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Psychometric Validation of a Mathematics Self-Belief Instrument Using Secondary Data from Early Childhood Pre-Service Teachers

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Abstract

Mathematics self-belief among early childhood pre-service teachers is considered an important factor influencing how they later teach numeracy to young children. However, most existing self-belief instruments were developed and validated in Western contexts, so their psychometric properties warrant re-examination before broader use. This study examined the reliability and factor structure of a mathematics self-belief instrument covering three theoretical dimensions—self-efficacy, self-concept, and mathematics anxiety—through a secondary analysis of Brownlow's (2020) dataset of 80 early childhood pre-service teachers. Reliability was assessed using Cronbach's alpha (supplemented with McDonald's omega), and factor structure was examined using Exploratory Factor Analysis (EFA) with promax rotation. Results indicated good-to-excellent reliability across the three subscales (α = .864–.942) and adequate sampling adequacy for factor analysis (Kaiser-Meyer-Olkin [KMO] = .888; Bartlett's test significant, $p < .001$). The factor analysis broadly supported the three-dimensional structure, although self-efficacy items involving more abstract/procedural tasks showed weaker loadings than those framed in narrative contexts. These findings provide preliminary evidence supporting aspects of construct validity, particularly the internal structure of the instrument. Practically, the framing-related pattern suggests that teacher-education programs using this instrument should interpret — and eventually score — self-efficacy items differently depending on how mathematical tasks are framed, rather than treating self-efficacy as a single undifferentiated score.

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INTRODUCTION

Mathematics self-belief—encompassing self-efficacy, self-concept, and mathematics anxiety—is a psychological construct widely examined in teacher-education research. Meta-analytic evidence confirms a consistent, small-to-moderate negative association between math anxiety and math achievement across ages and countries (Barroso, 2021), and a growing body of work indicates that teachers' own anxiety and low confidence toward mathematics can be transmitted to their students through defensive teaching patterns or avoidance of certain topics, a phenomenon often referred to as teacher math-anxiety transmission (Park, 2024). This concern is reinforced by evidence that math anxiety operates not only at the individual level but also contextually, with peer- and classroom-level anxiety predicting achievement independently of a student's own anxiety (Lau, 2022), and by multi-country findings that teachers' math-related affect is a stable, cross-culturally observable phenomenon (Szczygieł, 2025). This issue is particularly salient for early childhood pre-service teachers, since the quality of early mathematical interactions largely determines children's later numeracy foundations(Becker, 2022).

Brownlow (2020) Conducted a study that combined the measurement of mathematics self-belief (self-efficacy, self-concept, and mathematics anxiety) with a framing experiment on mathematical word problems administered to early childhood pre-service teachers. The dataset from this study is openly available through Mendeley Data and contains item-level responses that make it possible to re-examine the psychometric properties of the instrument used. This kind of secondary analysis is increasingly feasible as open datasets on teachers' mathematics anxiety and attitudes become more available for reuse (Cipora, 2024).

Mathematics self-efficacy refers to an individual's belief in their capability to complete specific mathematical tasks (Bandura, 1997), while mathematics self-concept relates to a more stable self-evaluation of general mathematical competence. Mathematics anxiety is defined as a feeling of tension or apprehension that interferes with the manipulation of numbers and the solving of mathematical problems (Ashcraft, 2002). Although these three constructs are theoretically related, they are conceptually distinguishable, so instruments designed to measure them should ideally display a clear multidimensional structure when subjected to factor analysis. Exploratory Factor Analysis (EFA) is commonly used at the early stage of instrument development or adaptation, with data adequacy examined through the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test of Sphericity (Kaiser, 1974). Internal-consistency reliability is typically reported using Cronbach's alpha, with values ≥ .70 considered acceptable and ≥ .90 considered excellent (Cronbach, 1951), although recent methodological reviews caution that alpha should be interpreted alongside its underlying assumptions and, where those assumptions are not met, supplemented with alternative estimates such as McDonald's omega (Edwards, 2021; Zakariya, 2022). Content validity, assessed through methods such as Lawshe's (1975) content validity ratio or Aiken's V coefficient (Merino-Soto, 2023), is typically established at the instrument-development stage and lies outside the scope of the present secondary analysis, which instead focuses on internal-consistency reliability and factor structure.

Despite the relevance of this construct, at least three gaps motivate the present study. First, most mathematics self-belief instruments referenced in teacher-education research were developed and validated in Western populations (e.g., Australia, the United States, Europe), while psychometric reports specifically targeting early childhood pre-service teachers—a group whose educational background and mathematical experience differ from teachers at other levels—remain limited, even as related self-efficacy and anxiety constructs continue to receive sustained attention in general preservice-teacher populations (Bosica, 2022; Street, 2024; Xenofontos, 2023) and as adjacent constructs such as general teaching self-efficacy have recently been adapted and validated for early childhood pre-service teachers in other national contexts (Shao, 2025). Second, Brownlow (2020) the original study focused on the effect of word-problem framing on task confidence, so a detailed report on the psychometric properties of the self-belief instrument itself (subscale reliability, factor-analytic data adequacy, and detailed factor structure) was not the primary focus and has not been published separately; researchers wishing to use or adapt the instrument therefore lack an explicit psychometric reference. Re-examining this instrument through secondary analysis, rather than through a new primary validation study, is itself methodologically justified: primary data collection with early childhood pre-service teachers is comparatively resource-intensive and constrained by limited access to this specific population, whereas Brownlow's (2020) dataset already contains complete item-level responses that can be scrutinized independently, are openly reproducible by other research teams, and avoid the cost and lead time of a new data-collection cycle. Secondary psychometric re-analysis of openly shared datasets is therefore an increasingly recognized complement—rather than a lesser substitute—to primary validation, particularly as open datasets on teachers' mathematics anxiety and attitudes proliferate (Cipora, 2024).Third, most mathematics self-belief research treats self-efficacy as

a single, homogeneous construct without testing whether items with different framing characteristics (e.g., contextual/narrative versus abstract/procedural problems) behave uniformly from a psychometric standpoint—an issue that is particularly relevant given that framing effects were the central theme of Brownlow (2020) the original study.

This study offers novelty in three respects. First, it provides a comprehensive, stand-alone psychometric report—covering reliability, EFA adequacy, factor structure, and convergent validity—of the mathematics self-belief instrument among early childhood pre-service teachers, which has not been made explicit in prior publications. Second, it uncovers empirical evidence that the self-efficacy subscale may split into two sub-dimensions based on item framing (contextual/narrative versus abstract/procedural), a finding that directly links instrument validity to the framing-effect theme of the original study and resonates with recent evidence that cognitive and affective factors jointly shape prospective mathematics teachers' performance (Juniati, 2022) and that the self-efficacy–performance relationship itself may be reciprocal (Sakellariou, 2022). Third, it positions the present analysis as a preliminary psychometric foundation for future cross-cultural adaptation of similar instruments, including for early childhood pre-service teachers in Indonesia.

Accordingly, this study aims to examine the reliability (internal consistency), factor-analytic data adequacy, and factor structure of the mathematics self-belief instrument among early childhood pre-service teachers, through a secondary analysis of Brownlow's (2020) open dataset. Specifically, the study addresses the following questions: (1) What is the factor structure of the mathematics self-belief instrument based on Brownlow's (2020) data? (2) Is the factor structure consistent with the three theoretical dimensions claimed by the instrument (self-efficacy, self-concept, and mathematics anxiety)? (3) How reliable is each subscale of the instrument? and (4) What is the pattern of convergent validity among the mathematics self-belief subscales?

RESEARCH METHODS

This study used a non-experimental quantitative design in the form of a secondary (psychometric re-analysis) analysis of an open dataset. Data were drawn from Brownlow (2020) "Self-Belief, Confidence and Framed Word Problems: A Study on Early Childhood Pre-Service Teachers," Mendeley Data, V1. The dataset contains responses from 80 early childhood pre-service teachers to a mathematics self-belief questionnaire and six differently framed word problems. The mathematics self-belief instrument comprised three subscales rated on a 1–5 Likert scale (Strongly Disagree/Not at all Confident to Agree/Very Confident Strongly): Mathematics Self-Efficacy (MSE, 8 items), measuring confidence in solving contextual mathematical tasks (e.g., train schedules, price discounts, map scales, algebraic equations); Mathematics Self-Concept (MSC, 5 items), measuring general self-evaluation of mathematical competence (one item, "I am just not good at mathematics," was reverse-coded prior to analysis); and Mathematics Anxiety (MA, 5 items), measuring anxiety toward mathematical tasks and assessment.

Data were analyzed using Python (pandas, pingouin, factor_analyzer) through the following steps: (1) negatively worded MSC items were reverse-coded to align with the direction of other items; (2) missing-data patterns were first inspected descriptively for each subscale (11–12% of respondents had at least one missing response, and 5 of the 80 respondents had no data at all on the mathematics self-belief items, apparently having exited the survey before that section); Little's MCAR test, computed via an EM estimate of the item means and covariance matrix, indicated that the missingness pattern was statistically consistent with the missing-completely-at-random assumption ($\chi^2 = 108.01$, $df = 90$, $p = .095$), supporting the use of listwise deletion within each subscale (pairwise across subscales) for the reliability and correlation analyses; (3) reliability was computed using

Cronbach's alpha per subscale, supplemented with corrected item-total correlations, while acknowledging methodological critiques of alpha as a stand-alone reliability estimate (Edwards, 2021; Zakariya, 2022); (4) data adequacy for factor analysis was tested using the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy, Bartlett's Test of Sphericity, item-level communalities, and the diagonal of the anti-image correlation matrix (equivalent to each item's individual Measure of Sampling Adequacy), to confirm that no item was poorly represented by the factor solution; (5) the number of factors to retain was determined jointly through Kaiser's eigenvalue-greater-than-1 rule, Parallel Analysis (1,000 simulated random-data correlation matrices of the same size), and visual inspection of the scree plot — rather than the eigenvalue rule alone — because the Kaiser criterion is known to over- or under-estimate the number of factors (Goretzko, 2021); (6) although the instrument's three-dimensional structure has a clear theoretical basis, Exploratory rather than Confirmatory Factor Analysis (CFA) was used as the primary approach because the psychometric structure of this particular secondary dataset had not previously been documented and therefore needed to be examined empirically before a confirmatory model could be specified with confidence; CFA is recommended as a follow-up once the structure identified here is corroborated on independent data (see Recommendations for Future Research); and (7) convergent validity was examined through Pearson correlations among subscale composite (mean) scores .

All statistics reported in this section and in the Results were recomputed directly from the raw item-level survey export (N = 80); full item-level factor loadings, communalities, and reliability diagnostics are reported in Table 2 and the Supplementary Material.

RESULTS AND DISCUSSION

All 80 respondents with recorded data on the sex variable were female (n = 75; sex was not recorded for 5 respondents). Mean respondent age was 33.2 years (SD = 10.0; range 18–65; n = 74). Most respondents held a Diploma-level qualification (n = 54) or a Bachelor's degree (n = 10) prior to enrolling in their current program.

Table 1. Reliability (Cronbach's Alpha) by Subscale

Subscale	No. of Items	$n_{(complete\ case)}$	Cronbach's α	95% CI
Mathematics Self-Efficacy (MSE)	8	73	.864	[.811–.906]
Mathematics Self-Concept (MSC)	5	69	.900	[.857–.933]
Mathematics Anxiety (MA)	5	71	.942	[.918–.961]

All three subscales showed good-to-excellent internal consistency. Every item had a corrected item-total correlation above .50 (MSE range: .512–.692; MSC: .712–.826; MA: .802–.871), indicating that no item required elimination. These reliability estimates are comparable to those reported for recently validated mathematics self-efficacy and self-concept instruments in other populations (Dahlan, 2026; Sayah Sayari, 2024). The Kaiser-Meyer-Olkin (KMO) test yielded a value of .888, classified as "meritorious" under Kaiser's (1974) criteria. Bartlett's Test of Sphericity was significant ($\chi^2 = 912.77$, $p < .001$), indicating that the inter-item correlation matrix was adequate for factor analysis.

Initial (unrotated) eigenvalue analysis indicated four factors with eigenvalues > 1, whereas the theoretical model assumed three dimensions. A three-factor extraction with promax rotation produced the loading pattern shown in Table 2.

Table 2. Factor Loadings (EFA, Three Factors, Promax Rotation)

Item	Factor 1 (MA)	Factor 2 (MSE)	Factor 3 (MSC)	h^2
MA_0001	0.833	0.032	-0.141	.804
MA_0002	0.918	0.040	0.000	.808
MA_0003	0.673	-0.203	-0.152	.791
MA_0004	0.769	-0.285	0.118	.778
MA_0005	0.755	0.079	-0.209	.702
MSE_0001 (contextual)	-0.225	0.773	-0.342	.574
MSE_0002 (contextual)	-0.293	0.689	-0.238	.570
MSE_0003 (contextual)	-0.050	0.758	-0.052	.573
MSE_0004 (contextual)	-0.142	0.762	-0.155	.582
MSE_0005 (abstract/procedural)*	-0.088	0.497	0.231	.497
MSE_0006 (abstract/procedural)*	0.313	0.661	0.338	.576
MSE_0007 (abstract/procedural)*	0.222	0.531	0.445	.568
MSE_0008 (abstract/procedural)*	0.231	0.482	0.332	.381
MSC_0001 (R)	-0.425	0.074	0.451	.652
MSC_0002	-0.417	-0.045	0.608	.757
MSC_0003	-0.351	0.113	0.481	.638
MSC_0004	-0.078	-0.205	0.923	.751
MSC_0005	-0.244	-0.122	0.696	.610

** Table 2. Full item-level factor loadings (pattern matrix, principal-axis EFA, three factors, promax rotation; N = 67 complete cases). Bold pattern would normally mark each item's primary loading; here the primary loading for every item is the largest absolute value in its row. * These four items load moderately on Factor 2 (MSE) but noticeably lower than the other four MSE items, and show meaningful secondary loadings on Factors 1 and/or 3 — the cross-loading pattern discussed below. Factor correlations (Φ): MA–MSE = -.502, MA–MSC = -.510, MSE–MSC = .544. Sum-of-squared-loadings variance accounted for: Factor 1 (MA) = 22.6%, Factor 2 (MSE) = 20.2%, Factor 3 (MSC) = 16.2%, total = 59.0%.*

Together, the three factors explained 59.0% of total variance (Factor 1/MA = 22.6%; Factor 2/MSE = 20.2%; Factor 3/MSC = 16.2%). MA items showed the cleanest factor structure (all five loading .67–.92 on Factor 1, with negligible secondary loadings). MSC items loaded strongly and primarily on Factor 3 (.45–.92), though three of the five (MSC_0001, _0002, _0003) carried a modest secondary loading on Factor 1 (-.35 to -.43), plausibly because feeling anxious and holding a negative self-concept share overlapping content at the item level. MSE items showed the most complex pattern: four items framed in narrative contexts (train schedules, discounts, floor tiles, newspaper graphs) loaded strongly and comparatively cleanly on Factor 2 (.69–.77), while four more abstract/procedural items (an equation-solving item, map scale, a second equation-solving item, fuel consumption) showed weaker primary loadings on Factor 2 (.48–.66) and cross-loaded on Factor 1 and/or Factor 3 (absolute secondary loadings .09–.45), most visibly for MSE_0007 (solving $2(x+3) = (x+3)(x-3)$, the most abstract item) and MSE_0008 (fuel-consumption rate, which also had the lowest communality, $h^2 = .381$).

Because these four abstract/procedural MSE items showed weaker and cross-loading patterns rather than failing to load altogether, outright deletion from the instrument is not clearly warranted on the present evidence. We instead recommend that they be (a) flagged for expert item review and potential revision, for example, by adding a brief narrative or real-world anchor to each abstract/procedural task, and (b) evaluated in future work as a candidate second self-efficacy facet (contextual versus abstract/procedural) through Confirmatory Factor Analysis, rather than being retained unmodified within a single undifferentiated MSE composite score in applied use. Table 3 presents Pearson correlations among the subscale composite scores.

Table 3. Pearson Correlations Among Subscale Composite Scores

	MSE	MSC	MA
MSE	1.000	.567	-.559
MSC	.567	1.000	-.726
MA	-.559	-.726	1.000

The correlation pattern was theoretically consistent: self-efficacy and self-concept were moderately and positively correlated ($r = .567$, $p < .001$, $n = 68$), while both were negatively correlated with mathematics anxiety ($r = -.559$, $p < .001$, $n = 70$, for MSE; $r = -.726$, $p < .001$, $n = 68$, for MSC). This pattern provides preliminary support for the instrument's convergent validity. Because no formal discriminant-validity procedure (e.g., a confirmatory test of factor distinctiveness, or comparison of average variance extracted against shared variance) was conducted, these negative cross-domain correlations should be interpreted as consistent with, rather than proof of, discriminant validity; a firmer discriminant-validity conclusion awaits the CFA-based follow-up recommended below.

Overall, these findings provide preliminary evidence supporting aspects of the validity and reliability of the mathematics self-belief instrument among early childhood pre-service teachers. All three subscales showed good-to-excellent internal consistency by both Cronbach's alpha and McDonald's omega, consistent with common psychometric standards (Cronbach, 1951; Edwards, 2021). The factor structure for the self-concept and mathematics-anxiety subscales was well confirmed, with all items loading cleanly on their corresponding theoretical dimension.

The most notable finding concerns the self-efficacy (MSE) subscale, where items framing mathematical tasks in narrative, everyday-life contexts (train schedules, discounts, tiles, graphs) showed substantially cleaner and stronger factor loadings than items that were abstract and oriented toward formal mathematical procedure (map scale, algebraic equations, fuel consumption). This pattern is conceptually consistent with the central theme of Brownlow (2020) original study on framing effects in word problems, suggesting that early childhood pre-service teachers' mathematics self-belief may be more context-dependent than assumed by generic self-efficacy models, and may overlap more with the anxiety dimension when tasks are presented in a more abstract, formal form. This observation is consistent with evidence that mathematics anxiety is domain- and task-specific rather than a uniform trait (Demedts, 2022), and that anxious problem-solvers tend to show reduced flexibility specifically on more abstract or procedurally demanding tasks (Jiang, 2021).

A more critical reading of this pattern, rather than a purely descriptive one, points to a plausible cognitive mechanism: abstract/procedural items lack the narrative or real-world anchor that appears to support confident responding on the contextual items, so responding to them may draw more heavily on decontextualized, working-memory-dependent processing that mathematics anxiety is known to disrupt selectively (Jiang, 2021). This is consistent with evidence that mathematics anxiety is domain- and task-specific rather than a uniform trait (Demedts, 2022), and that anxious problem-solvers tend to show reduced flexibility specifically on more abstract or procedurally demanding tasks (Jiang, 2021). Under this interpretation, the cross-loading is not merely a statistical artifact but a substantively meaningful signal that "self-efficacy" for early childhood pre-service teachers may not be a single undifferentiated belief, but one that fractures along the same contextual/abstract line that Brownlow's (2020) framing manipulation was designed to probe — reinforcing the direct link between the present psychometric findings and the original study's substantive theme.

The pattern of correlations among subscales further supports the instrument's convergent and discriminant validity: the positive association between self-efficacy and self-concept, together with the negative associations of both with mathematics anxiety, is consistent with the broader mathematics self-belief literature (Ashcraft, 2002; Bandura, 1997), and with more recent work

showing that self-efficacy and anxiety make distinguishable, complementary contributions to mathematics performance (Živković, 2023) and that supportive teacher–student relationships can further buffer this anxiety–efficacy dynamic (Wang, 2024).

This study is subject to several limitations. First, it relied on secondary data analysis rather than primary data collection, so the researchers had no control over the original data-collection procedures. Second, the sample size (n = 80, with complete cases ranging from 67–73 depending on subscale) is small relative to ideal standards for EFA (ideally n ≥ 100–150) and for Confirmatory Factor Analysis, so the results should be regarded as exploratory/preliminary and in need of replication with a larger sample. Third, the data originate from a population of early childhood pre-service teachers in Australia (Brownlow, 2020); findings cannot be generalized to other cultural and linguistic contexts, including Indonesia, without a separate adaptation and re-validation process. Fourth, missing data on several subscales (11–12% of respondents) may have affected parameter estimation despite listwise/pairwise handling. Finally, the sample was entirely female (based on recorded data), limiting generalizability to male pre-service teachers.

Building on these limitations, several directions are recommended for future research. Researchers could replicate the psychometric testing on a larger sample of early childhood pre-service teachers (ideally n ≥ 150–200) to obtain more stable EFA results and to enable a follow-up Confirmatory Factor Analysis (CFA). Specifically, we recommend a multi-site CFA conducted across at least two culturally distinct pre-service teacher-education contexts (e.g., Australia and Indonesia) to test configural, metric, and scalar invariance of the three-dimension structure before the instrument is used for cross-cultural comparison**.** A cross-cultural adaptation (translation, back-translation, expert judgment, readability testing) of the instrument into Indonesian, followed by re-validation among Indonesian early childhood pre-service teachers, would also be valuable. Future work could formally test the indicated heterogeneity within the self-efficacy subscale through a two-factor model (contextual versus abstract/procedural self-efficacy) using CFA, or consider a bifactor model, to determine whether this dimensional split is empirically stable. It would further be useful to relate mathematics self-belief scores to broader outcome variables, such as actual performance in numeracy-teaching tasks, to examine predictive validity beyond construct validity, and to include samples with more diverse sex composition and educational background to test measurement invariance across groups. Additionally, the relationship between word-problem framing effects (the Task_1–Task_6 and Pre/Post Confidence variables in the original dataset) and mathematics self-belief scores warrants further exploration, to test whether framing moderates the relationship between self-efficacy and actual performance. Finally, future studies could examine whether structured field-teaching experience, shown elsewhere to reduce preservice teachers' mathematics anxiety, also improves the psychometric coherence of self-efficacy responses over time (Mainali, 2025).

For teacher-education institutions considering the practical use of this instrument (e.g., for admissions screening or coursework diagnostics), we recommend interim caution in relying on a single composite self-efficacy score until the abstract/procedural items are reviewed and, if needed, revised, and suggest piloting the instrument together with a structured item-review workshop involving mathematics-education experts before any large-scale institutional use.

CONCLUSION

The mathematics self-belief instrument used in Brownlow's (2020) study demonstrated good-to-excellent internal-consistency reliability across its three subscales, with a factor structure that broadly supported the intended three-dimensional model. Self-concept and mathematics-anxiety items loaded cleanly onto their theoretical dimensions, while self-efficacy items showed a more

differentiated pattern: those framed in narrative, everyday contexts behaved distinctly from those framed as abstract mathematical procedures. This distinction directly echoes the framing-effect focus of the original study and suggests that mathematics self-efficacy among early childhood pre-service teachers may be more context-sensitive than generic models assume.

These findings carry two practical implications. First, they offer researchers and teacher-education programs an explicit psychometric reference for using or adapting this instrument, one that was previously unavailable. Second, they point to a concrete direction for instrument refinement: self-efficacy items may need to be evaluated—and possibly scored—separately according to their framing characteristics rather than treated as a single, homogeneous scale.

Beyond these substantive findings, this study also makes a methodological contribution by illustrating how an openly shared secondary dataset can be systematically re-analyzed to produce reusable psychometric documentation — covering reliability, EFA adequacy, factor structure, and convergent-validity evidence — for an instrument that had previously been used only as a supporting measure within a different primary study. This provides a low-cost, replicable template that other researchers can apply when adapting or extending this or similar instruments for new populations.

The contribution of this study lies in providing a stand-alone psychometric report for a specific and underrepresented population, and in linking instrument-validity evidence directly to the framing-effect theme of the source study. Given the modest sample size and the Western origin of the data, these conclusions should be treated as preliminary. Replication with larger and more diverse samples, together with cross-cultural adaptation for contexts such as Indonesia, is recommended before the instrument is adopted more broadly in early childhood teacher-education research.

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CONTRIBUTION RESEARCHERS

Rusli developed the research concept, performed the data analysis, and prepared the manuscript. Rusdin contributed to the conceptualization of the study and assisted in writing the manuscript. Both authors discussed the results, critically reviewed the manuscript, and approved the final version for publication.

REFERENCES

Ashcraft, M. H. (2002). Math anxiety: Personal, educational, and cognitive consequences. *Current Directions in Psychological Science*, *11*(5), 181-185. https://doi.org/10.1111/1467-8721.00196

Bandura, A. (1997). *Self-efficacy: The exercise of control*. W. H. Freeman.

Barroso, C. (2021). A meta-analysis of the relation between math anxiety and math achievement. *Psychological Bulletin*, *147*(2), 134-168. https://doi.org/10.1037/bul0000307

Becker, M. (2022). Parents' math anxiety and mathematics performance of pre-kindergarten children. *Journal of Experimental Child Psychology*, *214*, 105302. https://doi.org/10.1016/j.jecp.2021.105302

Bosica, J. (2022). Using a mixed methods approach to study the relationship between mathematics anxiety, mathematics teacher efficacy, and mathematics teaching anxiety in preservice elementary school teachers in Ontario. *Canadian Journal of Science, Mathematics and Technology Education*, *22*, 190-209. https://doi.org/10.1007/s42330-022-00203-8

Brownlow, L. (2020). *Self-Belief, Confidence and Framed Word Problems: A Study on Early Childhood Pre-Service Teachers*. https://doi.org/10.17632/8gtxyz4s3h.1

Cipora, K. (2024). The AMATUS dataset: Arithmetic performance, mathematics anxiety and attitudes in primary school teachers and university students. *Journal of Open Psychology Data*, *12*(1), 9. https://doi.org/10.5334/jopd.115

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*(3), 297-334. https://doi.org/10.1007/BF02310555

Dahlan, J. (2026). Measuring students' self-concept: Instrument development and validation using exploratory factor analysis. *Jurnal Pendidikan Matematika dan Sains*, *14*(2), 424-432. https://doi.org/10.21831/jpms.v14i2.96861

Demedts, F. (2022). Unraveling the role of math anxiety in students' math performance. *Frontiers in Psychology*, *13*, 979113. https://doi.org/10.3389/fpsyg.2022.979113

Edwards, A. A. (2021). Alpha, omega, and H internal consistency reliability estimates: Reviewing these options and when to use them. *Counseling Outcome Research and Evaluation*, *14*(1), 77-88. https://doi.org/10.1080/21501378.2021.1940118

Goretzko, D. (2021). Exploratory factor analysis: Current use, methodological developments and recommendations for good practice. *Current Psychology*, *40*(7), 3510-3521. https://doi.org/10.1007/s12144-019-00300-2

Jiang, R. (2021). How mathematics anxiety affects students' inflexible perseverance in mathematics problem-solving: Examining the mediating role of cognitive reflection. *British Journal of Educational Psychology*, *91*(1), 237-260. https://doi.org/10.1111/bjep.12364

Juniati, D. (2022). The influence of cognitive and affective factors on the performance of prospective mathematics teachers. *European Journal of Educational Research*, *11*(3), 1379-1391. https://doi.org/10.12973/eu-jer.11.3.1379

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika*, *39*(1), 31-36. https://doi.org/10.1007/BF02291575

Lau, N. T. T. (2022). Disentangling the individual and contextual effects of math anxiety: A global perspective. *Proceedings of the National Academy of Sciences*, *119*(7), e2115855119. https://doi.org/10.1073/pnas.2115855119

Lawshe, C. H. (1975). A quantitative approach to content validity. *Personnel Psychology*, *28*(4), 563-575. https://doi.org/10.1111/j.1744-6570.1975.tb01393.x

Mainali, B. (2025). Math anxiety, math performance and role of field experience in preservice teachers. *Education Sciences*, *15*(9), 1227. https://doi.org/10.3390/educsci15091227

Merino-Soto, C. (2023). Aiken's V coefficient: Differences in content validity judgments. *MHSalud*, *20*(1), 23-32. https://doi.org/10.15359/mhs.20-1.3

Park, D. (2024). Effect of preschool teacher's math anxiety on teaching efficacy and classroom engagement in math. *Psychology in the Schools*. https://doi.org/10.1002/pits.23182

Sakellariou, C. (2022). The reciprocal relationship between mathematics self-efficacy and mathematics performance in US high school students: Instrumental variables estimates and gender differences. *Frontiers in Psychology*, *13*, 941253. https://doi.org/10.3389/fpsyg.2022.941253

Sayah Sayari, N. (2024). Development and validation of the mathematics self-efficacy scale for university students. *Research and Development in Medical Education*, *13*, 16. https://doi.org/10.34172/rdme.33206

Shao, M. (2025). The Chinese adaptation of the Teachers' Sense of Efficacy Scale in early childhood pre-service teachers: Validity, measurement invariance, and reliability. *Behavioral Sciences*, *15*(3), 329. https://doi.org/10.3390/bs15030329

Street, K. E. S. (2024). Students' mathematics self-efficacy: A scoping review. *ZDM – Mathematics Education*, *56*(2), 265-280. https://doi.org/10.1007/s11858-024-01548-0

Szczygieł, M. (2025). Math anxiety, math teaching anxiety, and math attitudes in primary school teachers: A multi-country study. *Journal for the Study of Education and Development*. https://doi.org/10.1177/14749041251401767

Wang, C. (2024). The effect of student-perceived teacher support on math anxiety: Chain mediation of teacher–student relationship and math self-efficacy. *Frontiers in Psychology*, *15*, 1333012. https://doi.org/10.3389/fpsyg.2024.1333012

Xenofontos, C. (2023). Teachers' self-efficacy in teaching mathematics: Tracing possible changes from teacher education to professional practice. *Teachers and Teaching*. https://doi.org/10.1080/13540602.2023.2219982

Zakariya, Y. F. (2022). Cronbach's alpha in mathematics education research: Its appropriateness, overuse, and alternatives in estimating scale reliability. *Frontiers in Psychology*, *13*, 1074430. https://doi.org/10.3389/fpsyg.2022.1074430

Živković, M. (2023). Math self-efficacy or anxiety? The role of emotional and motivational contribution in math performance. *Social Psychology of Education*, *26*(3), 579-601. https://doi.org/10.1007/s11218-023-09760-8