



SOCIOECONOMIC AND PSYCHOLOGICAL CORRELATES OF MATHEMATICAL LITERACY IN SOUTHEAST ASIA: AN ANALYSIS OF PISA 2022 DATA

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Abstract

Mathematical literacy remains a key indicator of students' capacity to apply mathematical knowledge in real-life contexts. This study examines how teacher support, mathematical confidence, mathematics anxiety, economic, social, and cultural status (ESCS), and gender are associated with students' mathematical literacy in four Southeast Asian countries: Indonesia, Malaysia, Thailand, and Singapore. Using PISA 2022 student data, the study included 35,609 students: 13,439 from Indonesia, 7,069 from Malaysia, 6,606 from Singapore, and 8,495 from Thailand. The reported analyses used descriptive statistics, reliability testing, country comparisons, and multiple linear regression. The unweighted results show substantial cross-country differences in mathematics achievement, with Singapore recording the highest sample mean and Indonesia the lowest. The pooled regression model explained 39.0% of the variance in the unweighted mathematics score. ESCS showed the largest standardized association with mathematical literacy, whereas mathematics anxiety showed a negative association. Mathematical confidence was positively associated with achievement in Malaysia, Singapore, and Thailand but had a negative coefficient in Indonesia. Teacher support was positively associated with achievement in Malaysia, Singapore, and Thailand but was not statistically significant in Indonesia. Because the original analysis averaged the ten plausible values at the student level rather than applying the full PISA estimation framework, all numerical estimates should be interpreted with appropriate caution. Subject to this limitation, the findings suggest that policies should address socioeconomic disparities, strengthen students' mathematical self-efficacy, and reduce mathematics anxiety through targeted learning support.

Keywords *Mathematical Literacy, ESCS, Mathematics Anxiety, Mathematical Confidence, Teacher Support, PISA 2022*

INTRODUCTION

Mathematical literacy is an important competence in contemporary education because it reflects students' ability to use mathematics in real-life contexts. It includes the ability to reason mathematically, formulate problems, employ mathematical concepts and procedures, interpret results, and make evidence-based decisions. The PISA 2022 Mathematics Framework defines mathematical literacy as students' capacity to reason mathematically and to formulate, employ, and interpret mathematics in a variety of real-world contexts (OECD, 2023a). This definition shows that mathematical literacy is related not only to school achievement but also to students' readiness to participate in academic, social, and economic life.

PISA 2022 provides a strong basis for analysing mathematical literacy because mathematics was the major assessment domain in that cycle. The assessment measured the performance of 15-year-old students and emphasised mathematical reasoning,

problem-solving, and the application of mathematics in changing real-world situations (OECD, 2023a). PISA 2022 also shows clear differences in mathematics performance across Southeast Asian education systems. Singapore was the highest-performing participating system in mathematics, whereas Indonesia, Malaysia, and Thailand recorded substantially lower national mean scores (OECD, 2023b). This variation makes Indonesia, Malaysia, Thailand, and Singapore relevant cases for comparative analysis.

Previous research confirms that mathematics achievement is associated not only with cognitive skills but also with affective and contextual factors. Gabriel et al. (2020) found that mathematics anxiety was linked to mathematical literacy through self-regulated learning factors, particularly perseverance and self-efficacy. Similarly, Shimizu (2025) reported positive relationships between mathematics self-efficacy, behavioural engagement, and mathematics achievement, together with negative relationships involving mathematics anxiety. These findings suggest that students' confidence and emotional responses are important for understanding variation in mathematical literacy.

In addition, classroom-level factors such as teacher support contribute to students' mathematics-learning experiences. Wang et al. (2024) found that perceived mathematics teacher support was associated with lower mathematics anxiety through teacher–student relationships and mathematics self-efficacy. This indicates that teacher support may influence learning through instructional, emotional, and motivational mechanisms. OECD (2025) likewise reports that teacher support is associated with student learning outcomes, although the strength of the relationship varies across contexts and student groups. However, much of the previous research focuses on a single country, examines only one or two affective variables, or does not compare Southeast Asian systems using a common analytical framework. Limited evidence is available on whether teacher support, mathematical confidence, and mathematics anxiety are associated with mathematical literacy in similar or different ways across Indonesia, Malaysia, Thailand, and Singapore. This gap is important because a relationship observed in a high-performing system such as Singapore not have the same magnitude or direction in Indonesia, Malaysia, or Thailand.

The contribution of this study lies in its comparative focus on four Southeast Asian education systems using the same PISA 2022 framework. It considers teacher support, mathematical confidence, mathematics anxiety, ESCS, and gender together rather than examining mathematics achievement in isolation. This approach makes it possible to identify both common and country-specific patterns of association with mathematical literacy. The findings contribute to comparative education research and inform mathematics-education policy by identifying the student and contextual factors that require greater attention in each country.

This study aims to compare students' mathematical literacy, teacher support, mathematical confidence, and mathematics anxiety across Indonesia, Malaysia, Thailand, and Singapore. It also examines the associations of teacher support, mathematical confidence, and mathematics anxiety with mathematical literacy after accounting for ESCS and gender. Based on these aims, the study addresses four research questions. First, how do students' mathematical literacy scores differ across the four countries? Second, how do teacher support, mathematical confidence, and mathematics anxiety differ across the four

countries? Third, to what extent are teacher support, mathematical confidence, and mathematics anxiety associated with mathematical literacy after accounting for ESCS and gender? Fourth, do these patterns of association differ across Indonesia, Malaysia, Thailand, and Singapore?

Literature Review

2.1 Mathematical Literacy in PISA

Mathematical literacy in PISA refers to students' capacity to reason mathematically and to formulate, employ, and interpret mathematics in real-world contexts (OECD, 2023a). This concept is broader than procedural mathematics because students must connect concepts, reasoning, representations, and contextual interpretation. PISA 2022 is particularly suitable for examining mathematics outcomes because mathematics was the major assessment domain and the framework emphasised reasoning, modelling, problem-solving, technology, and contemporary mathematical demands (OECD, 2023a). The four selected countries also represent markedly different mathematics-performance levels within Southeast Asia (OECD, 2023b). PISA reports achievement through ten plausible values rather than a single observed student score. Consequently, each statistic must be estimated separately for all ten plausible values and then combined; plausible values must not be averaged at the student level (OECD, 2024).

2.2 Teacher Support and Mathematical Literacy

Teacher support refers to students' perceptions that their mathematics teacher shows interest in their learning, provides extra help when needed, supports learning, and continues teaching until students understand. In PISA 2022, these four items form the index of teacher support in mathematics (TEACHSUP) (OECD, 2025). Teacher support may promote mathematical literacy by increasing engagement, reducing uncertainty, and helping students connect mathematical procedures with contextual problems. Wang et al. (2024) found that perceived mathematics teacher support was associated with lower mathematics anxiety through stronger teacher–student relationships and mathematics self-efficacy. Chen et al. (2024) also found that perceived teacher support was positively related to mathematics feedback literacy, with mathematics self-efficacy partly mediating the relationship. Together, this evidence suggests that teacher support operates through instructional, emotional, and motivational pathways. Therefore, teacher support is expected to be positively associated with mathematical literacy, although the magnitude of the association may vary across education systems.

2.3 Mathematical Confidence and Mathematical Literacy

Mathematical confidence refers to students' beliefs that they can successfully perform mathematical tasks. In this study, the construct was operationalised from PISA 2022 ST291 items concerning confidence in mathematical reasoning and contemporary mathematical tasks. This construct is conceptually close to mathematics self-efficacy; therefore, the terminology and scoring should be aligned consistently with the PISA codebook. From a social-cognitive perspective, beliefs about capability influence effort,

persistence, and strategy use in difficult learning situations (Bandura, 1997). Students with stronger mathematical confidence are more likely to attempt unfamiliar problems, tolerate uncertainty, and revise strategies when an initial solution fails. These behaviours are important in PISA because mathematical literacy requires non-routine problem-solving rather than the mechanical application of formulas. Shimizu (2025) found that mathematics self-efficacy was positively related to behavioural engagement and mathematics achievement in Japan using PISA 2022 data.

Furthermore, Situmeang et al. (2026) found that problem-based learning was related to mathematical literacy both directly and indirectly through self-confidence and mathematical resilience. Likewise, Husna et al. (2020) reported relationships among mathematical literacy, school context, gender, and self-confidence. Together, these studies indicate that mathematical confidence is an important affective factor that may support engagement, persistence, and the development of mathematical literacy.

2.4 Mathematics Anxiety and Mathematical Literacy

Mathematics anxiety refers to worry, nervousness, tension, and fear experienced in mathematics-related situations. In PISA 2022, six items are combined to form the mathematics-anxiety index (ANXMAT), with higher index values indicating greater anxiety than the OECD average (OECD, 2025). Gabriel et al. (2020), using Australian PISA 2012 data and structural equation modelling, found that mathematics anxiety was related to mathematical literacy through self-regulated learning factors, especially perseverance and self-efficacy. Ding (2016) also reported that the relationships among mathematics anxiety, self-efficacy, self-concept, and mathematical literacy varied across Shanghai-China and Sweden. These findings indicate that anxiety should not be interpreted in isolation from other affective factors. Students with higher anxiety often report weaker self-efficacy, lower self-concept, or reduced persistence in mathematical problem-solving. Therefore, mathematics anxiety is expected to be negatively associated with mathematical literacy, although the magnitude of the association may differ across countries and learning contexts.

2.5 Socioeconomic Status, Gender, and Mathematical Literacy

Socioeconomic status and gender are relevant covariates in research on mathematical literacy. In PISA, ESCS is a composite index based on parents' education, parents' occupational status, and home possessions (OECD, 2025). Nolka and Sofianopoulou (2024) reported relationships between mathematical literacy and family-background indicators, including parental education, occupation, books, and digital resources at home. Chiu (2018) likewise found that socioeconomic status mediated relationships between early numeracy activities and later mathematics outcomes. These findings suggest that family resources can shape students' opportunities to develop mathematical knowledge, confidence, and learning strategies.

Gender differences in mathematical literacy are context-dependent and should not be treated as universal. Chiu (2018) found gendered differences in early numeracy opportunities, while Lailiyah (2017) and Prabawati et al. (2019) reported differences in

selected mathematical-literacy indicators in local student samples. However, such small-scale studies cannot establish a general regional pattern. Gender is therefore included as a control variable, and its coefficient is interpreted separately within each national context rather than as evidence of an inherent gender advantage.

2.6 Conceptual Framework

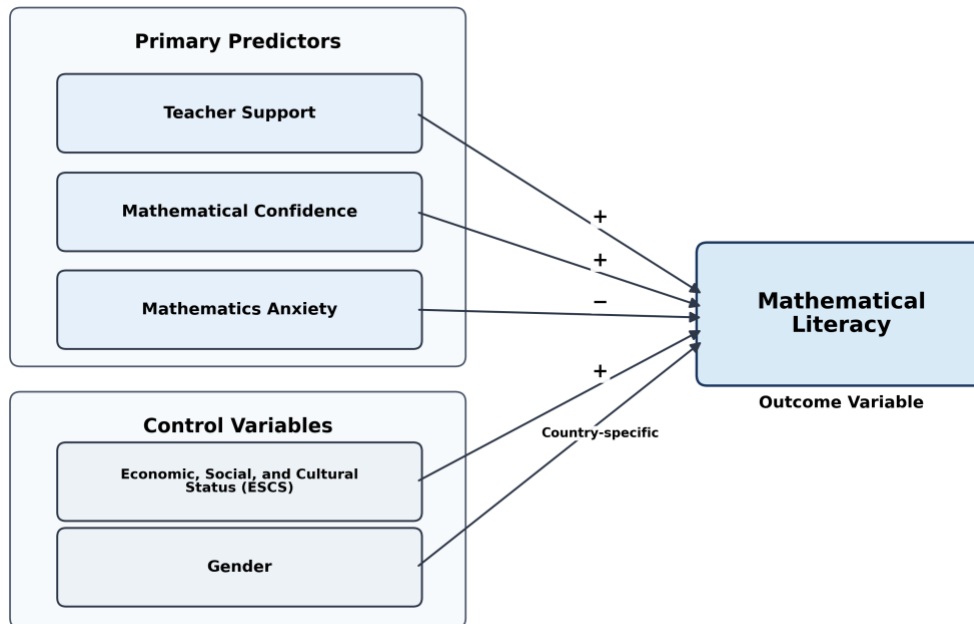


Figure 1. Proposed Conceptual Framework

Note: “+” indicates an expected positive association, “–” indicates an expected negative association, and the gender association is expected to be country-specific. Source: Authors’ own elaboration based on the PISA 2022 variables.

The conceptual framework proposes that mathematical literacy is associated with teacher support, mathematical confidence, mathematics anxiety, ESCS, and gender. Teacher support and mathematical confidence are expected to show positive associations because they may strengthen engagement, persistence, and problem-solving readiness. Mathematics anxiety is expected to show a negative association because it may interfere with concentration, confidence, and cognitive efficiency. ESCS is expected to show a positive association, whereas gender may show a statistically significant but country-specific relationship. The framework contributes to comparative mathematics education by testing whether these classroom, affective, and socioeconomic correlates operate similarly or differently across Indonesia, Malaysia, Thailand, and Singapore.

METHODS

Research Design

This study employed a quantitative, cross-sectional comparative design using secondary data from the Programme for International Student Assessment (PISA) 2022. The study compared Indonesia, Malaysia, Thailand, and Singapore. This design permits a

systematic examination of cross-country differences and statistical associations within a standardised international assessment framework; however, it does not support causal conclusions.

Data Source

The data were obtained from the PISA 2022 Student Questionnaire and mathematics-assessment database released by the Organisation for Economic Co-operation and Development (OECD). The database includes students' questionnaire responses, ten plausible values for mathematics performance, a final student sampling weight, and replicate weights required for design-consistent standard errors (OECD, 2024). The selected countries represent diverse mathematics-performance levels within Southeast Asia, allowing a meaningful regional comparison when the survey design is properly incorporated.

Sample

The analytic file contained 35,609 students across four countries. Indonesia contributed 13,439 students, Malaysia 7,069 students, Singapore 6,606 students, and Thailand 8,495 students. Indonesia had the largest unweighted sample, whereas Singapore had the smallest. The unequal country sample sizes reflect the PISA sampling design and must be handled with the final student weight rather than described as a balanced sample.

Table 1. Sample Size by Country

Country	Sample Size
Indonesia	13,439
Malaysia	7,069
Singapore	6,606
Thailand	8,495
Total	35,609

Variables

The dependent variable was mathematical literacy, represented by ten plausible values of mathematics performance (PV1MATH to PV10MATH) provided in the PISA 2022 database. The original exploratory analysis computed a student-level arithmetic mean of these ten plausible values. This procedure is not appropriate for final PISA inference. For publication-ready analysis, every descriptive statistic, group comparison, and regression model must be estimated separately for each plausible value and the resulting estimates and variances must then be combined according to the PISA procedure (OECD, 2024).

The focal independent variables were teacher support, mathematical confidence, and mathematics anxiety. Where available, the final analysis should use the OECD-scaled indices TEACHSUP and ANXMAT rather than ad hoc averages of raw items, because the official indices incorporate the intended direction and scaling. Mathematical confidence was constructed from ST291 items, but the extremely small valid sample sizes reported for its two item blocks indicate a probable routing, missing-by-design, coding, or

data-processing problem that must be resolved against the PISA 2022 codebook before the construct is used. ESCS was included as a continuous socioeconomic indicator. Gender was coded as female = 1 and male = 0. All coding decisions, missing-value rules, and scale directions should be reported explicitly and checked separately for each country.

Data Analysis

The original analyses were conducted in IBM SPSS Statistics at a nominal 95% confidence level. For a valid final analysis, all estimates must incorporate the PISA final student weight (W_FSTUWT), the 80 replicate weights (W_FSTR1–W_FSTR80), Fay-adjusted balanced repeated replication, and all ten mathematics plausible values (OECD, 2024). Descriptive statistics should be calculated as survey-weighted estimates. Internal-consistency analysis should be performed only after confirming the questionnaire routing, item availability, and coding in each country; where official OECD indices are used, additional raw-item alpha estimates may be unnecessary. Cross-country differences should be tested with design-adjusted procedures rather than ordinary one-way ANOVA based on simple random sampling.

To examine associations across the pooled sample, the regression model should include country indicators so that coefficients are not driven by unmodelled between-country mean differences. Country-by-predictor interaction terms can then test whether associations differ across Indonesia, Malaysia, Singapore, and Thailand. Alternatively, separate country models may be estimated using the correct PISA weights and plausible-value procedures. Because students are clustered within schools, a multilevel sensitivity analysis is also recommended. These models estimate conditional associations and should not be described as causal effects.

The corrected pooled regression model is specified as follows:

Mathematical Literacy = $b_0 + b_1(\text{Teacher Support}) + b_2(\text{Mathematical Confidence}) + b_3(\text{Mathematics Anxiety}) + b_4(\text{ESCS}) + b_5(\text{Gender}) + \text{Country Fixed Effects} + \text{Country} \times \text{Predictor Interactions} + \text{error}$

Multicollinearity should be assessed using variance inflation factors (VIF), but acceptable VIF values do not address omitted-variable bias, survey-design misspecification, or measurement problems. Missing data should be described transparently, and listwise deletion should not be used without reporting the resulting country-specific analytic sample for each model.

Important analytical status: The numerical results retained below reproduce the original SPSS output and are included for editorial continuity. They are not publication-ready because the original calculations averaged plausible values at the student level and did not use PISA final and replicate weights. The tables and inferential statistics must be re-estimated before submission.

RESULTS

Sample Distribution

Table 1 presents the unweighted distribution of the analytic sample across Indonesia, Malaysia, Singapore, and Thailand. The file contains 35,609 students. Indonesia

contributes the largest share (37.7%), followed by Thailand (23.9%), Malaysia (19.9%), and Singapore (18.6%).

These percentages describe the achieved sample only and should not be interpreted as the countries' population shares. Nationally representative estimates require the PISA final student weight, and uncertainty estimates require the replicate weights.

Descriptive Statistics of Study Variables

Table 2 presents the original unweighted descriptive statistics for mathematics achievement and the focal study variables. These sample statistics are retained provisionally and must be replaced with survey-weighted estimates based on all ten plausible values.

Singapore has the highest unweighted mathematics mean ($M = 573.98$, $SD = 99.34$), followed by Thailand ($M = 414.59$, $SD = 90.62$), Malaysia ($M = 409.49$, $SD = 71.00$), and Indonesia ($M = 379.03$, $SD = 61.48$). The large sample-level difference between Singapore and the other countries is consistent with the general PISA 2022 performance pattern; however, these values should not be labelled national means until the survey weights and plausible-value procedure have been applied.

The raw teacher-support means range from 3.03 in Indonesia to 3.26 in Singapore. These differences are small on the reported response scale, but direct comparisons require confirmation that the items were coded identically and that measurement comparability is adequate across countries.

The reported mathematical-confidence mean is highest in Singapore ($M = 2.60$) and lowest in Thailand ($M = 2.27$). Because the confidence scale shows severe valid-sample problems in the reliability analysis, these descriptive comparisons should be treated with caution until the construction of the ST291 measure has been corrected.

The reported mathematics-anxiety mean is lowest in Singapore ($M = 2.54$) and highest in Malaysia ($M = 2.83$). This descriptive pattern does not by itself establish that lower-performing systems have stronger emotional barriers; such an interpretation requires survey-weighted analysis and a verified common scale.

Table 2. Descriptive Statistics by Country

Country	Mathematics Achievement M (SD), N	Teacher Support M (SD), N	Mathematical Confidence M (SD), N	Mathematics Anxiety M (SD), N
Indonesia	379.03 (61.48), 13,439	3.03 (0.78), 12,847	2.40 (0.62), 12,595	2.76 (0.62), 12,637
Malaysia	409.49 (71.00), 7,069	3.22 (0.74), 6,598	2.33 (0.61), 6,388	2.83 (0.65), 6,374
Singapore	573.98 (99.34), 6,606	3.26 (0.72), 6,542	2.60 (0.67), 6,528	2.54 (0.79), 6,527
Thailand	414.59 (90.62), 8,495	3.20 (0.82), 8,234	2.27 (0.65), 8,199	2.75 (0.71), 8,184

Country	Mathematics Achievement M (SD), N	Teacher Support M (SD), N	Mathematical Confidence M (SD), N	Mathematics Anxiety M (SD), N
Total	429.73 (105.75), 35,609	3.15 (0.78), 34,221	2.40 (0.65), 33,710	2.73 (0.69), 33,722

Reliability of Measurement Constructs

Table 3 reports the original Cronbach's alpha coefficients. Teacher support shows high internal-consistency coefficients across the four samples, ranging from .853 to .931. Nevertheless, reliability alone does not establish cross-country measurement equivalence, and the official TEACHSUP index is preferable for PISA-based comparisons.

Mathematics anxiety shows acceptable to high alpha coefficients in the reported item blocks, ranging from .788 to .895. However, splitting the six-item construct into two three-item blocks should be theoretically and procedurally justified; the official ANXMAT index should otherwise be used.

The mathematical-confidence reliability results are not acceptable evidence of measurement quality because the valid sample sizes are extremely small relative to the country samples (for example, overall N = 138 and N = 107 for the two item blocks). This pattern strongly suggests a questionnaire-routing, missing-by-design, coding, or filtering error. The confidence variable and all analyses involving it must be reconstructed and rechecked before substantive interpretation.

Table 3. Reliability Test Results

Construct	Items	Overall α (N)	Indonesia α (N)	Malaysia α (N)	Singapore α (N)	Thailand α (N)
Teacher support	4	.887 (33,904)	.853 (12,665)	.873 (6,528)	.915 (6,530)	.931 (8,181)
Mathematical confidence, items 1 to 5	5	.906 (138)	.834 (46)	.926 (34)	.939 (25)	.911 (33)
Mathematical confidence, items 6 to 10	5	.874 (107)	.928 (41)	.718 (19)	.833 (18)	.940 (29)
Mathematics anxiety, items 1 to 3	3	.855 (16,501)	.813 (6,125)	.805 (3,107)	.878 (3,202)	.895 (4,067)
Mathematics anxiety, items 4 to 6	3	.827 (16,842)	.833 (6,312)	.788 (3,199)	.817 (3,310)	.872 (4,021)

Differences Across Countries (Preliminary ANOVA Results)

Table 4 presents the original ordinary one-way ANOVA results. All variables show $p < .001$ in this preliminary output, but the reported p -values and standard errors assume simple random sampling and therefore do not reflect the PISA complex survey design.

Mathematics achievement shows the largest reported between-country difference ($F = 9,481.99$, $\eta^2 = .444$). The effect-size estimate indicates substantial variation in the unweighted sample, but it should not be described as structural inequality until a design-adjusted analysis confirms the result.

Teacher support also shows a statistically significant unweighted difference ($F = 186.25$, $\eta^2 = .016$), with a small reported effect size. This suggests limited sample-level variation relative to the achievement differences.

Mathematical confidence ($\eta^2 = .030$) and mathematics anxiety ($\eta^2 = .020$) show small reported between-country effect sizes. All four comparisons must be repeated using survey-design-adjusted procedures before inferential conclusions are drawn.

Overall, the preliminary comparisons indicate sample-level differences across the four education systems, but final conclusions depend on weighted, design-consistent estimates.

Table 4. Country Comparison Results

Variable	df Between	df Within	F	p	η^2
Mathematics achievement	3	35,605	9,481.99	< .001	.444
Teacher support	3	34,217	186.25	< .001	.016
Mathematical confidence	3	33,706	350.86	< .001	.030
Mathematics anxiety	3	33,718	227.94	< .001	.020

Pooled Regression Analysis (Preliminary)

Table 5 presents the original unweighted pooled regression results. The reported model is statistically significant ($F = 4,170.24$, $p < .001$) and has $R^2 = .390$. However, the model omits country indicators, averages plausible values at the student level, and does not incorporate survey weights or replicate weights. Consequently, the reported coefficients, standard errors, significance tests, and R^2 should be treated as preliminary rather than as final population estimates.

ESCS has the largest standardized coefficient in the reported pooled model ($\beta = .564$). Part of this coefficient may reflect unmodelled differences between countries as well as within-country socioeconomic differences; a corrected pooled model must therefore include country fixed effects and, where appropriate, interactions.

Mathematics anxiety has a negative reported coefficient ($\beta = -.133$), indicating an inverse conditional association with the averaged mathematics score in the preliminary model. This association should not be described as a causal effect.

Mathematical confidence has a positive reported coefficient ($\beta = .089$), and teacher support has a smaller positive coefficient ($\beta = .062$). Because of the identified measurement problem for mathematical confidence, its coefficient requires particular caution.

Gender has a small positive reported coefficient ($\beta = .041$), which indicates a slightly higher conditional score for female students under the stated coding in the preliminary pooled model.

All reported VIF values are close to 1, suggesting no serious linear multicollinearity among the included predictors; however, this does not resolve the model's survey-design and measurement limitations.

Table 5. Preliminary Unweighted Regression Results for All Countries

Predictor	B	SE	β	t	p	VIF
Constant	465.155	3.616		128.626	< .001	
Teacher support	8.482	0.599	.062	14.155	< .001	1.011
Mathematical confidence	14.674	0.765	.089	19.180	< .001	1.147
Mathematics anxiety	-20.548	0.713	-.133	-28.828	< .001	1.131
ESCS	49.327	0.385	.564	128.268	< .001	1.033
Female	8.821	0.933	.041	9.459	< .001	1.023

Country-Specific Regression Results (Preliminary)

Separate unweighted regression models were estimated for each country to examine contextual variation. The reported coefficients describe conditional associations within the analysed samples; their statistical significance must be reassessed using all plausible values and the PISA sampling and replicate weights.

In Indonesia, the reported model explains 13.0% of the variance in the averaged mathematics score ($R^2 = .130$; $F = 358.926$, $p < .001$). ESCS has the largest standardized coefficient ($\beta = .346$, $p < .001$). Gender also has a positive coefficient under the stated coding ($\beta = .086$, $p < .001$). Mathematics anxiety ($\beta = -.079$, $p < .001$) and mathematical confidence ($\beta = -.052$, $p < .001$) have negative coefficients, whereas teacher support is not statistically significant ($\beta = .005$, $p = .585$). The negative confidence coefficient should not be interpreted as overconfidence without first resolving the scale-construction problem and examining suppression, coding, and missing-data effects.

In Malaysia, the reported model explains 25.2% of the variance ($R^2 = .252$; $F = 413.961$, $p < .001$). ESCS has the largest coefficient ($\beta = .409$, $p < .001$). Mathematical confidence ($\beta = .172$, $p < .001$), teacher support ($\beta = .080$, $p < .001$), and gender ($\beta = .072$, $p < .001$) have positive coefficients, whereas mathematics anxiety has a negative coefficient ($\beta = -.071$, $p < .001$).

In Singapore, the reported model explains 28.0% of the variance ($R^2 = .280$; $F = 501.575$, $p < .001$). ESCS has a positive coefficient ($\beta = .377$, $p < .001$). Mathematics anxiety has the largest absolute coefficient among the reported psychological variables ($\beta = -.205$, $p < .001$), mathematical confidence has a positive coefficient ($\beta = .140$, $p < .001$), and teacher support has a smaller positive coefficient ($\beta = .047$, $p < .001$). Gender is not statistically significant ($\beta = -.006$, $p = .608$).

In Thailand, the reported model explains 28.0% of the variance ($R^2 = .280$; $F = 622.475$, $p < .001$). ESCS has the largest coefficient ($\beta = .475$, $p < .001$). Mathematical confidence ($\beta = .110$, $p < .001$) and teacher support ($\beta = .078$, $p < .001$) have positive

coefficients, whereas mathematics anxiety has a negative coefficient ($\beta = -.081, p < .001$). Gender has a small positive coefficient under the stated coding ($\beta = .059, p < .001$).

Across the four preliminary models, ESCS has the largest standardized coefficient, and mathematics anxiety has a negative coefficient in every country. Teacher support and mathematical confidence vary in magnitude, significance, and, for confidence in Indonesia, direction. These differences are potentially important, but they cannot be considered robust country contrasts until the measurement and complex-survey corrections are completed.

DISCUSSION

This study examined socioeconomic, affective, and instructional correlates of mathematical literacy across Indonesia, Malaysia, Singapore, and Thailand using PISA 2022 data. The results show large unweighted cross-country differences, with Singapore recording a much higher sample mean than Indonesia, Malaysia, and Thailand. This broad pattern is consistent with the official PISA 2022 results (OECD, 2023b). However, the manuscript should not attribute these differences directly to curriculum quality, instructional effectiveness, or national capacity because those mechanisms were not measured in the reported models. The analysis demonstrates association, not causation, and final interpretation requires survey-weighted plausible-value estimates.

ESCS has the largest standardized coefficient in each country model. This pattern is consistent with research showing that socioeconomic resources are associated with opportunities to learn, access to educational materials, and mathematics outcomes (Chiu, 2018; Nolka & Sofianopoulou, 2024; OECD, 2023b). Nevertheless, the present models do not directly measure parental academic support, private tutoring, or specific resource pathways; these mechanisms should therefore be presented as possible explanations rather than established findings. Mathematics anxiety has a negative coefficient in every preliminary country model, which is broadly consistent with the literature on anxiety, self-regulation, and mathematical performance (Gabriel et al., 2020; Shimizu, 2025). The relatively large Singapore coefficient may indicate a stronger conditional association in that sample, but it does not by itself demonstrate that academic competition or performance pressure caused the anxiety.

Mathematical confidence has positive coefficients in Malaysia, Singapore, and Thailand, consistent with the view that self-efficacy can support engagement and persistence (Bandura, 1997; Shimizu, 2025). The negative coefficient in Indonesia should not be interpreted as evidence that students overestimate their competence. Given the extremely small valid samples in the confidence reliability analysis, the coefficient may reflect coding error, questionnaire routing, missing-by-design data, suppression among correlated predictors, or a mismatch between the intended construct and the computed composite. The confidence scale must be corrected before a substantive explanation is offered.

Teacher support has a small positive coefficient in the pooled preliminary model and is statistically significant in Malaysia, Singapore, and Thailand but not in Indonesia. This is compatible with research suggesting that teacher support may operate through motivation,

relationships, and mathematics self-efficacy (Chen et al., 2024; Wang et al., 2024). However, a non-significant coefficient does not mean that teacher support is unimportant; it indicates only that no independent linear association was detected in the specified model. Country differences should be tested directly through interaction terms in a correctly weighted pooled model rather than inferred solely from separate significance tests.

The study has several limitations. First, the design is cross-sectional and cannot establish temporal or causal relationships. Second, the original estimates did not account for plausible-value and complex-sampling procedures. Third, the confidence measure shows a serious data-processing problem. Fourth, the pooled model omitted country fixed effects, and the analysis did not model students' clustering within schools. Finally, cross-country comparisons of questionnaire constructs require evidence that the scales function comparably across languages and education systems.

CONCLUSION

This study contributes to the growing literature on mathematical literacy by providing a comparative examination of socioeconomic, psychological, and instructional correlates across four Southeast Asian education systems using PISA 2022 data. Across the pooled and country-specific analyses, socioeconomic status emerged as the most consistent correlate of mathematical literacy, underscoring the enduring influence of educational inequality on students' mathematics performance. Mathematics anxiety demonstrated a consistently negative association with mathematical literacy across all four countries, whereas teacher support and mathematical confidence exhibited context-dependent relationships that varied in magnitude and significance. These findings suggest that students' mathematics achievement is shaped not only by socioeconomic resources but also by the interaction of affective and classroom-related factors within different national contexts.

Beyond identifying common regional patterns, this study highlights the importance of avoiding a one-size-fits-all interpretation of mathematics learning in Southeast Asia. The observed cross-country variation indicates that the relationships between teacher support, students' confidence, and mathematics achievement are embedded within broader educational, cultural, and socioeconomic environments. Consequently, effective interventions to improve mathematical literacy should integrate strategies that reduce socioeconomic disparities, strengthen students' confidence in learning mathematics, alleviate mathematics anxiety, and support instructional practices that are responsive to local educational contexts.

The study also extends comparative mathematics education research by examining multiple psychological and contextual variables simultaneously within a common analytical framework. Rather than focusing exclusively on cognitive achievement, the findings reinforce the multidimensional nature of mathematical literacy and demonstrate the value

of integrating socioeconomic, affective, and instructional perspectives when evaluating educational outcomes across countries.

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