, the revised model demonstrated improved fit indices, with CFI (0.952), TLI (0.939), and RMSEA (0.065), indicating a very good model fit. The revised instrument also showed high reliability across the three factors: value (0.874), growth (0.862), and struggle (0.735). This study produces a more valid and reliable instrument for measuring mathematical resilience among prospective elementary school teachers, which is expected to contribute to improving the quality of mathematics instruction in Indonesia.

Keywords: *Confirmatory Factor Analysis; Dimensions of Mathematical Resilience; Elementary School Teachers; Mathematical Resilience Scale*

Abstrak

Penelitian ini bertujuan untuk merekonstruksi dan memvalidasi Mathematical Resilience Scale (MRS) yang terdiri dari tiga faktor, yaitu value, growth, dan struggle, agar sesuai dengan konteks calon guru sekolah dasar di Indonesia. Proses rekonstruksi dilakukan melalui dua tahap Confirmatory Factor Analysis (CFA) dan Exploratory Factor Analysis (EFA) untuk menilai validitas dan reliabilitas instrumen yang direvisi. Hasil analisis menunjukkan bahwa model awal MRS tidak sepenuhnya sesuai dengan data partisipan, khususnya pada faktor struggle, yang menunjukkan nilai Average Variance Extracted (AVE) yang rendah. Melalui EFA, beberapa item dihapus, dan struktur faktor diperbaiki. Pada CFA kedua, model yang direvisi menunjukkan hasil yang lebih baik, dengan nilai CFI (0.952), TLI (0.939), dan RMSEA (0.065) yang menandakan fit model yang sangat baik. Instrumen yang direvisi memiliki reliabilitas yang tinggi untuk ketiga faktor, yaitu value (0.874), growth (0.862), dan struggle (0.735). Penelitian ini menghasilkan instrumen yang lebih valid dan reliabel untuk mengukur ketahanan matematika pada calon guru SD, yang diharapkan dapat digunakan untuk meningkatkan kualitas pengajaran matematika di Indonesia.

Kata kunci: *Confirmatory Factor Analysis; Dimensi Ketahanan Matematika; Guru Sekolah Dasar; Mathematical Resilience Scale*

INTRODUCTION

Mathematics education is a critical domain that significantly determines the overall success of education (Ellis & Elizabeth Wrightsman, 2024). In Indonesia, teachers face numerous challenges in teaching mathematics at the elementary school level, one of which is the low level of mental resilience in dealing with difficulties that arise during the teaching and learning process (Cahyo et al., 2025; Suri & Herman, 2020). Mathematical resilience refers to an individual's ability to face, overcome, and

grow through difficulties in learning mathematics, which may include experiences of frustration, failure, or academic pressure. Enhancing mathematical resilience among prospective elementary school teachers is therefore essential, as resilient teachers are better equipped to teach mathematics effectively and to exert a positive influence on students' learning outcomes (Awofala, 2021).

Although mathematical resilience has become an important focus in mathematics education, instruments to measure it remain limited, particularly those that are appropriate for the Indonesian context (Cahyo et al., 2025; Muntazhimah et al., 2023). One existing instrument used to assess mathematical resilience is the Mathematical Resilience Scale (MRS), which was developed to measure resilience across various participant groups. The MRS was originally designed with three main factors: (1) a positive attitude toward mathematics, (2) problem-solving strategies, and (3) perseverance in learning mathematics (Kookan et al., 2016). However, despite its established validity and reliability in other contexts, adaptation and reconstruction for prospective elementary school teachers in Indonesia are still urgently needed. This is due to differences in participant characteristics, as well as their more complex roles within the context of elementary education (Kawane et al., 2025; Muñoz et al., 2025).

Within the Indonesian educational context, several gaps need to be addressed in the use of the existing MRS instrument. First, although mathematical resilience has been measured using a valid and reliable MRS instrument in other countries, there has been no scale reconstruction that takes into account the distinct cultural and educational characteristics of Indonesia (Mauliyda & Hidayati, 2025). Prospective elementary school teachers have roles that are far more complex than those of typical students. They are not only confronted with personal challenges in learning mathematics but are also required to manage challenges related to the teaching process, such as motivating and supporting students who experience difficulties in mathematics (Mauliyda et al., 2025).

Second, although several studies have attempted to adapt the Mathematical Resilience Scale (MRS) for various populations, this instrument has not been specifically tested on prospective elementary school teachers, who have distinct needs and challenges (Binti Ishak et al., 2020). Elementary school teachers in Indonesia, for instance, must cope with the reality of teaching students from diverse backgrounds and with varying levels of ability, which inevitably influences their resilience in teaching mathematics. Third, existing instruments do not always provide a sufficiently transparent reconstruction process regarding changes to items and the factors being measured. The process of scale adaptation to ensure that the instrument remains valid and reliable in a new context is often overlooked, even though it is a highly critical step (Misbach & Sumintono, 2014; Wijayanti et al., 2025). Content validity, for example, becomes essential to ensure that the items in the MRS adequately capture the various aspects of mathematical resilience that are relevant to the context of elementary education in Indonesia.

This study offers a significant contribution to addressing the existing research gap by reconstructing the Mathematical Resilience Scale (MRS) originally designed for a more general population to better align with the characteristics of prospective elementary school teachers in Indonesia. This adjustment is essential to ensure that the instrument more accurately captures mathematical resilience among teachers. Furthermore, this study re-examines the validity and reliability of the instrument following reconstruction, thereby providing important empirical evidence for its use within the Indonesian educational context (Gafoor & Kurukkan, 2014; Ngueutsa et al., 2023). In addition, the study provides new insights into how mathematical resilience among elementary school teachers can be enhanced, enabling them to teach mathematics more effectively.

Based on the gap analysis above, this study aims to address the primary research question: "How can a valid and reliable Mathematical Resilience Scale (MRS) be constructed and reconstructed for prospective elementary school teacher participants in Indonesia?" The findings of this study are expected to produce an instrument that is not only valid and reliable but also contextually appropriate for elementary education in Indonesia, thereby contributing to the advancement of more effective

mathematics education and strengthening teachers' mental resilience in teaching mathematics at the elementary school level.

METHOD

Research Design

This study employed a quantitative psychometric approach with a survey design (Maulyda & Hidayati, 2025). The primary objective was to reconstruct and examine the validity and reliability of the Mathematical Resilience Scale (MRS) for prospective elementary school teachers. As an instrument for measuring mathematical resilience, the MRS was originally developed for university students. However, it requires adaptation for prospective elementary school teachers in Indonesia, who face different contexts and challenges in mathematics instruction.

Participants

A total of 122 prospective elementary school teachers from various universities in Indonesia participated in this study. Participants were selected using a convenience sampling technique (Krishnaswamy et al., 2012), with inclusion criteria consisting of students enrolled in elementary teacher education programs and willing to participate in the study. Although no strict exclusion criteria were applied, participants were expected to possess a basic understanding of mathematics instruction. The demographic characteristics of the participants included variations in age, gender, and educational background; however, all were prospective elementary school teachers currently undertaking university-level education in Indonesia.

Instrument

The instrument used in this study was the Mathematical Resilience Scale (MRS) originally developed by Kookan et al. (2016). The scale consists of seven items measured on a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree). It is designed to assess three main dimensions of mathematical resilience: (1) a positive attitude toward mathematics, (2) problem-solving ability, and (3) perseverance in facing mathematical difficulties. The internal reliability of the instrument in previous student populations was reported to be excellent ($\alpha = .90$). For the purposes of this study, the MRS was used with minor modifications to enhance its relevance for prospective elementary school teachers. These modifications included linguistic adjustments to ensure clarity and comprehensibility for Indonesian participants. Each dimension comprises several items that capture different aspects of mathematical resilience.

Table 1: Dimensions and Items of the Mathematical Resilience Scale (MRS)

No.	Dimension/ Factor	Number of Items	Item Statements
1	Value	9	V1: Mathematics is very important for my future. V2: Mathematics will be useful in my future career. V3: Mathematics courses are very helpful to me, regardless of what I choose to study. V4: Understanding mathematics contributes greatly to achieving my goals. V5: Having a good knowledge of mathematics helps me understand more complex topics in my field of study. V6: People who are good at mathematics have more opportunities than those who are not. V7: Thinking mathematically can help me with things that are important to me. V8: It would be difficult to succeed in life without mathematics. V9: Mathematics develops strong thinking skills that are

No.	Dimension/ Factor	Number of Items	Item Statements
			necessary for success in any career.
2	Struggle	8	S1: Everyone experiences difficulties in mathematics at some point. S2: Even those who are good at mathematics experience difficulties when solving problems. S3: Successful individuals working in mathematics-related fields also struggle when dealing with difficult mathematical problems. S4: Everyone makes mistakes sometimes when working on mathematics. S5: Difficulty is a normal part of working with mathematics. S6: People in my group also sometimes struggle with mathematics. S7: Even people who are good at mathematics can fail difficult mathematics exams. S8: Mathematics teachers are sometimes confused by mathematical problems.
3	Growth	8	G1: Everyone can improve in mathematics if they put in effort. G2: Mathematics can be learned by anyone. G3: If someone is not naturally good at mathematics, they will not be able to learn much mathematics. G4: If someone is not good at mathematics, nothing can be done to change that. G5: People can be categorized as either good at mathematics or not. G6: I believe that a person's mathematical ability is determined at birth. G7: Some people cannot learn mathematics. G8: I believe I can develop my mathematical knowledge.

Data were collected online using Google Forms, which were distributed over a period of five weeks. Participants completed the instrument independently without any prior briefing or specific training. This approach was intended to preserve respondents' natural ability to comprehend the instrument. During the response process, participants were given the freedom to answer each item based on their own understanding of mathematical resilience within the context of teaching. After the data collection was completed, all gathered data were processed for further analysis.

Data Analysis

Data analysis was conducted using Confirmatory Factor Analysis (CFA) to examine the factor structure and construct validity of the reconstructed scale. Two CFA procedures were performed: the first to evaluate the initial model, and the second after removing items with low factor loadings or cross-loadings on multiple factors. This process ensured that the retained items contributed significantly to their intended factors and did not compromise the overall validity of the model. The primary criteria used to evaluate the model were (Hair et al., 2019):

- 1) Average Variance Extracted (AVE): to assess the extent to which variance is explained by the indicators within a factor.

- 2) Composite Reliability (CR): to evaluate the internal consistency of each factor.
- 3) Heterotrait-Monotrait Ratio (HTMT): to assess discriminant validity between factors.

As additional criteria for assessing model fit, the indices used included the Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR). These indices were employed to ensure that the resulting model demonstrated an adequate and reliable fit. To establish content validity, the instrument was reviewed by experts in psychometrics and mathematics education to ensure that the scale items adequately represented the dimensions of mathematical resilience relevant to prospective elementary school teachers. Construct validity was examined through CFA to determine whether the proposed factor structure was consistent with the empirical data obtained from participants. External validity was assessed by comparing the mathematical resilience scores derived from the instrument with relevant external criteria, such as academic achievement in mathematics education. Reliability testing was conducted using Cronbach’s alpha and omega coefficients to evaluate the internal consistency of the scale after reconstruction. Good reliability indicates that the instrument yields consistent and dependable results across different participants of prospective elementary school teachers.

RESULTS AND DISCUSSION

Results

Confirmatory Factor Analysis 1

The first analysis was conducted using Confirmatory Factor Analysis (CFA) to examine whether the initial theoretical three-factor structure of the Mathematical Resilience Scale (MRS) namely value, struggle, and growth was consistent with the empirical data obtained from prospective elementary school teacher participants. At this stage, the evaluation of the model was not only focused on overall model fit but also on the quality of measurement for each construct. Therefore, the primary criteria assessed included Average Variance Extracted (AVE) to evaluate convergent validity, the Heterotrait Monotrait Ratio (HTMT) to assess discriminant validity, and reliability to examine the internal consistency of each factor.

Table 2: Main Measurement Criteria for CFA 1

No.	Kriteria	Faktor	Nilai
1	<i>Average variance extracted</i>	Value	0.545
		Struggle	0.354
		Growth	0.517
2	<i>Heterotrait-monotrait ratio</i>	Value→Struggle	0.500
		Value→Growth	0.098
		Struggle→Growth	0.327
3	<i>Reliability</i>	Value	0.904
		Struggle	0.822
		Growth	0.822

Based on Table 2, the value factor obtained an AVE of 0.545 and the growth factor 0.517; thus, both met the criterion for convergent validity, as their values exceeded the 0.50 threshold. In contrast, the struggle factor yielded an AVE of only 0.354, indicating that the proportion of variance in its indicators explained by the construct remained low. Therefore, the initial model still exhibited a weakness in the measurement quality of the struggle factor. In terms of discriminant validity, all HTMT values 0.500 for the relationship between value and struggle, 0.098 for value and growth, and 0.327 for struggle and growth were below the commonly accepted threshold of 0.85, indicating that the three factors were adequately distinct from one another. Furthermore, the reliability values for value (0.904), struggle (0.822), and growth (0.822) demonstrated that all constructs possessed good

internal consistency. Thus, the primary issue in the first CFA did not lie in reliability or discriminant validity, but rather in convergent validity, particularly within the struggle factor.

After examining the measurement quality of each factor, the next step was to evaluate the overall model fit. This analysis is necessary because a model that is reliable does not necessarily exhibit a structure that fits the empirical data. Therefore, additional criteria were employed, including the Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR), to determine whether the initial three-factor MRS model was suitable to be retained.

Table 3 Additional Measurement Criteria for CFA 1

No	Kriteria	Nilai
1	Comparative Fit Index (CFI)	0.812
2	Tucker-Lewis Index (TLI)	0.792
3	Root means square error of approximation (RMSEA)	0.096
4	Standardized root mean square residual (SRMR)	0.128

The results presented in Table 3 indicate that the initial model did not achieve an adequate level of fit. The CFI value of 0.812 and TLI value of 0.792 were both below the commonly recommended threshold of 0.90. In addition, the RMSEA value of 0.096 exceeded the acceptable limit of 0.08, as did the SRMR value of 0.128, which was also higher than the expected standard. These findings suggest that the initial factor structure was not able to optimally represent the empirical data from prospective elementary school teacher participants. In other words, the original theoretical three-factor MRS model was not fully appropriate for the context of this sample. These results provide a basis for conducting further analysis to re-examine the arrangement of items and the factor structure of the instrument. This issue is also illustrated in Figure 1, which shows that several indicators did not function optimally within the initial model. The output of the CFA 1 plot diagram is presented in Figure 1 below.

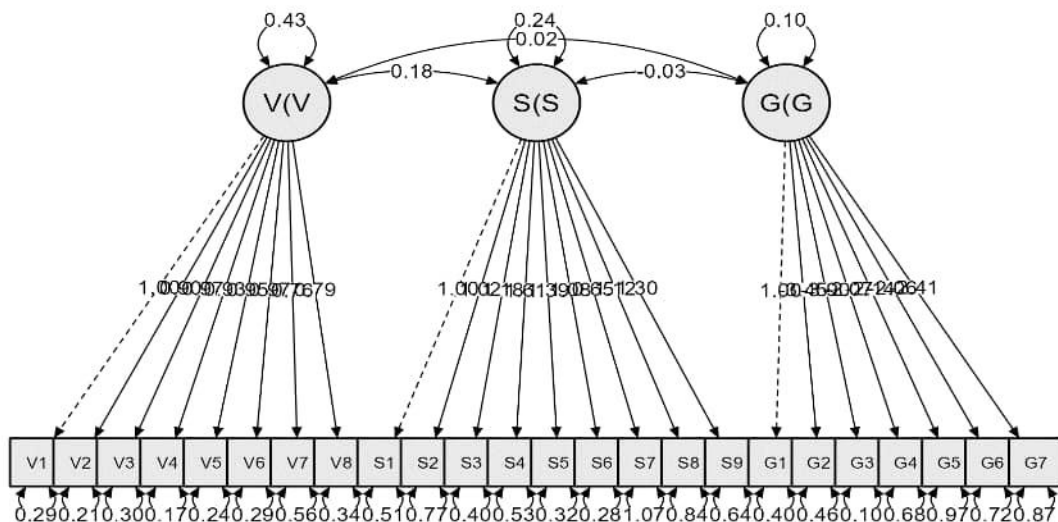


Figure 1: Plot Diagram of CFA 1 Results

Exploratory Factor Analysis

The results of the first CFA indicated that the initial model did not achieve an adequate fit, the analysis was continued using Exploratory Factor Analysis (EFA). This analysis was conducted to explore the empirical factor structure derived from the data, as well as to identify items that were potentially weak, unstable, or did not clearly represent the intended constructs. Prior to factor

extraction, the adequacy of the data was assessed using the Kaiser Meyer Olkin Measure of Sampling Adequacy (KMO-MSA) to ensure that the correlation matrix was suitable for further analysis.

Table 4. Hasil Kaiser-Meyer-Olkin Test

	MSA
Overall MSA	0.830
G1	0.743
G2	0.781
G3	0.740
G4	0.804
G5	0.789
G6	0.818
G7	0.816
S1	0.915
S2	0.807
S3	0.849
S4	0.796
S5	0.897
S6	0.819
S7	0.547
S8	0.834
S9	0.878
V1	0.867
V2	0.806
V3	0.891
V4	0.902
V5	0.832
V6	0.887
V7	0.814
V8	0.861

Based on Table 4, the overall MSA value of 0.830 indicates that the data have good sampling adequacy for factor analysis. In general, almost all items also demonstrated adequate MSA values, with most falling within the moderate to high range. Although item S7 had the lowest MSA value at 0.547, it still exceeded the minimum threshold of 0.50 and could therefore be considered acceptable for inclusion in the initial stage of analysis. These results indicate that the data are suitable for further exploration through EFA.

After confirming that the data met the requirements for factor analysis, the next step was to examine the distribution of factor loadings for each item. The purpose was to identify the pattern of item clustering within the emerging factors, detect items with low loadings, and assess the presence of cross-loading or items that did not clearly load onto a specific factor. At this stage, the promax rotation method was employed, as the three factors in the MRS are conceptually expected to be correlated.

Tabel 5. Sebaran Loading Factor

	Value	Stuggle	Growth	Uniqueness
V4	0.971			0.251
V5	0.856			0.339
V3	0.773			0.446
V6	0.744			0.404
V1	0.742			0.418
V2	0.725			0.388
V8	0.665			0.538
V7	0.565			0.620
G3		1.017		0.067

G2	0.832	0.321	
G6	0.625	0.596	
G7	0.612	0.589	
G4	0.584	0.588	
G5	0.568	0.640	
G1	-0.524	0.437	0.472
S5		0.878	0.330
S4		0.759	0.462
S3		0.651	0.522
S9		0.626	0.623
S6		0.530	0.493
S2		0.515	0.624
S8		0.407	0.737
S1			0.624
S7			0.869

Note. Applied rotation method is promax.

The results presented in Table 5 indicate that, in general, the items clustered into three factors consistent with the conceptual structure of the MRS, namely factors representing the dimensions of value, growth, and struggle. Items within the value dimension, such as V4, V5, V3, V6, V1, V2, V8, and V7, demonstrated relatively strong loadings on the same factor. Similarly, most items within the growth and struggle dimensions exhibited a fairly consistent loading pattern. These findings suggest that the three-factor structure remains empirically supported; however, not all items functioned optimally.

Specifically, three items G1, S1, and S7 were removed. Item G1 was excluded due to cross-loading, as it loaded on more than one factor and did not clearly represent a single construct. This condition indicates ambiguity and the potential to compromise the clarity of the factor structure. Meanwhile, items S1 and S7 were removed because they did not demonstrate adequate factor loadings on any factor following the EFA and tended to show weak contributions to the construct. Therefore, these items were considered to disrupt model stability and were not retained for the subsequent stage of analysis.

After examining the factor loading patterns, the next evaluation focused on the overall model fit of the EFA results. This step is essential to ensure that the empirically derived factor structure, following item refinement, demonstrates a good fit to the data. Accordingly, several additional indices were employed, including RMSEA, SRMR, TLI, CFI, and BIC.

Table 6: Additional Measurement Criteria for EFA

<i>Additional fit indices</i>					
RMSEA	RMSEA 90% confidence	SRMR	TLI	CFI	BIC
0.067	0.053 - 0.082	0.049	0.982	0.914	-671.624

Based on Table 6, the model resulting from the EFA demonstrated a good fit. The RMSEA value of 0.067, with a confidence interval of 0.053–0.082, indicates an acceptable level of approximation error. The SRMR value of 0.049 also reflects low residuals, suggesting that the model has a good fit. Furthermore, the TLI value of 0.982 and the CFI value of 0.914 indicate that the exploratory model meets the criteria for good model fit. Overall, these results support the decision to revise the initial model by removing problematic items, resulting in an instrument structure that is more representative of prospective elementary school teacher participants.

Confirmatory Factor Analysis 2

After identifying and removing problematic items based on the EFA results, a second Confirmatory Factor Analysis (CFA) was conducted to re-evaluate the revised model. The purpose of the second CFA was to ensure that the simplified three-factor structure demonstrated improved measurement quality. At this stage, the evaluation once again focused on convergent validity, discriminant validity, and construct reliability using AVE, HTMT, and reliability indices.

Table 7: Main Measurement Criteria for CFA 2

No.	Kriteria	Faktor	Nilai
1	<i>Average variance extracted</i>	Value	0.632
		Growth	0.573
		Struggle	0.614
2	<i>Heterotrait-monotrait ratio</i>	Value→Struggle	0.547
		Value→Growth	0.013
		Growth→ Struggle	0.212
3	<i>Reliability</i>	Value	0.874
		Growth	0.862
		Struggle	0.735

The results presented in Table 7 indicate that the revised model demonstrates better measurement quality compared to the initial model. All factors have met the criteria for convergent validity, with AVE values of 0.632 for value, 0.573 for growth, and 0.614 for struggle. These values indicate that each construct is able to explain more than half of the variance of its indicators. In terms of discriminant validity, all HTMT values are well below the recommended threshold, namely 0.547 for value struggle, 0.013 for value growth, and 0.212 for growth struggle. This indicates that the three factors are clearly distinguishable from one another. Furthermore, the reliability values for value (0.874), growth (0.862), and struggle (0.735) suggest that all constructs possess good internal consistency. Thus, the revised model has satisfied the primary measurement criteria.

In addition to evaluating measurement quality at the construct level, the second CFA was also conducted to examine whether the revised model achieved an overall good model fit. Therefore, the same model fit indices used in the first CFA were applied again, namely the Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR).

Table 3: Additional Measurement Criteria for CFA 2

No	Kriteria	Nilai
1	Comparative Fit Index (CFI)	0.952
2	Tucker-Lewis Index (TLI)	0.939
3	Root means square error of approximation (RMSEA)	0.065
4	Standardized root mean square residual (SRMR)	0.032

Based on Table 3, the revised model demonstrates a substantially better fit compared to the initial model. The CFI value of 0.952 and TLI value of 0.939 both exceed the 0.90 threshold, indicating a good model fit. The RMSEA value of 0.065 reflects an acceptable level of approximation error, while the SRMR value of 0.032 confirms that the model residuals are very low. These findings indicate that the reconstructed three-factor MRS model is well aligned with the empirical data obtained from prospective elementary school teacher participants. Therefore, the revised instrument can be considered to have a more valid and reliable structure for use within this research context. This is further supported by Figure 2, which illustrates that the relationships between indicators and constructs in the final model appear more stable and well-defined. The output of the CFA 2 plot diagram is presented in Figure 2 below.

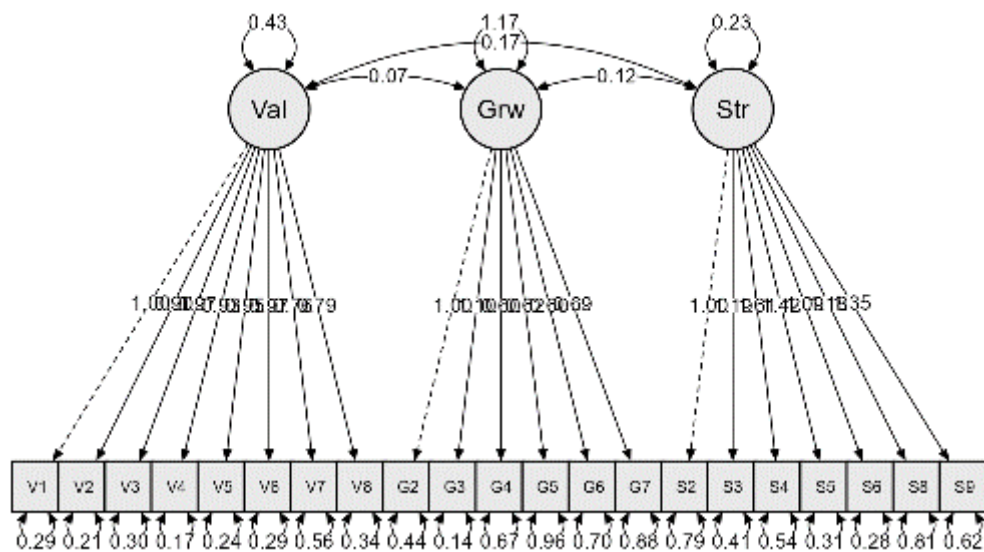


Figure 2. Plot Diagram of CFA 2 Results

Discussion

This study aimed to reconstruct and validate a three-factor Mathematical Resilience Scale (MRS) comprising value, struggle, and growth for use with prospective elementary school teachers in Indonesia. The results obtained from two stages of Confirmatory Factor Analysis (CFA) and Exploratory Factor Analysis (EFA) provide robust empirical evidence regarding the validity and reliability of the proposed instrument. The refinement of the factor structure and the removal of problematic items underscore the importance of continuous validation processes in the development of psychometric instruments for specific populations.

The initial CFA model yielded inadequate results, particularly for the struggle factor, which exhibited an Average Variance Extracted (AVE) value of 0.354, well below the recommended threshold of 0.50. This finding indicates that the struggle construct was not able to adequately explain the variance of its indicators. This result is consistent with previous studies suggesting that resilience in dealing with mathematical difficulties is often challenging to quantify, especially within teaching contexts. For instance, studies by (Xenofontos & Mouroutsou, 2023; Zheng et al., 2025) indicate that the struggle experienced by teachers when teaching mathematics is frequently influenced by various external factors, such as limited resources and student-related challenges, which are not fully captured by existing measurement instruments. Therefore, the struggle factor may require additional dimensions to better represent its inherent complexity.

The decline in measurement quality for the struggle factor in the initial model can be further understood by referring to broader theories of mathematical resilience, as developed by (Neumann et al., 2021; Pulungan et al., 2022; Tang, 2025). These studies suggest that resilience in mathematics among teachers encompasses not only personal struggles but also the ability to cope with challenges within broader teaching contexts, including interactions with students and curriculum demands (Cahyo et al., 2025; Suri & Herman, 2020). Therefore, within the context of prospective elementary school teachers, the struggle dimension may need to be expanded to include pedagogical experiences and instructional challenges, rather than focusing solely on personal experiences in learning mathematics. This may explain why this factor exhibited a lower AVE compared to the other factors.

The results of the Exploratory Factor Analysis (EFA) further support the need for modifications to the structure of the struggle factor. Items G1, S1, and S7 were removed after demonstrating cross-loadings and low factor loadings, indicating that these items did not clearly represent a single construct. This process highlights the importance of using EFA as a diagnostic tool in the development

of psychometric instruments. In line with this, (Mauliyda & Hidayati, 2025; Nurfaizin, 2019; Rofiah et al., 2024) argue that although CFA provides an overall assessment of model fit, EFA is particularly useful for exploring factor structures and identifying items that do not align with the underlying theoretical framework. This exploratory process enables researchers to refine the initial model to better reflect the empirical data while enhancing construct validity.

Following item removal and model revision, the second CFA demonstrated significant improvement. The high values of CFI (0.952) and TLI (0.939), along with acceptable RMSEA (0.065) and SRMR (0.032) values, indicate that the revised model achieved an excellent fit. These findings are consistent with those reported by (Kookan et al., 2016), which suggest that the MRS model, when adapted to more specific contexts such as elementary education, can achieve improved measurement quality with appropriate modifications. The results are also in line with studies by (Ellis & Elizabeth Wrightsman, 2024; Thirhar et al., 2023), which demonstrate that culturally and contextually adapted instruments can enhance the accuracy of measuring mathematical resilience in more specific groups, such as prospective or in-service elementary school teachers.

Furthermore, the reliability of the three factors value, growth, and struggle each exceeding 0.70 indicates that the revised instrument possesses strong internal consistency. This suggests that the scale is a reliable tool for measuring mathematical resilience among prospective elementary school teachers. (Binti Ishak et al., 2020; Martínez-Padrón et al., 2022; Panaoura, 2025) emphasize that reliability is a fundamental criterion in psychometric instrument development, and these findings support the use of the reconstructed MRS as a valid and reliable measurement tool.

The CFA 2 model also confirms that the three factors in the revised model are clearly distinguishable, as evidenced by the Heterotrait–Monotrait Ratio (HTMT) values, which are well below the threshold of 0.85 for all factor pairs. This finding supports the argument of (Hair et al., 2019), who state that good discriminant validity indicates that the factors within a model measure distinct constructs without significant overlap. Therefore, the proposed three-factor structure value, growth, and struggle demonstrates strong discriminant validity and is appropriate for measuring mathematical resilience among prospective elementary school teachers.

CONCLUSION

This study successfully reconstructed the Mathematical Resilience Scale (MRS) for the context of prospective elementary school teachers in Indonesia. The results from two stages of Confirmatory Factor Analysis (CFA) and Exploratory Factor Analysis (EFA) indicate that the resulting model demonstrates good validity and reliability after the removal of several items and adjustments to the factor structure. The revised instrument is able to measure mathematical resilience more accurately, encompassing the dimensions of value, growth, and struggle, which are more relevant to the experiences of prospective elementary school teachers. The primary contribution of this study lies in the development of a more valid and reliable instrument for measuring mathematical resilience among prospective elementary school teachers in Indonesia. This instrument can be utilized to evaluate teachers' mental resilience in facing the challenges of mathematics instruction, as well as to provide insights into improving the quality of mathematics teaching at the elementary school level. Furthermore, this study highlights the importance of adapting psychometric instruments to align with specific cultural and educational contexts, thereby enhancing the accuracy of measurement outcomes.

However, this study has several limitations. One limitation is the use of convenience sampling, which may reduce the generalizability of the findings. In addition, the instrument was tested only on prospective elementary school teachers and has not yet been validated with in-service teachers. Future research is recommended to examine the validity and reliability of this instrument across more diverse populations and to evaluate its impact on the effectiveness of mathematics instruction in elementary schools.

REFERENCES

- Awofala, A. O. A. (2021). A validation of the mathematical resilience scale for twelfth graders through confirmatory factor analysis and its relationship with achievement in mathematics in Nigeria. *SN Social Sciences*, 1(8), 204. <https://doi.org/10.1007/s43545-021-00212-8>
- Binti Ishak, N. H. F., Yusoff, N. F. B. M., & Madihie, A. (2020). Resilience in Mathematics, Academic Resilience, or Mathematical Resilience?: An Overview. *Universal Journal of Educational Research*, 8(5A), 34–39. <https://doi.org/10.13189/ujer.2020.081905>
- Cahyo, E. D., Sari, D. R. P., Mustika, J., & Ikashaum, F. (2025). *Analysis of factors that influence learning motivation and mathematics resilience in elementary school students*. 130007. <https://doi.org/10.1063/5.0290316>
- Ellis, B., & Elizabeth Wrightsman. (2024). An Anti-deficit Counter-story of a Black Girl's Forms of Resilience in a Standards-based Mathematics Classroom. *Journal of Urban Mathematics Education*, 17(1), 48–83. <https://doi.org/10.21423/jume-v17i1a514>
- Gafoor, A., & Kurukkan, A. (2014). Construction and Validation of Scale of Parenting Style. *Guru Journal of Behavioral and Social Sciences*, 2(4). www.gjbss.org
- Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *MULTIVARIATE DATA ANALYSIS (EIGHTH EDITION)*. Annabel Ainscow. www.cengage.com/highered
- Kawane, T., Adu-Gyamfi, B., & Shaw, R. (2025). Exploring the elements of strengthening online higher education in disaster risk reduction: a perspective of sustained strategy in post COVID-19. *International Journal of Disaster Resilience in the Built Environment*, 16(2), 173–192. <https://doi.org/10.1108/IJDRBE-12-2022-0125>
- Kookan, J., Welsh, M. E., McCoach, D. B., Johnston-Wilder, S., & Lee, C. (2016). Development and Validation of the Mathematical Resilience Scale. *Measurement and Evaluation in Counseling and Development*, 49(3), 217–242. <https://doi.org/10.1177/0748175615596782>
- Krishnaswamy, K. N., Sivakumar, A. I., & Mathirajan, M. (2012). *Management Research Methodology Integration of Principles, Methods and Techniques* (1st ed.). Pearson.
- Martínez-Padrón, O. J., De Tejada-Lagonell, M. D., & García-González, M. D. S. (2022). Resiliencia en aprendices de contenidos matemáticos. *Revista Electrónica Educare*, 26(2), 1–20. <https://doi.org/10.15359/ree.26-2.25>
- Mauliyda, M. A., & Hidayati, V. R. (2025). Studi Psikometrik pada Skala Pengukuran Mathematical Resilience Calon Guru: Confirmatory Factor Analysis. *Griya Journal of Mathematics Education and Application*, 5(4), 1664–1681. <https://doi.org/10.29303/griya.v5i4.872>
- Mauliyda, M. A., Rakhmawati, Y., Putri, H. R., Zhabbasbayev, U. K., & Kassymova, G. K. (2025). Resilience's Role in Self-Efficacy and Well-Being of Primary Students in Mathematics: Mediation and Moderation Effects. *Numerical: Jurnal Matematika Dan Pendidikan Matematika*, 9(2), 1–13. <https://doi.org/10.25217/numerical.v9.i2.6630>
- Misbach, I. H., & Sumintono, B. (2014). Pengembangan dan Validasi Instrumen “Persepsi Siswa Terhadap Karakter Moral Guru” di Indonesia dengan Model Rasch. *PROCEEDING Seminar Nasional Psikometri*, 148–162.
- Muñoz, D., Bull, R., Khng, K. H., Ng, E. L., Poon, K., & Lee, K. (2025). Mathematics resilience in preschool and executive functions. *Learning and Instruction*, 100, 102197. <https://doi.org/10.1016/j.learninstruc.2025.102197>

- Muntazhimah, Khusna, H., & Anjarwati, R. (2023). *Reflective thinking ability in terms of mathematical resilience of mathematics student teachers*. 040002. <https://doi.org/10.1063/5.0122354>
- Neumann, I., Jeschke, C., & Heinze, A. (2021). First Year Students' Resilience to Cope with Mathematics Exercises in the University Mathematics Studies. *Journal Für Mathematik-Didaktik*, 42(2), 307–333. <https://doi.org/10.1007/s13138-020-00177-w>
- Ngueutsa, R., Wassouo, E., & Kouabenan, D. R. (2023). Construction and validation of a scale measuring cultural beliefs and values in Cameroon. *Current Psychology*, 42(11), 8931–8945. <https://doi.org/10.1007/s12144-021-02187-4>
- Nurfaizin, N. (2019). Uji Validitas Konstruk Self Control Terhadap Prokrastinasi Akademik Dengan Metode Confirmatory Factor Analysis (CFA). *Jurnal Pengukuran Psikologi Dan Pendidikan Indonesia (JP3I)*, 7(1), 41–48. <https://doi.org/10.15408/jp3i.v7i1.12107>
- Panaoura, R. (2025). Sustainable Learning Practices in Engineering Mathematics: Building Self-Regulation and Resilience. *Sustainability*, 17(22), 10137. <https://doi.org/10.3390/su172210137>
- Pulungan, D. A., Retnawati, H., & Jaedun, A. (2022). Mathematical Resilience: how Students Survived in Learning Mathematics Online During the Covid-19 Pandemic. *Qualitative Research in Education*, 11(2), 151–179. <https://doi.org/10.17583/qre.9805>
- Rofiah, N. H., Kawai, N., & Hayati, E. N. (2024). Disability-inclusive disaster risk reduction in schools: A confirmatory factor analysis. *Jambá Journal of Disaster Risk Studies*, 16(1). <https://doi.org/10.4102/jamba.v16i1.1559>
- Suri, A., & Herman, T. (2020). How are the contributions of mathematics resilience for developing attitude rubric to assess mathematics learning? *Journal of Physics: Conference Series*, 1521(3), 032055. <https://doi.org/10.1088/1742-6596/1521/3/032055>
- Tang, X. (2025). 'I Survived the First Year!': Teacher Resilience of Chinese Novice Mathematics Teachers. *European Journal of Education*, 60(4). <https://doi.org/10.1111/ejed.70300>
- Thirthar, A. A., Sk, N., Mondal, B., Alqudah, M. A., & Abdeljawad, T. (2023). Correction: Utilizing memory effects to enhance resilience in disease-driven prey-predator systems under the influence of global warming. *Journal of Applied Mathematics and Computing*, 69(6), 4909–4910. <https://doi.org/10.1007/s12190-023-01963-8>
- Wijayanti, A., Dwiningrum, S. I. A., Saptono, B., & Mauliyda, M. A. (2025). Elementary school student digital literacy framework: A Confirmatory Factor Analysis (CFA). *Ricerche Di Pedagogia e Didattica*, 20(1), 29–44. <https://doi.org/10.6092/issn.1970-2221/19986>
- Xenofontos, C., & Mouroutsou, S. (2023). *Resilience* in mathematics education research: a systematic review of empirical studies. *Scandinavian Journal of Educational Research*, 67(7), 1041–1055. <https://doi.org/10.1080/00313831.2022.2115132>
- Zheng, P., You, Y., & Luo, G. (2025). Math Interest on Primary School Students' Mathematics Achievement: Self-Control/Resilience Chain Mediation. *Journal of Psychoeducational Assessment*, 43(5), 488–501. <https://doi.org/10.1177/07342829251326435>