Literature Review

Effect of Teacher-Student Relationship and Emotional Intelligence on Mathematics Performance: A Meta-Analysis

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Abstract: The purpose of this meta-analysis was to investigate the influence of teacher-student relationship (TSR) and emotional intelligence (EI) on students' mathematics performance, focusing on elementary, secondary, and university populations. Employing a meta-analytic design, the study synthesized findings from 31 peer-reviewed quantitative studies published between 2017 and 2025, rigorously selected based on predefined eligibility criteria and coded using standardized procedures. The study analysis was performed using JASP software. A random-effects model was applied to compute pooled effect sizes and assess heterogeneity using Q and I^2 statistics. The results indicated a small, positive but statistically non-significant effect of TSR on mathematics performance ($g = 0.194$, $p = 0.078$), with extreme heterogeneity ($I^2 = 100\%$). In contrast, EI demonstrated a moderate, statistically significant effect ($g = 0.418$, $p < 0.01$), also marked by high heterogeneity ($I^2 = 97.80\%$). Publication bias was ruled out via Rosenthal's fail-safe N, which exceeded critical thresholds in both models. While the overall effect of TSR on math achievement was small and statistically inconclusive ($g = 0.194$, $p = 0.078$), it nonetheless underscores the potential influence of positive relational dynamics in educational settings. Conversely, EI emerged as a moderately strong and statistically significant predictor ($g = 0.418$, $p < 0.01$), highlighting the critical role of emotional competencies in academic success. This study is among the first to quantitatively synthesize the dual impact of relational and emotional variables on mathematics performance, offering novel insights for educational psychology and informing future interventions targeting socio-emotional learning in mathematics education.

Keywords: emotional intelligence; mathematics performance; meta-analysis; teacher-student relationship

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1. Introduction

Mathematics serves as a foundational pillar in both education and society, essential for logical reasoning, critical thinking, and problem-solving across diverse disciplines and professions (Maass et al., 2019). Despite its significance, mathematics continues to be perceived as challenging by many students, contributing to widespread anxiety, low confidence, and underperformance (Emelda et al., 2024; Ramirez et al., 2018). While cognitive factors have historically dominated discussions about math achievement, recent research emphasizes the growing importance of emotional and relational dimensions in mathematics learning environments (Abrahamson et al., 2020). Specifically, how students relate to their teachers and manage their emotions can critically shape their engagement, resilience, and academic outcomes in mathematics. Thus, understanding these non-cognitive influences is essential for developing more holistic and effective educational strategies.

Two key constructs at the heart of this discussion are the teacher-student relationship (TSR) and emotional intelligence (EI). TSR encompasses the quality of interpersonal interactions between educators and learners, typically characterized by trust, respect, warmth, open communication, and academic support (Hussain & Batool, 2024). A positive TSR has been linked to increased motivation, persistence, and academic self-efficacy (Guo et al., 2025). Meanwhile, EI refers to an individual's capacity to recognize, understand, and regulate emotions, both their own and those of others (Drigas et al., 2021). Students with high EI are better equipped to cope with stress, adapt to challenges, and collaborate effectively, which are crucial skills for thriving in mathematics (Gkintoni et al., 2024). Both theory and research suggest that TSR and EI can strengthen each other and positively influence students' mathematics performance, but the exact nature and strength of these effects are still not well understood.

Despite increasing scholarly interest in TSR and EI, the literature presents mixed and sometimes contradictory findings regarding their effects on mathematics performance. While some studies report significant positive associations (Asare, 2024; Asare & Larbi, 2025). Others show weak or inconsistent effects depending on age, cultural background, and assessment method (Appiah et al., 2023). Moreover, there is a noticeable lack of comprehensive quantitative syntheses, especially meta-analyses, focusing explicitly on the joint contributions of TSR and EI to mathematics performance. Existing reviews often emphasize general academic performance without disaggregating outcomes by subject domain or considering the interactive influence of emotional and relational variables in mathematics-specific contexts (Beasley & McClain, 2021; Kelcey et al., 2019; Lynch & Gonzalez, 2025). This gap limits our ability to draw generalizable conclusions and formulate evidence-based interventions tailored to mathematics education.

The present study aims to address this gap by conducting a meta-analysis of primary studies investigating the effect of TSR and EI on students' mathematics performance. By quantitatively synthesizing evidence across diverse educational contexts and student populations, this meta-analysis provides a robust estimate of the magnitude and consistency of these effects. The findings will offer valuable insights to educators, school psychologists, curriculum designers, and policymakers aiming to improve mathematics outcomes by integrating relational and emotional dimensions into teaching practices. In doing so, this review contributes not only to theory and empirical scholarship but also to actionable strategies for enhancing the mathematics learning experience in primary and secondary education worldwide.

Research objectives include the following: (1) to assess the overall effect size of TSR significantly predicting students' mathematics performance; (2) to assess the overall effect size of EI significantly predicting students' mathematics performance.

Research hypotheses concern:

H_1: The overall effect size of TSR significantly predicts students' mathematics performance.

H_2: The overall effect size of EI significantly predicts students' mathematics performance.

2. Materials and Methods

2.1. Research Design

A meta-analysis was employed in this study to systematically synthesize and quantify the collective findings from existing research on the influence of the TSR and EI on mathematics performance. This design allows for rigorous aggregation of effect sizes across diverse studies, offering a statistically robust and comprehensive overview that transcends the limitations of individual investigations. By converting different metrics into a common scale and applying a random-effect model, the meta-analysis captures both the average impact and the variability of results across educational contexts. This approach enhances the generalizability of findings and provides deeper insights into complex psychological and relational factors influencing mathematical achievement. The conceptual framework guiding this study is presented in Figure 1. It outlines the key variables and their hypothesized relationships, forming the basis for the research design and data collection process. This framework served as a roadmap for analyzing how each component contributes to the overall objectives of the study.

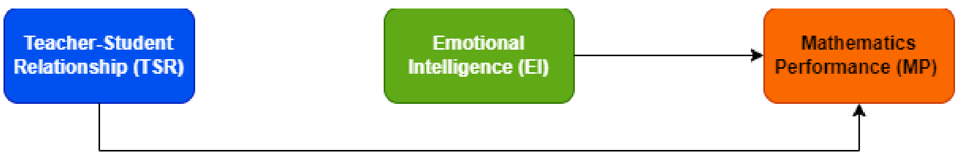

Figure 1. Conceptual framework.
Source: Author construct, 2025.

2.2. Eligibility Criteria and Study Selection

To ensure methodological rigor and relevance, this meta-analysis adopted strict eligibility criteria. Only peer-reviewed journal articles published between 2017 and 2025 inclusive were included to maintain contemporary relevance and academic credibility. Eligible studies employed quantitative methods, explicitly reporting either correlation coefficients (r) or standardized effect sizes (Cohen's *d*). The target population comprised school or university students, reflecting developmental stages where both TSR and EI play pivotal roles in shaping mathematics performance. Studies were required to be published in English and to include at least one measurable indicator of TSR, EI, or math achievement using psychometrically validated instruments. Non-quantitative studies, non-peer-reviewed articles, and studies involving non-student populations were excluded from the analysis to preserve the interpretability and comparability of the findings.

2.3. Population and Sampling Procedures

The population for this study consisted of published empirical research articles that examined the effect of the TSR and EI on mathematics performance, covering the period from 2017 to 2025. To meet the objectives and align the study design, a total of 1,042 articles were retrieved from various academic databases.

After a thorough review of 1,042 articles, only thirty-one (31) were ultimately selected for inclusion in this study, reflecting a highly selective and focused process. This careful screening ensured that only the most relevant and methodologically sound studies were retained for analysis. To achieve this, a purposive sampling technique was employed, meaning we intentionally selected studies based on specific criteria related to the research focus, such as relevance of TSR and EI to mathematics performance, the quality of the research design, and the availability of necessary data. This targeted approach helped ensure that the final sample of studies provided meaningful and comparable insights for the meta-analysis.

2.4. Search Strategy

A comprehensive literature search was conducted across five multidisciplinary databases renowned for educational and psychological research: Google Scholar, Scopus, ERIC, Web of Science, and SCISPACE. Regarding this, Figure 2 shows the SCISPACE interface. The search was guided by Boolean logic using carefully selected keywords such as: "teacher-student relationship" and "mathematics performance", "emotional intelligence" and "mathematics achievement", and "math performance" and "social-emotional learning." These search terms were refined iteratively to ensure comprehensive coverage of relevant studies. Additionally, backward and forward citation tracking was applied to capture potentially overlooked studies. This approach maximized sensitivity and specificity, capturing both well-established and emerging literature at the intersection of TSR, EI, and mathematical outcomes.

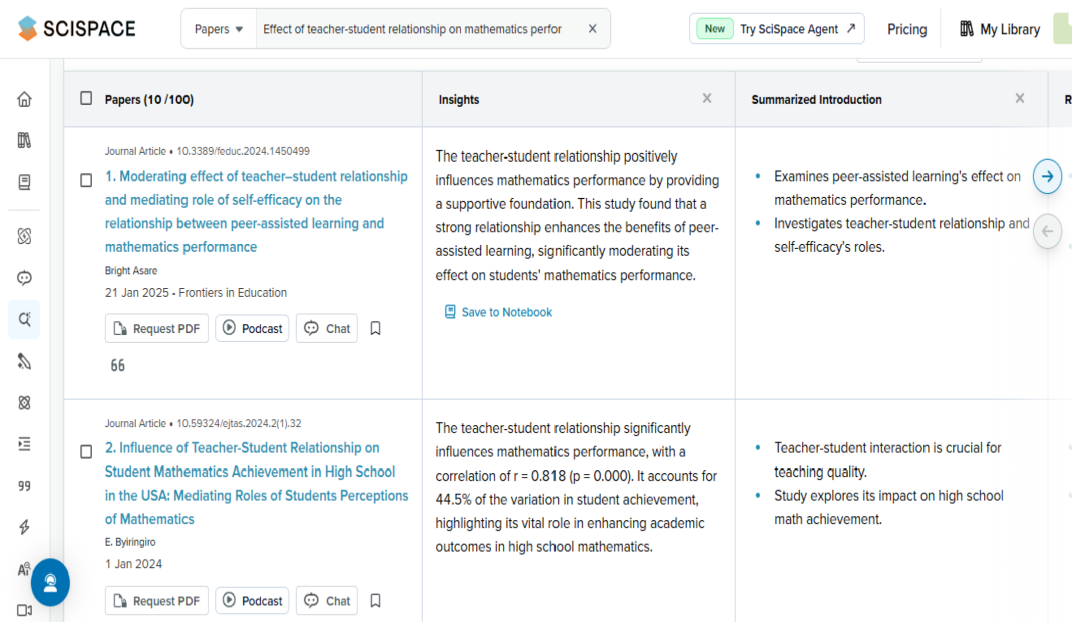

Figure 2. SCISPACE interface

2.5. Study Selection and Data Extraction

The study selection process followed the Preferred Reporting Items for Meta-Analyses

(PRISMA) framework. Initial search results were exported, and duplicates were removed using reference management software. The remaining records underwent title and abstract screening, followed by full-text evaluation against the eligibility criteria. Data extraction was conducted using a standardized template to ensure consistency. Key variables included: author(s), year of publication, country of study, sample size, level of education (elementary, secondary, or tertiary), effect size values (r or d), type of research design (e.g., cross-sectional or longitudinal), and measurement instruments for TSR, EI, and math performance. This systematic approach enabled a structured synthesis of effect sizes and study characteristics for subsequent meta-analytical computations.

Figure 3 illustrates the systematic flow of the study screening and selection procedure, grounded in the PRISMA framework. An initial pool of 1,042 records was identified through database searches (n = 987) and manual searching (n = 55). After removing duplicates, 922 unique records were retained for preliminary screening. Of these, 129 studies were excluded based on title and abstract reviews for lacking relevance. The remaining 793 articles underwent full-text screening, resulting in the exclusion of 209 studies that failed to meet the inclusion criteria, either due to the absence of empirical data or a lack of focus on TSR and EI. Out of 589 empirically eligible studies, 558 were omitted due to inadequate or missing data required for effect size computation. Ultimately, 31 high-quality studies met all inclusion benchmarks and were retained for meta-analytic synthesis. This rigorous filtration process ensured methodological integrity and conceptual alignment with the research objectives.

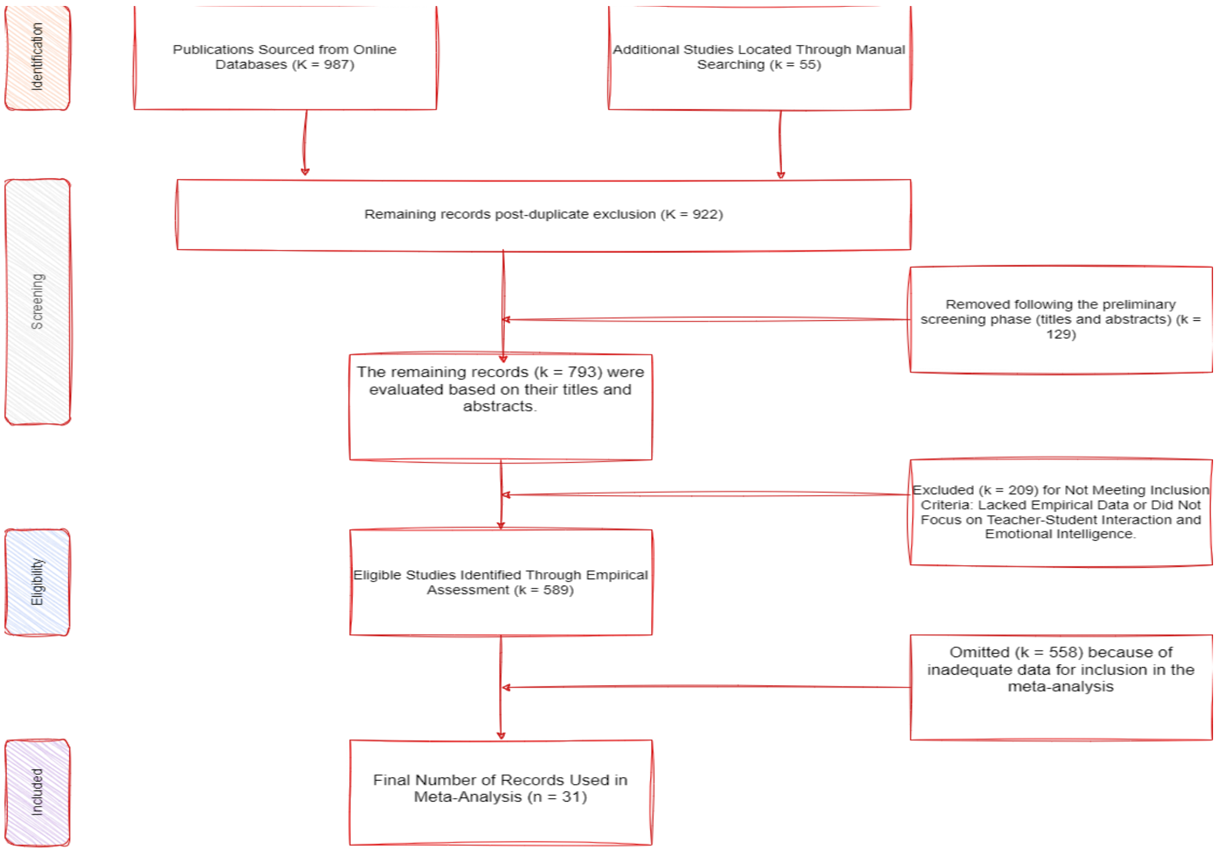

Figure 3. PRISMA-based study inclusion flowchart.
Source: Authors' creation, 2025.

2.6. Coding and Quality Assessment

Coding was initially conducted using Excel and was later exported into an advanced statistical platform such as JASP (ver. 0.19.3.0) for rigorous quantitative synthesis. The Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Analytical Cross-Sectional Studies was employed for quality assessment, examining dimensions such as sample appropriateness, measurement reliability, internal validity, and risk of bias. Only studies rated as moderate to high in quality were retained for meta-analysis, ensuring that the conclusions drawn were grounded in robust empirical evidence and free from substantial methodological weaknesses.

2.7. Effect Size Calculation

In this research, the effect sizes were obtained directly from the standardized beta coefficients (β) presented in the original studies reviewed. Rather than recalculating or converting statistical values, the analysis utilized the standardized estimates reported by the primary authors, as these coefficients enable meaningful comparisons among studies that differ in measurement scales and sample compositions. Employing the reported beta values not only maintains methodological uniformity but also upholds the authenticity of the original findings, thereby offering a sound and credible foundation for integrating the overall effect size across studies.

2.8. Heterogeneity Analysis

Evaluating the variability in effect sizes is central to understanding the consistency of findings across studies. To assess the degree of heterogeneity, the Q-statistic and the I^2 index were calculated. The formula for Q is given as:

$$Q = \sum_{i=1}^{k} w_i \,(y_i - \dot{y})^2$$

From the above formular, w_i, yi, y, and k represent the weight for all study i, the effect size for study i, the pooled effect size, and the number of studies, respectively. The Q-statistic serves as a traditional test of heterogeneity, while I^2 quantifies the percentage of total variation across studies that is due to heterogeneity rather than chance. The formula for I^2 is given as:

$$I^2 = \frac{Q - (k-1)}{k} \times 100\%$$

The above formula is satisfied if and only if Q>(k-1), where Q and k are Cochran's Q statistic and the number of studies, respectively. Thresholds for interpreting I^2 were applied, with 25% indicating low, 50% moderate, and 75% high heterogeneity. Elevated levels of heterogeneity would signal the influence of contextual or methodological moderators, warranting further analytical exploration. Understanding the magnitude of inconsistency among studies helps refine the interpretation of pooled effect sizes and informs the necessity for moderator analysis in subsequent steps.

2.9. Publication Bias Check

A crucial methodological concern in meta-analytical research is the risk of publication bias, which can lead to an overestimation of true effects. To assess this, funnel plots were generated to visually inspect for asymmetry, a potential indicator of bias arising from unpublished studies or selective reporting. In addition, a fail-safe N analysis was conducted to assess potential publication bias. This method estimates and imputes missing studies to provide a corrected pooled effect size. Together, these publication bias diagnostics enhance the credibility and transparency of the meta-analytic conclusions, reinforcing the study's contribution to evidence-based educational practice.

2.10. Ethical Consideration

This meta-analysis was conducted exclusively using previously published data, which removed the necessity for direct interaction with research participants and ensured adherence to ethical research practices. By relying solely on secondary data extracted from pre-reviewed journals and reputable academic publications, the study maintains a high standard and is thoroughly cited to uphold academic rigor and enable traceability of all sources. Meticulous citation not only ensured full transparency in the research process but also honored intellectual property rights, thereby safeguarding against issues of plagiarism or data misrepresentation.

3. Results

From table 1, the Q statistic is reported as 330.074 with 12 degrees of freedom (df) and a p-value less than 0.001, indicating statistically significant heterogeneity among the included studies. This means that the variation in effect size is not likely due to sampling error alone but is influenced by real differences across studies, such as differences in study design, population characteristics, or measurement tools. Additionally, the I2 value is 1.000 (or

100%), which reflects the proportion of total variation in observed effect sizes that is due to heterogeneity rather than chance. An I2 of 100% indicates extreme heterogeneity, suggesting that virtually all the variability among the study results is attributed to actual differences rather than random error. This high degree of heterogeneity emphasizes the need for further analysis, such as moderator or subgroup analysis, to explore potential sources of variability and better understand how and under what conditions TSR impacts mathematics performance.

Table 1. Heterogeneity test data summary for the effect of TSR on student mathematics performance.

Q	df	p-value	I^2
330.074	12	< 0.001	1.000

3.1. The combined effect size estimation for the effect of TSR on student mathematics performance

Table 2 presents the aggregated findings from the meta-analysis, estimating the overall effect size of TSR on mathematics performance. The computed effect size (g) is 0.194, indicating a small positive effect. This suggests that, on average, improved TSR is associated with a modest enhancement in students' mathematics performance across the studies included in the analysis.

Table 2. The results of the combined effect size estimation for the effect of TSR on student mathematics performance.

				95% confidence interval	
	Effect size (g)	**Std. error**	**p-value**	**Lower limit**	**Upper limit**
Overall	0.194	0.101	0.078	-1.995	2.384

Furthermore, the standard error (SE) of the effect size is 0.110, which reflects the degree of variability around the estimated effect. The p-value associated with this estimate is 0.078, indicating that the result is not statistically significant at the conventional 0.05 threshold. This means that while there appears to be a positive trend, it cannot to ruled out that this effect occurred by chance. The 95% confidence interval ranges from -1.995 to 2.384, is notably wide, and includes zeros, further supporting the conclusion that the overall effect is statistically inconclusive. Based on the result, the hypothesis that "the overall effect size of TSR significantly predicts students' mathematics performance" was rejected by this study.

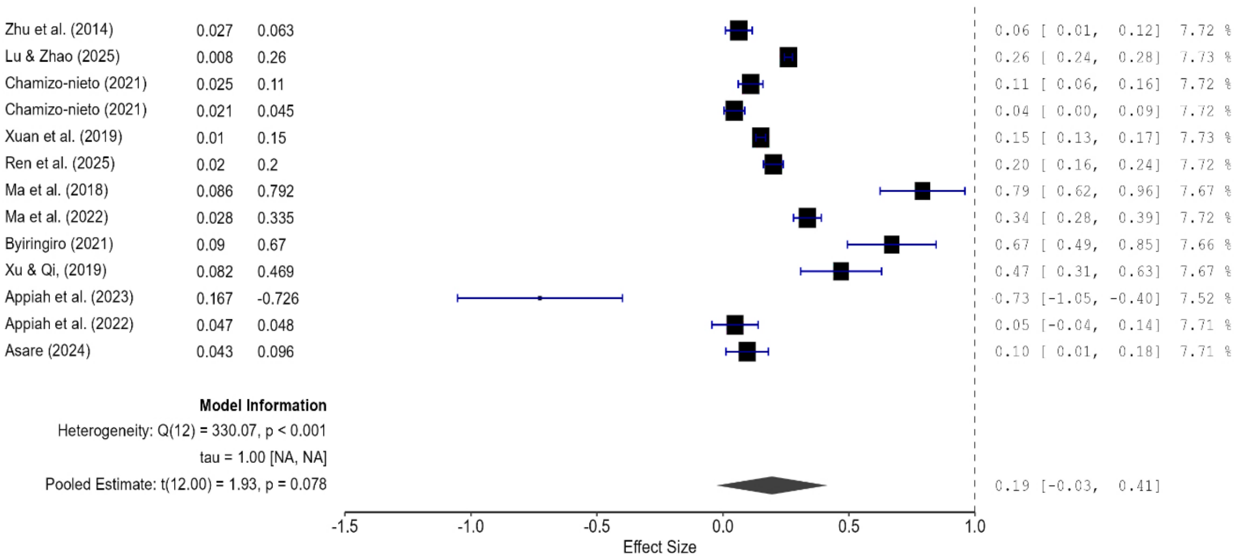

Figure 4. Forest plot showing the overall effect size of TSR on student mathematics performance.

Figure 4 presents the individual and pooled effect sizes from 13 studies included in a meta-analysis investigating the effect of TSR on mathematics performance. Each line represents a study's effect size (the black square) and its confidence interval (horizontal blue line), which visually indicates the precision of the estimate. The size of each black square corresponds to the weight assigned to the study in the meta-analysis, influenced by factors such as sample size and variance. On the far right, the confidence intervals and weights for each study are displayed numerically. For example, Ma, Du, Hau, and Liu (2017) reported the highest effect size (0.79), with a narrow confidence interval [0.62, 0.96], indicating both a strong and precise effect. In contrast, Appiah, Arthur, Boateng, and Akweittey (2023) show a large negative effect size (-0.73) with a wide confidence interval, suggesting high uncertainty and limited reliability.

The model information at the bottom indicates significant heterogeneity among the studies (Q (12) = 330.07, < 0.001), meaning the variation in effect size is more than would be expected by chance alone. This level of heterogeneity suggests that the studies differ in meaningful ways, possibly due to methodological variation, sample characteristics, or measurement tools. The pooled effect size, shown as a diamond at the bottom of the graph, is 0.19 with a 95% confidence interval of [-0.03, 0.41]. Since this interval includes zero, the overall effect is not statistically significant at the conventional 0.05 level (p = 0.078). This indicates that, despite several individual studies showing significant results, the overall evidence is inconclusive when synthesized, emphasizing the need for further research and possibly subgroup analyses to understand the sources of variability.

3.1.1. Evaluation of Publication Bias

To assess the potential publication bias, a fail-safe N analysis was conducted, as shown in Table 3, focusing on the effect of the TSR on students' mathematics performance. With 13 studies included (k = 13), the critical threshold for bias detection was calculated as 5k + 10 = 75. Impressively, the analysis produced a Rosenthal's fail-safe N of 2,856.898, far surpassing the threshold and indicating that over 2,000 additional null-result studies would be needed to nullify the observed effects. With a target significance level of α = 0.05 and a p-value of less than 0.001, these results suggest that the findings are statistically robust and not influenced by publication bias. This meta-analysis, grounded in methodological precision and objectivity, revealed a pooled effect size of d = 0.194 using a random-effect model.

Table 3. File-safe N for the effect of TSR on student mathematics performance.

File drawer analysis			
	Fail-safe N	Target significance	Observed significance
Rosental	2,856.898	.05	< .001

Table 4 presents a synthesis of empirical studies examining the effect of TSR on students' mathematics performance across different countries, sample sizes, and educational levels. The reported effect sizes (r or β) vary widely, ranging from negative (e.g., Appiah et al., 2023, β = -0.726) to strong positive relationships (e.g., Ma et al., 2017, r = 0.792), indicating that the impact of TSR is context-dependent. Most studies employed descriptive or cross-sectional survey designs, relying primarily on questionnaires, with some combining standardized tests to assess mathematics achievement. Standard errors also differ considerably, reflecting variability in measurement precision and sample characteristics. Finally, the table suggests that positive TSR generally correlates with better mathematics performance, though the strength of this relationship is influenced by factors such as sample size, grade level, and research design.

Table 4. Effect of TSR on student mathematics performance.

Author(s)	**Country**	**Sample size**	**Level of education**	**Effect size (r or β)**	**Type of design**	**Standard error**	**Measurement instrument**
Asare, 2024	Ghana	250	Secondary school	0.096	Descriptive correlation design	0.43	Questionnaire
Appiah et al., 2022	Ghana	400	Secondary school	.048	Descriptive survey design	.047	Questionnaire
Appiah et al., 2023	Ghana	320	Secondary school	-.726	Descriptive survey design	.167	Questionnaire
Xu & Qi, 2019	China	762	Secondary school	.469	Not stated	.082	Questionnaire
Byiringiro, 2021	USA	216	High school	.670	Descriptive survey design	.090	Questionnaire

Ma et al., 2022	China	321	High school	.335	Cross-sectional survey design	0.028	Questionnaire and standardized tests
Ma et al., 2017	China	11,036	Grade 8	.792	Cross-sectional survey design	.086	Questionnaire
Ren et al., 2025	China	283	Grade 4	.200	Cross-sectional survey design	.020	Questionnaire
Xuan et al., 2019	China	10,784	Grade 7 and 9	.150	Cross-sectional survey design	.010	Questionnaire and standardized tests
Chamizo-Nieto et al., 2021	China	19,845	Grade 4	.045	Cross-sectional survey design	.021	Questionnaire
Chamizo-Nieto et al., 2021	China	11,691	Grade 8	.110	Cross-sectional survey design	.025	Questionnaire
Lu & Zhao, 2024	China	156,661	Grade 8	.260	Cross-sectional survey design	.008	Questionnaire and standardized tests
Zhiying et al., 2024	China	6,534	Grade 4 and 6	.063	Cross-sectional survey design	.027	Questionnaire

Table 5 summarizes multiple studies examining the effect of EI on mathematics performance across different countries, educational levels, and research designs. The reported effect sizes (r or β) range widely, from small correlations such as .146 (Setyawan & Simbolon, 2018) to very strong effects like .862 (Nur et al., 2023), indicating that higher EI is generally associated with better mathematics performance, though the strength varies by sample, context, and methodology. Most studies used questionnaires, often combined with standardized tests, to measure EI and math achievement, and designs included correlational, ex-post facto, descriptive, and meta-analytic approaches. Larger samples, such as 400 secondary school students in Nigeria (Ugwuanyi et al., 2020), produced moderate effects around .503, while smaller or meta-analyzed samples in Indonesia reported higher effect sizes, highlighting that both study design and sample characteristics can influence the observed relationship between EI and mathematical outcomes. Finally, the table illustrates a consistent positive association, suggesting that students' emotional intelligence may play a meaningful role in supporting their mathematical learning and performance.

Table 5. Effect of EI on mathematics performance.

Author(s)	**Country**	**Sample size**	**Level of education**	**Effect size (r or β)**	**Type of design**	**Standard error**	**Measurement instrument**
Asare & Larbi, 2025	Ghana	356	Tertiary (University students)	.521	Descriptive-correlational design	.087	Questionnaire
Ugwuanyi et al., 2020	Nigeria	400	Secondary school	.503	Correlational survey research design	.053	Questionnaire and standardized tests
Prafitriyani et al., 2019	Indonesia	100	Grade 9	.705	Ex-post facto design	.055	Questionnaire
Akaneme & Metu, 2024	Nigeria	330	SSI students	.203	Correlational research design	.043	Questionnaire and standardized tests
Nurfitriyanti & Rusmana, 2020	Indonesia	72	Secondary school	.219	Correlation survey design	.027	Questionnaire

Ugwuanyi al., 2020	Nigeria	400	Secondary school	.253	Correlational survey research design	.056	Questionnaire and standardized tests
Nur et al., 2023	Indonesia	22	Elementary, junior high, and senior high schools	.778	Meta-analysis design	.110	Coding sheet
Nur et al., 2023	Indonesia	22	Elementary, junior high, and senior high schools	.770	Meta-analysis design	.156	Coding sheet
Nur et al., 2023	Indonesia	11	Elementary, junior high, and senior high schools	.862	Meta-analysis design	.170	Coding sheet
Nur et al., 2023	Indonesia	11	Elementary, junior high, and senior high schools	.710	Meta-analysis design	.195	Coding sheet
Ramadhani & Putranto, 2022	Indonesia	42	Grade 11	.357	Correlation research design	.123	Questionnaire
Hanifah & Gunawan 2023	Indonesia	57	Grade 5	.227	Ex-post facto design	.051	Questionnaire and documentation data
Warsi et al., 2022	Indonesia	123	Senior high school	.312	Correlation research design	.005	Questionnaire
Ariati et al., 2022	Indonesia	140	Senior high school	.148	Correlation research design	.636	Questionnaire and standardized tests
Setyawan & Simbolon, 2018	Indonesia	191	Senior high school	.146	Ex-post facto design	13.010	Questionnaire
Siagian et al., 2021	Indonesia	30	Junior high school	.157	Ex-post facto design	.015	Questionnaire and standardized tests
Maghbouli & Moradi, 2021	Philippines	150	Junior high school	.189	Correlation research design	.042	Questionnaire and Standardized tests
Winarso & Supriady, 2016	Indonesia	36	Senior high school	.742	Ex-post facto design	10.888	Questionnaire and standardized tests

Table 6 reveals a striking degree of heterogeneity in the relationship between EI and student mathematics performance, as evidenced by a Q value of 239.206 ($df = 17$, $p < 0.001$) and an I^2 of 97.804%. This exceptionally high I^2 indicates that nearly 98% of the variability in effect sizes across studies is due to true differences rather than chance alone, signaling substantial inconsistency in the findings. Such a result highlights the importance of exploring potential moderating variables, such as age group, educational context, or assessment tools, to better understand the diverse ways EI may influence mathematical achievement.

Table 6. Heterogeneity test data summary for the effect of EI on student mathematics performance.

Q	df	p-value	I2
239.206	17	< 0.001	97.804

Table 7 showcases the combined effect size estimation, revealing that EI has a moderate positive effect (g = 0.418) on students' mathematics performance. Although the effect size appears promising, the 95% confidence interval (-0.065 to 0.902) crosses zero, indicating some uncertainty around the true effect. However, the statistically significant p-value ($p < 0.01$) suggests that this relationship is unlikely to be chance. These findings highest the potential importance of EI in shaping mathematical achievement, while also emphasizing the need for cautious interpretation and further investigation to refine the precision of this estimate. Based on the result, the hypothesis that "*the overall effect size of emotional intelligence significantly predicts students' mathematics performance*" was accepted by this study.

Table 7. The results of the combined effect size estimation for the effect of EI on student mathematics performance.

				95% confidence interval	
	Effect Size (g)	**Std. Error**	**p-value**	**Lower limit**	**Upper limit**
Overall	0.418	0.058	< 0.01	-0.065	0.902

The forest plot, Figure 5, illustrates the individual and pooled effect of 18 studies examining the effect of EI on students' mathematics performance. Each black square represents a study's effect size, with horizontal lines denoting 95% confidence intervals, and square sizes reflecting the relative weight of each study. Most effect sizes cluster positively, ranging from moderate to strong, with the pooled effect size estimated at 0.42 (95% CI: 0.30 to 0.54), indicating a statistically significant and moderately strong relationship. This prediction interval (PI: -0.07 to 0.90) suggests potential variability in future studies, though the central tendency remains positive. The test for heterogeneity was significant ($Q(17) = 239.21$, $p < 0.01$; $\tau^2 = 0.22$), indicating considerable variation across studies, likely due to differences in population, methods, or measurement tools. Despite this heterogeneity, the overall pooled effect ($t(17) = 7.27$, $p < 0.001$) confirms that EI is a meaningful predictor of mathematics performance across diverse educational contexts.

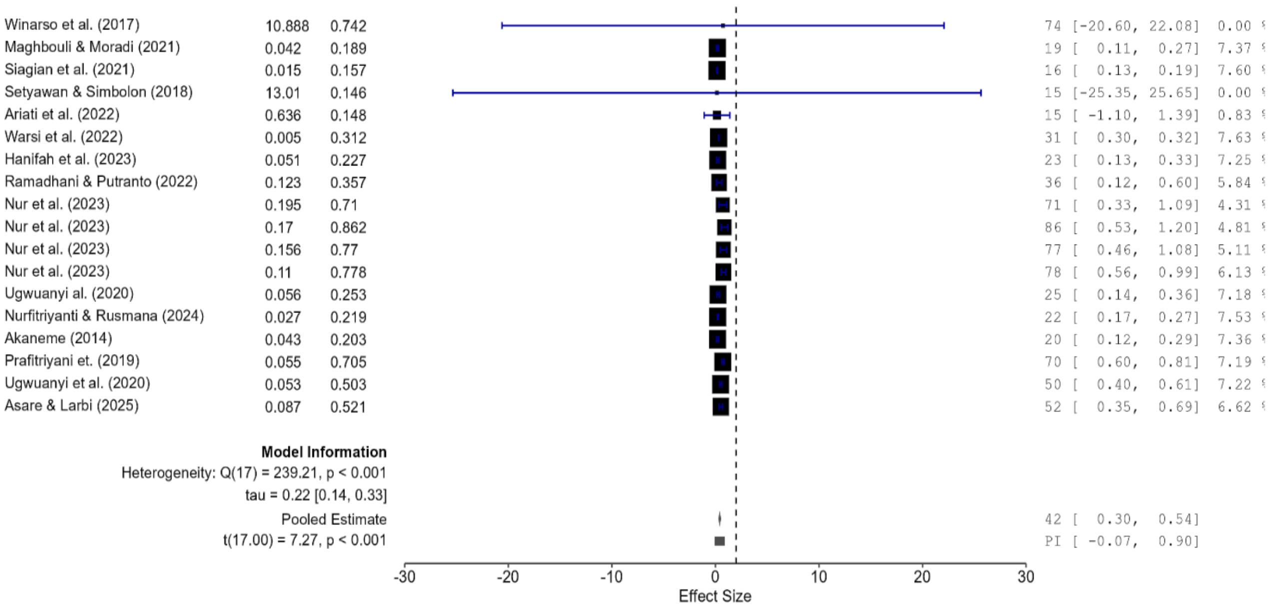

Figure 5. Forest plot showing the overall effect size of EI on student mathematics performance.

3.2. Evaluation of Publication Bias

To assess potential publication bias, Rosenthal's fail-safe N analysis was conducted (see Table 8), yielding a remarkably high value of 5,084.041. With 18 studies included (k = 18), the threshold value of 5k + 10 equals 100, far surpassed by the observed fail-safe N. This substantial difference, coupled with a target significance level of $\alpha = 0.05$ and an observed p-value of less than 0.001, strongly suggests that the findings are robust and not unduly influenced by unpublished or non-significant studies. These results reinforce the statistical validity of the meta-analysis, which uniquely explores the impact of EI on students' mathematics performance, a previously unexamined relationship in meta-analytic literature. The study's overall effect size (d = 0.418) was derived using a random-effect model and demonstrates a moderate, statistically significant influence, further underscoring the rigor and objectivity with which this was conducted.

Table 8. File-safe N for the effect of EI on student mathematics performance.

File Drawer Analysis			
	Fail-safe N	Target significance	Observed significance
Rosenthal	5, 084.041	0.05	< 0.01

The findings of this meta-analysis provide compelling evidence that EI exerts a meaningful influence on students' mathematics performance. The moderate yet significant effect size (d = 0.418) highlights that emotional factors play an essential role alongside cognitive abilities in academic achievement. The exceptionally high fail-safe N value confirms that the observed effect is highly stable and resistant to potential publication bias, underscoring the credibility of the results. These outcomes suggest that fostering EI may enhance students' capacity to manage stress, maintain motivation, and engage more effectively in mathematical problem-solving. Moreover, the robustness of the data reinforces the importance of integrating emotional and social learning components into educational practice and research. Future studies should continue to explore contextual and cultural variables that may moderate this relationship, contributing to a more comprehensive understanding of how EI supports mathematical success.

5. Conclusions

In conclusion, this meta-analysis offers compelling insights into the complex interplay between TSR, EI, and mathematics performance among students. While the overall effect of TSR on math achievement was small and statistically inconclusive ($g = 0.194$, $p = 0.078$), it nonetheless underscores the potential influence of positive relational dynamics in educational settings. Conversely, EI emerged as a moderately strong and statistically significant predictor ($g = 0.418$, $p < 0.01$), highlighting the critical role of emotional competencies in academic success, particularly in mathematics. Despite substantial heterogeneity across studies, robust fail-safe N values and consistent analytical rigor lend credibility to these findings. Collectively, the results emphasize the importance of integrating both relational and emotional dimensions into educational practice and policy, and they pave the way for future research to explore contextual moderators and intervention strategies that can enhance student outcomes in mathematics through social-emotional and pedagogical pathways.

A key limitation of this meta-analysis lies in the exceptionally high heterogeneity observed across included studies ($I^2 = 100\%$ for TSR; $I^2 = 97.80\%$ for EI), indicating substantial variation in study characteristics such as measurement tools, cultural contexts, educational levels, and research designs. While the random-effects model accounted for this variability statistically, it limits the precision and generalizability of the pooled effect sizes. To address this, future meta-analyses should incorporate moderator analyses or meta-regression to explore potential sources of heterogeneity. Moreover, primary research should aim for standardized measurement instruments and cross-cultural comparisons to enhance comparability. Expanding the scope to include unpublished dissertations, non-English studies, or grey literature could also reduce publication bias and yield a more comprehensive understanding of how emotional and relational factors influence mathematics achievement across diverse educational contexts.

This meta-analysis sheds new theoretical light on the intersection of cognitive and socio-emotional domains by empirically affirming the moderating roles of TSR and EI in shaping mathematics performance. From a theoretical standpoint, the findings support the integration of affective variables into cognitive performance models, aligning with socio-constructivist and emotional intelligence theories. While TSR displayed a small, statistically inconclusive effect on math achievement, the very presence of the impact, even amidst heterogeneity, emphasizes that emotional and relational dynamics should not be sidelined in traditional theories of academic achievement. Similarly, the moderate impact of EI on mathematics performance provides fresh evidence to support Gardner's theory of multiple intelligences, as well as Mayer and Salovey's model of emotional processing as integral to academic success.

From an educational perspective, the results highlight the need for more intentional efforts in integrating emotional intelligence training and relational pedagogy into math instruction. As the evidence suggests, emotionally intelligent learners may possess better self-regulation, resilience, and motivation, key components for navigating the cognitive demands of mathematics. Similarly, nurturing high-quality TSR may indirectly influence student engagement, confidence, and classroom participation, which are all critical for success in quantitative subjects. Educators and school leaders should, therefore, consider professional development initiatives that equip teachers with relational and emotional competencies alongside content knowledge, creating emotionally responsive and academically rigorous learning environments.

Practically, this study signals actionable insights for curriculum designers, policymakers, and educational psychologists. Embedding EI programs within math curricula or as co-curricular initiatives could enhance both student well-being and performance. Likewise, teacher appraisal frameworks could integrate relational effectiveness as a metric, given its relevance to academic outcomes. The study also encourages future researchers to explore contextual moderators, such as age, gender, cultural background, or instructional method, that might clarify the conditions under which TSR and EI exert their strongest effects.

Data availability statement: The datasets used for the meta-analysis were extracted from peer-reviewed published articles, which are cited in the references.

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