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Emotional Intelligence and Motivation as Predictors of Lower Secondary School Students' Mathematics Achievement

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ABSTRACT

Emotional intelligence (EI) and learning motivation are widely recognized as critical non-cognitive factors influencing academic success. However, empirical evidence regarding their impact on mathematics achievement within Indonesian Secondary School contexts remains limited. This study examines the individual and simultaneous effects of EI and learning motivation on mathematics learning outcomes among Grade VIII students. Utilizing an ex-post facto quantitative design, a saturated sampling technique was employed to select all 50 Grade VIII students from Lower Secondary School 12 Bulukumba, South Sulawesi, Indonesia. Data was collected via a validated mathematics achievement test and two Likert-scale questionnaires assessing EI and motivation. Descriptive and inferential statistical analyses, including multiple linear regression, were performed using SPSS. Descriptive results categorized student EI as high (M=51.62, SD=4.34), learning motivation as high (M=53.60, SD=6.66), and mathematics outcomes as moderate (M=75.80, SD=10.90). Inferential analysis revealed that EI significantly predicted mathematics outcomes ($R^2 = 0.14$, $p = 0.008$), and learning motivation emerged as a stronger individual predictor ($R^2 = 0.302$, $p<0.001$). Simultaneously, both variables exerted a significant combined effect, explaining 39.2% of the variance ($R^2 = 0.392$, $p<0.001$). These findings underscore the critical role of affective factors in STEM education, suggesting that integrating socio-emotional development programs into secondary mathematics instruction can significantly enhance student performance.

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1. INTRODUCTION

Contemporary educational research has increasingly acknowledged that academic success is not determined solely by cognitive ability. Over the past two decades, substantial attention has been directed toward non-cognitive factors, particularly emotional intelligence and motivational constructs, as influential determinants of student achievement across various disciplines (Gkintoni et al., 2025; González-Yubero et al., 2025; Nieto Carracedo et al., 2024; Shengyao et al., 2024). The mathematics curriculum, one of the most cognitively demanding subjects in the secondary school curriculum, presents a particularly challenging context in which these affective variables may exert significant influence on student performance.

Emotional intelligence (EI), first formally conceptualized by Salovey and Mayer (Emmerling & Cherniss, 2025) and subsequently popularized by Goleman (Li et al., 2025), refers to the capacity to perceive, use, understand, and regulate emotional information in ways that promote intellectual and emotional growth. Accumulating empirical evidence suggests that students with higher EI demonstrate better self-regulation, lower academic anxiety, and improved performance in cognitively demanding tasks (Asare & Larbi, 2025; Muhtadi et al., 2022). In the context of mathematics learning, where frustration and anxiety are prevalent, EI may serve as a critical moderating factor (Lei et al., 2025).

Learning motivation, conceptualized within the framework of self-determination theory (Deci & Ryan, 2024) and achievement goal theory by Elliot and McGregor (Chazan et al., 2022), refers to the internal and external forces that initiate, direct, and sustain academic behavior. Research consistently demonstrates that intrinsic motivation is positively associated with deep learning strategies and academic achievement (Kamberi, 2025; Vansteenkiste et al., 2012). In mathematics specifically, motivated students are more likely to persist in problem-solving, seek out challenging tasks, and maintain sustained engagement with the subject matter (Xiao & Sun, 2021).

Despite the theoretical foundations linking EI and learning motivation to academic performance, empirical investigations within Indonesian junior secondary school contexts remain sparse. Most existing studies have focused on senior high school or university-level students (Hendra et al., 2024; Susanto et al., 2024; Yuzarion et al., 2025), leaving a gap in understanding how these variables operate among early adolescents at the critical Grade VIII level. Furthermore, few studies have examined the simultaneous contribution of both EI and learning motivation using robust inferential statistical methods.

This study, therefore, addresses these gaps by investigating the influence of emotional intelligence and learning motivation—both independently and in combination—on mathematics learning outcomes among Grade VIII students in Bulukumba Regency, South Sulawesi, Indonesia. The research questions guiding this study are: (1) What are the descriptive profiles of emotional intelligence, learning motivation, and mathematics learning outcomes among the study participants? (2) Does emotional intelligence significantly influence mathematics learning outcomes? (3) Does learning motivation significantly influence mathematics learning outcomes? (4) Do emotional intelligence and learning motivation simultaneously and significantly influence mathematics learning outcomes?

Literature Review

Emotional Intelligence and Academic Achievement

Emotional intelligence encompasses a set of interrelated abilities including the accurate perception and appraisal of emotions, the use of emotions to facilitate cognitive activities, the understanding of emotional knowledge, and the reflective regulation of emotions to promote emotional and intellectual growth (Asare & Larbi, 2025; Emmerling, 2025; Perpiñà Martí et al., 2023). Within educational settings, EI has been linked to a broad array of positive academic outcomes, including higher grade point averages, reduced academic burnout, and enhanced self-regulated learning (Shengyao et al., 2024).

A meta-analysis by MacCann et al. (2020) examining 158 studies found a significant positive association between EI and academic performance ($r = 0.20$, $p < .001$), with the relationship being particularly pronounced in science and mathematics domains. The authors attributed this finding to the role of EI in regulating negative emotions such as mathematics anxiety, which is known to undermine working memory capacity and mathematical problem-solving performance. More recently, Prada Núñez et al. (2024) demonstrated that EI predicted mathematics achievement among secondary students in Colombia even after controlling for cognitive ability, suggesting that EI contributes unique variance beyond general intelligence. In the Indonesian educational context, Aljura et al. (2024) found that emotional intelligence positively and significantly predicted mathematics learning outcomes among junior high school students in Indonesia.

Learning Motivation and Mathematics Performance

Motivation in educational contexts is typically conceptualized along intrinsic–extrinsic and autonomous–controlled continua. Intrinsic motivation, characterized by engagement in an activity for its own inherent satisfaction, has been consistently associated with deeper cognitive processing, greater persistence, and higher academic achievement (Vansteenkiste et al., 2012). In mathematics, intrinsically motivated students are more likely to engage in exploratory problem-solving, adopt mastery-oriented goals, and demonstrate greater resilience in the face of failure (Liu, 2021).

Eccles and Wigfield's (2024) expectancy-value model provide an additional theoretical framework for understanding motivation in mathematics, positing that students' achievement behaviors are determined by their expectancies of success and the subjective task value they ascribe to mathematics. Students who perceive mathematics as important, useful, and intrinsically interesting are more likely to invest effort and achieve at higher levels. Longitudinal evidence supporting this model has been reported across diverse cultural contexts, including secondary school settings (Shone et al., 2024). In Indonesia, Arigiyati et al. (2023) conducted a study involving lower secondary school students and found that learning motivation significantly predicted mathematics achievement, with the relationship being mediated by self-regulated learning behaviors. These findings underscore the importance of motivational interventions in mathematics education.

Combined Effects of EI and Learning Motivation

Several studies have examined the joint effects of EI and learning motivation on academic outcomes, generally finding additive or interactive effects. Pekrun (2024) proposed a control-value theory of academic emotions, which posits that both cognitive appraisals (related to EI) and motivational factors jointly shape academic emotions, which in turn predict learning outcomes. Empirically, Sari et al. (2024) found that EI and learning motivation together explained mathematics achievement among lower secondary school students. Taking it together, the existing literature strongly supports the hypothesis that both emotional intelligence and learning motivation constitute meaningful positive predictors of mathematics learning outcomes. The present study contributes to this body of knowledge by providing context-specific evidence from an underserved population—early adolescent students in a regional district of South Sulawesi, Indonesia.

2. METHOD

This study employed a quantitative ex-post facto research design, which is appropriate for investigating naturally occurring differences in independent variables (emotional intelligence and learning motivation) and their relationship to a dependent variable (mathematics learning outcomes) without experimental. This design allowed the researchers to examine causal relationships as they occurred in the natural educational setting.

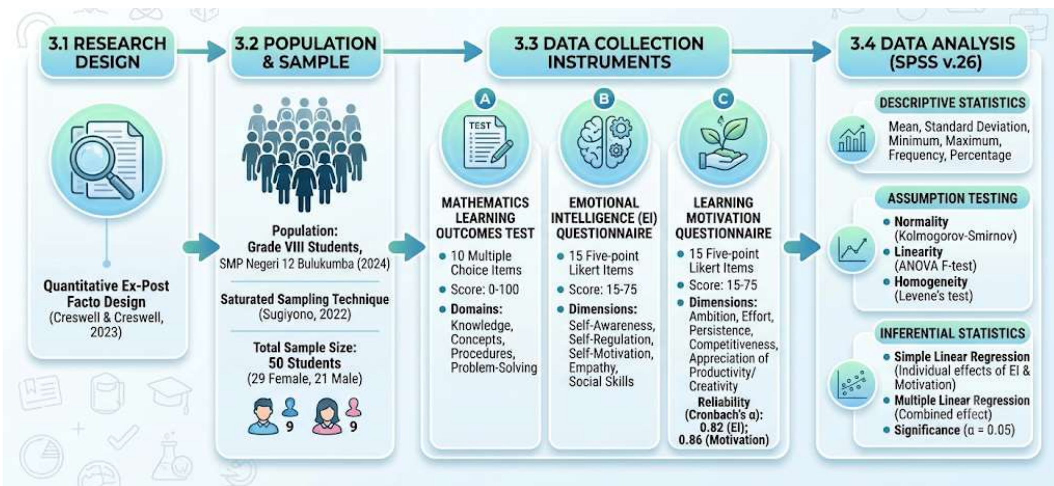

Figure 1. Quantitative Ex-Post Facto Design

The target population comprised all Grade VIII students enrolled at Lower Secondary School 12 Bulukumba, South Sulawesi, Indonesia, during the 2024 academic year. A saturated sampling technique was employed, meaning the entire population was included as the study sample, yielding a total of 50 participants. This technique is recommended when the population is small and accessible, as it eliminates sampling error and ensures representativeness. Participants consisted of 50 students (29 female, 21 male), aged between 13 and 15 years.

Three instruments were used to collect data. First, a mathematics learning outcomes test consisting of 10 multiple-choice items (score range: 0–100) was administered to assess students' cognitive performance across four domains: knowledge recall, conceptual understanding, procedural application, and problem-solving. Second, an emotional intelligence questionnaire comprising 15 items assessed on a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) was used, measuring five dimensions: self-awareness, self-regulation, self-motivation, empathy, and social skills (score range: 15–75). Third, a learning motivation questionnaire comprising 15 Likert-scale items assessed ambition, effort, persistence, competitiveness, and appreciation of productivity and creativity (score range: 15–75). Both questionnaires demonstrated satisfactory internal consistency (Cronbach's $\alpha = 0.82$ for EI; $\alpha = 0.86$ for learning motivation) and content validity confirmed through expert review.

Data was analysed using IBM SPSS Statistics version 26. Descriptive statistics (mean, standard deviation, minimum, maximum, frequency, and percentage) were computed for all variables. Prior to inferential analysis, assumption testing was conducted: normality was assessed using the Kolmogorov-Smirnov test, linearity was examined via ANOVA F-test, and homogeneity of variance was evaluated using Levene's test. Simple linear regression was performed to examine the individual effects of EI and learning motivation on mathematics learning outcomes, while multiple linear regression was used to assess their combined effect. Statistical significance was set at $\alpha = 0.05$.

3. RESULTS AND DISCUSSION

Results

Descriptive Statistics

Table 1 outlines the baseline descriptive metrics for the three primary constructs under investigation: emotional intelligence, learning motivation, and mathematics learning outcomes. Participants exhibited emotional intelligence scores spanning from 40.00 to 60.00 (M=51.62, SD=4.34). In accordance with the established normative classification criteria, this mean score places the sample squarely within the 'High' proficiency tier (51.00–62.00). Similarly, learning motivation scores demonstrated a range from 41.00 to 68.00 (M=53.60, SD=6.66), which likewise meets the threshold for the 'High' motivation category. In contrast, mathematics learning outcomes spanned from 60.00 to 100.00 (M=75.80, SD=10.90), positioning the participants' overall academic performance within the 'Moderate' range (64.00–79.00).

These empirical findings highlight a noteworthy structural disparity between non-cognitive affective attributes and academic achievement in mathematics. While the participants demonstrated robust psychological readiness—as evidenced by elevated levels of emotional self-regulation and motivation, their actual mathematical attainment remained at an intermediate level. This discrepancy suggests that while high emotional intelligence and learning motivation provide a favorable psychological foundation, they may not directly translate into high-level mathematical performance without intervening pedagogical or cognitive support mechanisms. Consequently, these baseline values warrant further inferential analysis to clarify the structural relationships and potential mediating pathways linking affective readiness to academic success in mathematics education.

Table 1. Descriptive Statistics for All Study Variables (N = 50)

Variable	Min	Max	M	SD	Category
Emotional Intelligence (X_1)	40	60	51.62	4.34	High
Learning Motivation (X_2)	41	68	53.60	6.66	High
Mathematics Learning Outcomes (Y)	60	100	75.80	10.90	Moderate

Table 2 details the distributional characteristics and frequency categorization of the participants' mathematics learning outcomes. The data reveal that most students demonstrated mid-to-upper tier academic performance, with the largest proportion of the sample (n=22, 44.00%) falling into the 'Moderate' achievement bracket (64.00–79.00). High academic performers constituted a substantial segment of the cohort, as 26.00% (n=13) attained scores within the 'High' range, and an additional 18.00% (n=9) achieved the 'Very High' tier. Conversely, low achievement was minimally represented across the sample; only 12.00% (n=6) of students recorded scores within the 'Low' category, and notably, no participants (0.00%) fell into the 'Very Low' classification.

The overall pattern of this frequency distribution indicates a positively skewed tendency toward academic proficiency, reflecting a generally favorable baseline of mathematical competency within the cohort. The total absence of students in the lowest proficiency band, combined with the concentration of over 88.00% of the sample in the Moderate or higher categories, suggests that fundamental instructional objectives are broadly being met. However, the prominent clustering around the Moderate category points to an ongoing need for targeted pedagogical intervention to assist students in bridging the gap between satisfactory competence and upper-echelon mathematical mastery.

Table 2. Frequency Distribution of Mathematics Learning Outcomes (N = 50)

Score Range	Category	Frequency	Percentage (%)
0 – 54	Very Low	0	0
55 – 64	Low	6	12
65 – 79	Moderate	22	44
80 – 89	High	13	26
90 – 100	Very High	9	18

Assumption Testing

Prior to conducting the linear regression analysis, the diagnostic prerequisite assumptions were evaluated to ensure the statistical validity of the estimated model. Specifically, testing was conducted to verify normality, linearity, and homogeneity of variance across the study variables.

The Kolmogorov-Smirnov normality test yielded D (50) = 0.11, $p = .365$, indicating that the residuals were normally distributed. The linearity assumption was confirmed via the ANOVA F-test, which showed a statistically significant linear relationship between the predictors and the outcome variable ($p = .009 < .05$). Levene's test for homogeneity of variance returned non-significant results for all variables ($p > .05$), confirming the homogeneity assumption. These results satisfied the prerequisite conditions for linear regression analysis in Table 3.

Table 3. Summary of Statistical Diagnostic Tests for Regression Assumptions

Diagnostic Test / Assumption	Test Statistic	Value	df	p-value	Statistical Decision / Interpretation
Normality (Residuals)	Kolmogorov–Smirnov D	0.11	50	365	Assumption Met (Normally distributed)
Linearity	ANOVA F-test	—	—	9	Assumption Met (Linear relationship established)
Homogeneity of Variance	Levene's Test	—	—	> .050	Assumption Met (Homoscedasticity confirmed)

Hypothesis Testing

Table 4 summarises the results of both simple and multiple linear regression analyses.

Table 4. Results of Regression Analyses

Model	Regression Equation	R^2	p-value	Decision
H_1: EI → Outcomes	$\hat{y} = 27.63 + 0.933X_1$	0.140	0.008	Significant
H_2: Motivation → Outcomes	$\hat{y} = 27.62 + 0.899X_2$	0.302	<0.001	Significant
H_3: EI + Motivation → Outcomes	$\hat{y} = -8.049 + 0.760X_1 + 0.832X_2$	0.392	<0.001	Significant

For Hypothesis 1, simple linear regression indicated that emotional intelligence was a statistically significant predictor of mathematics learning outcomes ($R^2 = 0.140$, $p = .008$). The regression coefficient ($b = 0.933$) indicates that for each one-unit increase in EI score, mathematics learning outcome scores increased by 0.933 units, accounting for 14% of the variance in outcomes.

For Hypothesis 2, simple linear regression demonstrated that learning motivation significantly predicted mathematics learning outcomes ($R^2 = 0.302$, $p < .001$). The regression coefficient ($b = 0.899$) indicates that each one-unit increase in motivation score was associated with a 0.899-unit increase in learning outcomes, explaining 30.2% of the outcome variance.

For Hypothesis 3, multiple linear regression revealed that EI and learning motivation together significantly predicted mathematics learning outcomes ($R^2 = 0.392$, $p < .001$). The combined model explained 39.2% of the variance in mathematics learning outcomes. In this combined model, the regression coefficient for EI was $b = 0.760$ and for learning motivation was $b = 0.832$, both contributing positively and independently.

Discussion

The primary aim of this study was to investigate the influence of emotional intelligence and learning motivation on mathematics learning outcomes among Grade VIII students. The results confirmed all three hypotheses, providing robust empirical support for the theoretical frameworks linking socio-emotional competencies and motivational dispositions to mathematics achievement. The finding that emotional intelligence significantly predicted mathematics learning outcomes ($R^2 = 0.14$, $p = .008$) is consistent with recent meta-analytic evidence. MacCann et al. (2020) reported a mean corrected correlation of $r = 0.20$ between EI and academic performance across a large sample of studies, while Sert and Arıkan (2025) found that EI significantly predicted mathematics grades even after controlling for general cognitive ability among Turkish secondary school students. The relatively modest effect size observed in the present study aligns with findings from Aljura et al. (2024) in a comparable Indonesian context and may reflect the multifactorial nature of mathematics performance, in which EI constitutes one of many contributing variables.

The stronger predictive effect of learning motivation ($R^2 = 0.302$, $p < .001$) relative to EI is noteworthy and consistent with theoretical expectations. Self-determination theory by Deci and Ryan (2024) posits that autonomous motivation is a proximal determinant of engagement and performance, and empirical studies consistently report moderate-to-large effects of motivation on mathematics achievement (Vansteenkiste et al., 2012). The finding that motivation explained more than twice the variance accounted for by EI (30.2% vs. 14%) suggests that direct motivational interventions—such as autonomy-supportive teaching, mastery-oriented feedback, and task-value enhancement—may yield greater returns in improving mathematics learning outcomes than broad EI training programs alone.

The simultaneous entry of both EI and learning motivation into the regression model produced an R^2 of 0.392, indicating that together these variables account for approximately 39% of the variance in mathematics learning outcomes. This combined effect exceeds the sum of their individual R^2 values (0.14 + 0.302 = 0.442 vs. 0.392), suggesting some shared variance between the two predictors. This is theoretically plausible, given that EI and motivation are conceptually related: students with higher EI are better equipped to regulate academic emotions, which may in turn sustain motivational states (Pekrun, 2024).

The remaining 61% of unexplained variance in mathematics learning outcomes points to the role of other factors not examined in this study, including prior mathematical knowledge, instructional quality, socioeconomic background, peer influence, and parental involvement (Eccles & Wigfield, 2024). Future research should adopt more comprehensive models that integrate cognitive, effective, social, and environmental variables to provide a fuller account of mathematics achievement.

From a practical standpoint, these findings carry several important implications for mathematics educators and school administrators in Indonesia. First, given that EI significantly, albeit modestly, predicts mathematics outcomes, schools should consider integrating structured socio-emotional learning (SEL) programs into the curriculum. Evidence-based SEL interventions have been shown to improve academic achievement by an average effect size of 0.33 across diverse educational contexts (Mahoney et al., 2021). Second, the stronger effect of learning motivation underscores the importance of creating autonomy-supportive learning environments in which students experience choice, competence, and meaningful connections between mathematics and their everyday lives. Third, the descriptive finding that mathematics outcomes were categorized as only moderate, despite high levels of EI and motivation, suggests that instructional and curricular factors may be constraining student achievement and warrant independent investigation.

This study is not without limitations. The relatively small and homogeneous sample (N = 50, single school) limits the generalisability of findings. The cross-sectional ex-post facto design precludes causal inference, and the use of self-report questionnaires introduces potential response bias. The EI measure used in this study was not a psychometrically validated international instrument, which may affect the comparability of results with international literature. Future studies should employ longitudinal designs, larger and more diverse samples, and validated instruments such as the Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT) (Mayer et al., 2025) or the Brief Emotional Intelligence Scale (Balakrishnan & Saklofske, 2015) to advance the rigour and generalisability of findings.

4. CONCLUSION

This study provides clear empirical evidence that both emotional intelligence and learning motivation are significant positive predictors of mathematics learning outcomes among Grade VIII students at Lower Secondary School 12 Bulukumba, South Sulawesi, Indonesia. Learning motivation demonstrated a stronger individual predictive effect (R^2 = 0.302) compared to emotional intelligence (R^2 = 0.140), while both variables together explained approximately 39.2% of the variance in mathematics learning outcomes. These findings reinforce the importance of attending to affective and motivational dimensions of the learning process in mathematics education at the junior secondary level.

Educators and policymakers are encouraged to develop and implement evidence-based interventions that simultaneously target students' emotional competencies and motivational orientations. Future research should examine these relationships within larger, more diverse samples, employ longitudinal designs to assess causal mechanisms, and investigate mediating and moderating variables such as academic self-efficacy, teacher support, and classroom climate to further elucidate the pathways through which EI and motivation shape mathematics achievement.

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