

Students' Mathematics Perceptions as a Distinct Predictor of Mathematics Learning Outcomes

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Abstract:

Mathematics learning outcomes remain a persistent challenge in many educational contexts, particularly when students develop unfavorable perceptions toward mathematics as a school subject. Students who perceive mathematics as difficult, abstract, stressful, or disconnected from everyday life often demonstrate lower engagement and weaker academic achievement. This study examined the predictive relationship between students' mathematics perceptions and mathematics learning outcomes. Employing a quantitative ex post facto design, the study involved 102 eighth grade students from an Indonesian Islamic boarding school selected through cluster random sampling. Data were collected using a mathematics perception questionnaire and a mathematics achievement test and analyzed using simple linear regression. Results indicated that students generally reported favorable mathematics perceptions ($M = 48.40$, $SD = 5.45$), whereas mathematics learning outcomes remained relatively low ($M = 50.25$, $SD = 21.32$). Regression analysis revealed that mathematics perceptions significantly predicted mathematics learning outcomes ($\beta = 0.268$, $p = 0.030$). Although the predictive contribution was modest, students with more favorable perceptions tended to achieve better academic performance. These findings highlight the importance of addressing students' psychological orientations toward mathematics alongside cognitive instruction to support improved learning outcomes.

Abstrak:

Hasil belajar matematika masih menjadi tantangan yang persisten dalam berbagai konteks pendidikan, khususnya ketika siswa mengembangkan persepsi yang kurang positif terhadap matematika sebagai mata pelajaran sekolah. Siswa yang memandang matematika sebagai pelajaran yang sulit, abstrak, menegangkan, atau tidak relevan dengan kehidupan sehari-hari cenderung menunjukkan keterlibatan belajar yang lebih rendah dan pencapaian akademik yang kurang optimal. Penelitian ini bertujuan untuk mengkaji hubungan prediktif antara persepsi matematika siswa dan hasil belajar matematika. Penelitian menggunakan desain kuantitatif ex post facto dengan melibatkan 102 siswa kelas VIII dari sebuah pondok pesantren di Indonesia yang dipilih melalui teknik cluster random sampling. Data dikumpulkan menggunakan

angket persepsi matematika dan tes hasil belajar matematika, kemudian dianalisis menggunakan regresi linear sederhana. Hasil penelitian menunjukkan bahwa siswa secara umum memiliki persepsi matematika yang positif ($M = 48,40$; $SD = 5,45$), sedangkan hasil belajar matematika mereka masih relatif rendah ($M = 50,25$; $SD = 21,32$). Analisis regresi menunjukkan bahwa persepsi matematika secara signifikan memprediksi hasil belajar matematika ($\beta = 0,268$; $p = 0,030$). Meskipun kontribusi prediktifnya tergolong moderat, siswa yang memiliki persepsi lebih positif terhadap matematika cenderung mencapai hasil belajar yang lebih baik. Temuan ini menegaskan pentingnya memperhatikan orientasi psikologis siswa terhadap matematika di samping aspek pembelajaran kognitif guna mendukung peningkatan hasil belajar.

Keywords:

Mathematics Perception, Mathematics Learning Outcomes, Predictive Relationship, Islamic Boarding School, Secondary Mathematics Education

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INTRODUCTION

Mathematics plays an important role in formal education because it develops reasoning, problem solving, and analytical thinking skills that are essential for academic and everyday decision-making (National Council of Teachers of Mathematics (NCTM, 2014; OECD, 2023). As a foundational discipline, mathematics supports learning in science, engineering, economics, and technology, while also cultivating habits of disciplined reasoning and intellectual perseverance (Boaler, 2016; Kilpatrick, Swafford, & Findell, 2001). For these reasons, mathematics continues to be universally positioned as a core subject in school curricula. Nevertheless, Despite its recognized importance, mathematics remains a challenging subject for many students and is frequently associated with low achievement, disengagement, and negative learning experiences (OECD, 2023; Von Davier, Kennedy, Reynolds, Fishbein, Khorramdel, Aldrich, Bookbinder, Bezirhan, & Yin, 2024).

A persistent concern in mathematics education is that many students develop unfavorable perceptions of mathematics during their schooling. Rather than viewing mathematics as a meaningful and intellectually stimulating domain, students often perceive it as abstract, difficult, rigid, emotionally demanding, and disconnected from real life experiences (Boaler, 2016; Martino

& Zan, 2010; Hannula, 2002). Such perceptions are not trivial because they influence how students emotionally and cognitively position themselves toward mathematical activity. Negative perceptions may emerge from repeated experiences of failure, procedural classroom instruction, excessive emphasis on correctness, limited conceptual engagement, or teacher centered pedagogical practices that reduce students' sense of agency in learning (Schoenfeld, 2016). Conversely, positive perceptions may foster confidence, persistence, curiosity, and willingness to engage in challenging mathematical tasks.

From a psychological perspective, perception is not merely the passive reception of external stimuli, but an interpretive cognitive process through which individuals assign meaning to experiences and construct subjective understandings of reality (Schunk & Benedetto, 2020). Within educational settings, students' perceptions shape how they interpret instructional experiences, teacher interactions, academic expectations, and their own learning capacities. In mathematics education specifically, students' perceptions toward mathematics may influence whether they approach mathematical learning with enthusiasm or apprehension, persistence or withdrawal, confidence or helplessness. This aligns with expectancy value theory, which posits that students' beliefs and expectations significantly influence achievement related behavior (Eccles & Wigfield, 2020), as well as control value theory, which explains how students' emotional experiences and perceptions shape academic engagement and performance (Pekrun, 2006).

The affective domain in mathematics learning has received increasing scholarly attention because mathematics achievement is no longer understood solely as a function of cognitive ability or instructional exposure. Researchers have demonstrated that beliefs, attitudes, emotions, self efficacy, identity, and perceptions significantly shape students' mathematical participation and achievement (Goldin, Hannula, Metzuyanim, Jansen, Kaasila, Lutomäki, Martino, Morselli, Eynon, Pantziara, & Zhang, 2016; Grootenboer & Marshman, 2016; Hannula, 2002). Schoenfeld (2016) argues that students' mathematical performance is deeply influenced by how they conceptualize mathematics and their place within mathematical activity. Similarly, Boaler (2016) emphasizes that students' beliefs about mathematics profoundly affect participation, confidence, and academic outcomes. These perspectives suggest that mathematics learning outcomes must be understood not only cognitively, but also psychologically and socioculturally.

Empirical evidence from international assessments reinforces this position. Results from PISA 2022 indicate that students' attitudes, beliefs, and emotional engagement toward mathematics are strongly associated with mathematics achievement across educational systems (OECD, 2023). Likewise, TIMSS findings have consistently demonstrated associations between students' affective dispositions toward mathematics and their academic performance (Von Davier, Kennedy, Reynolds, Fishbein, Khorramdel, Aldrich, Bookbinder, Bezirhan, & Yin, 2024). Students who report positive engagement, stronger confidence, and favorable beliefs about mathematics tend to demonstrate higher achievement than those with negative orientations. Such findings suggest that academic performance in mathematics is not simply a reflection of cognitive mastery, but also of students' interpretive and emotional relationship with the discipline.

Within the Indonesian educational context, concerns regarding mathematics learning outcomes remain substantial. Indonesia's mathematics performance in international assessments continues to indicate systemic challenges in mathematical proficiency, particularly in higher order reasoning and problem solving (OECD, 2023). Although structural explanations frequently emphasize curriculum implementation, instructional quality, assessment practices, and educational inequality, students' internal psychological orientation toward mathematics warrants equally serious attention. National and international studies have consistently documented significant relationships between affective variables including mathematics anxiety, self efficacy, learning motivation, and attitudes toward mathematics and mathematics achievement (Auliya, 2016; Eccles & Wigfield, 2020; Hannula, 2002; Leonard & Amanah, 2014; Schukajlow, Rakoczy, & Pekrun, 2022). However, specific empirical examination of students' mathematics perceptions as a direct predictive construct remains comparatively less emphasized, particularly when distinguished conceptually from broader constructs such as attitudes or motivation. Empirical evidence from Indonesian secondary education, especially within Islamic boarding school contexts, remains limited.

In the present study, mathematics perception refers to students' interpretive understanding of mathematics as reflected in perceived comprehensibility, relevance, usefulness, emotional comfort, and cognitive accessibility. Unlike attitudes, which primarily reflect evaluative tendencies, or motivation, which concerns goal-directed effort, mathematics perception focuses on how students make sense of mathematics as a subject and learning

experience. This distinction is important because perception occupies a unique conceptual position. While attitudes often reflect evaluative tendencies and motivation concerns goal directed energy, perception concerns students' interpretive understanding of mathematics itself as an academic object and lived educational experience. Students may be motivated to succeed academically while simultaneously perceiving mathematics as inherently threatening or inaccessible. Thus, perception deserves analytical attention as a theoretically distinct construct rather than merely a component absorbed into broader affective variables (Martino & Zan, 2010; Hannula, 2002).

The context of Islamic boarding schools further strengthens the relevance of this inquiry. Students in Islamic boarding school settings often experience dense academic routines involving both religious and general educational commitments, potentially influencing how they prioritize and interpret different school subjects. Educational experiences in such contexts may produce distinctive affective orientations toward mathematics compared to conventional schooling environments. Studies in Indonesian Islamic boarding school contexts have noted that institutional culture, academic discipline, and time allocation can shape students' learning behavior and academic engagement (Azra, 2012; Dhofier, 2011; Madjid, 1997). Investigating students' mathematics perceptions within this setting therefore contributes contextual specificity to mathematics education research while extending broader discussions about affective influences on achievement.

Previous studies have consistently shown that mathematics achievement is associated with various affective and psychological factors, including mathematics anxiety (Auliya, 2016), attitudes toward mathematics (Hannula, 2002), learning motivation (Eccles & Wigfield, 2020), and self efficacy (Schukajlow, Rakoczy, & Pekrun, 2022). These studies have contributed substantially to understanding the psychological dimensions of mathematics learning. However, most have examined achievement through broader multivariable frameworks in which mathematics perception is embedded within larger affective constructs or treated as a secondary component rather than as a distinct predictive variable. Consequently, limited empirical evidence is available regarding the specific predictive contribution of students' mathematics perceptions independent of related constructs such as motivation, anxiety, attitudes, or self efficacy. This limitation is particularly evident in Indonesian secondary education and remains largely unexplored within Islamic boarding school settings. Addressing this gap may provide a clearer

understanding of whether students' interpretations of mathematics itself constitute a meaningful predictor of mathematics learning outcomes.

Based on these considerations, this study aims to examine the influence of students' mathematics perceptions on their mathematics learning outcomes among eighth grade students in an Indonesian Islamic boarding school. To what extent do students' mathematics perceptions statistically predict mathematics learning outcomes among eighth grade students in an Indonesian Islamic boarding school? By focusing specifically on mathematics perception as a direct predictor, this study seeks to contribute empirical evidence to mathematics education discourse and provide pedagogical insight for improving mathematics learning outcomes through psychologically responsive educational practices.

METHODS

1. Research Design

This study employed a quantitative ex post facto research design to examine the influence of students' mathematics perceptions on their mathematics learning outcomes. A quantitative approach was selected because the study aimed to investigate the statistical relationship between measurable educational variables and to generate empirical evidence regarding the predictive contribution of students' mathematics perceptions to academic achievement. Quantitative research is particularly appropriate when the objective is to test relationships among variables using numerical data and inferential statistical procedures (Ary, Jacobs, Irvine, & Walker, 2019; Creswell & Creswell, 2018).

The ex post facto design was considered appropriate because the study examined naturally occurring variables without manipulating the independent variable or administering experimental treatment. In this design, students' mathematics perceptions were treated as pre existing psychological attributes that had developed through accumulated educational experiences, classroom interactions, and personal encounters with mathematics learning. Because these variables had already existed prior to the study, direct experimental control was neither feasible nor conceptually appropriate. Instead, the study sought to investigate whether differences in students' mathematics perceptions were associated with corresponding differences in mathematics learning outcomes.

This design aligns with educational research examining affective and psychological predictors of academic performance, particularly when ethical or

practical considerations make experimental manipulation impossible. Although *ex post facto* research does not establish causal relationships in the strict experimental sense, it remains valuable for identifying statistically meaningful predictive relationships among educational variables (Fraenkel, Wallen, & Hyun, 2019). In the present study, the design enabled systematic examination of whether students' perceptions toward mathematics significantly predicted their mathematics achievement within an authentic educational setting.

The conceptual model of the study involved a direct predictive relationship in which students' mathematics perceptions served as the independent variable, while mathematics learning outcomes functioned as the dependent variable. The analytical model may be represented as follows.

$$Y = \beta_0 + \beta_1 X + \varepsilon \quad (1)$$

Where Y represents mathematics learning outcomes, X represents students' mathematics perceptions, β_0 denotes the intercept, β_1 represents the regression coefficient indicating the predictive effect of mathematics perception, and ε represents unexplained error variance.

2. Research Setting and Participants

This study was conducted in an Islamic boarding school located in South Sulawesi, Indonesia, during the 2023/2024 academic year. The educational setting was considered relevant because Islamic boarding schools represent a distinctive learning environment in which students simultaneously engage in formal academic education and religious learning activities. Such educational contexts often involve dense academic schedules, structured daily routines, and multiple instructional commitments that may shape students' academic experiences and psychological orientations toward school subjects, including mathematics. This contextual characteristic makes the setting particularly appropriate for examining the relationship between affective educational variables and academic achievement.

The participants of this study were eighth grade students enrolled in the lower secondary level of the institution. This student group was selected because lower secondary mathematics introduces increasingly abstract concepts, formal symbolic reasoning, and more cognitively demanding problem solving activities, all of which may significantly influence students' perceptions toward mathematics. At this developmental stage, students' affective responses toward mathematics often become more stable and educationally consequential,

making this population theoretically relevant for investigating the predictive relationship between mathematics perceptions and mathematics learning outcomes.

The target population comprised all eighth grade students enrolled at the institution during the period of the study. From this population, a total of 102 students participated in the research. This sample size was considered adequate for quantitative inferential analysis examining predictive relationships between variables, particularly within a single-predictor regression framework (Field, 2018; Tabachnick & Fidell, 2019). The participants represented naturally occurring classroom groups within the educational setting, thereby preserving the ecological authenticity of the study context.

3. Sampling Technique

The sample for this study was selected using cluster random sampling. This sampling technique was considered appropriate because the target population was naturally organized into intact classroom groups rather than dispersed as individually independent units. In educational research, cluster random sampling is commonly employed when participants are administratively grouped in existing classes, allowing researchers to select clusters efficiently while preserving the natural structure of the educational setting (Ary, Jacobs, Irvine, & Walker, 2019; Creswell & Creswell, 2018).

The sampling procedure began by identifying the entire population of eighth-grade students enrolled in the institution during the 2023/2024 academic year (N = 229). Because students were already organized into classroom clusters, sampling was conducted at the group level rather than through individual random selection. Four classes were randomly selected through a lottery procedure, resulting in a final sample of 102 students who participated in the study. This procedure was considered methodologically appropriate because it reduced practical disruption to instructional activities while maintaining an acceptable level of representativeness within the institutional context.

The use of cluster random sampling also aligns with the logistical realities of school based quantitative research, where classroom based grouping frequently constitutes the most feasible sampling frame. Although cluster sampling may introduce certain limitations related to within-group similarity, its application remains widely accepted in educational studies when naturally occurring classroom units constitute the primary accessible population

structure (Fraenkel, Wallen, & Hyun, 2019). In the present study, this sampling strategy enabled efficient participant recruitment while preserving the authenticity of the educational environment under investigation.

4. Instruments

Data in this study were collected using two primary research instruments: a students' mathematics perception questionnaire and a mathematics learning outcomes test. These instruments were selected to correspond directly with the conceptual variables examined in the study, namely students' mathematics perceptions as the independent variable and mathematics learning outcomes as the dependent variable. The use of structured instruments was considered appropriate for generating quantitative data suitable for inferential statistical analysis.

Students' mathematics perceptions were measured using a questionnaire designed to capture students' interpretive and affective orientations toward mathematics as a school subject. The questionnaire assessed students' views regarding the nature of mathematics, their emotional responses to mathematics learning, perceived difficulty, relevance of mathematics, and general attitudes formed through prior educational experiences. Questionnaire based measurement is widely used in educational and psychological research because perceptions, beliefs, and affective orientations are internal constructs that are most appropriately accessed through structured self report instruments (Cohen, Manion, & Morrison, 2018; DeVellis & Thorpe, 2021). The instrument employed Likert type response categories to quantify students' responses, allowing systematic conversion of subjective perceptions into analyzable numerical data.

Mathematics learning outcomes were measured using an achievement test designed to assess students' academic performance in mathematics based on the curricular content appropriate to their educational level. The test was intended to capture students' demonstrated mathematical competence rather than perceived competence, thereby providing an objective academic indicator aligned with the dependent variable of the study. Achievement tests remain one of the most commonly accepted instruments in mathematics education research for evaluating learning outcomes because they provide direct evidence of academic attainment within a defined instructional domain (Nitko & Brookhart, 2014).

The selection of these two instruments was guided by conceptual alignment between the research variables and the measurement strategy. The

questionnaire provided data concerning students' internal psychological orientations toward mathematics, while the achievement test provided evidence of observable academic performance. Together, these instruments enabled examination of the predictive relationship between affective perception and academic achievement within the quantitative framework of the study.

5. Validity and Reliability Positioning

The credibility of quantitative findings depends substantially on the quality of the instruments used to measure the research variables. For this reason, the instruments employed in this study were positioned within established principles of educational measurement emphasizing validity and reliability. Instrument validity concerns the extent to which an instrument accurately measures the intended construct, whereas reliability concerns the consistency and stability of measurement results across respondents and contexts (Cohen, Manion, & Morrison, 2018; DeVellis & Thorpe, 2021).

The students' mathematics perception questionnaire was developed to measure a latent psychological construct that cannot be directly observed. Accordingly, particular attention was given to ensuring conceptual alignment between the questionnaire items and the theoretical meaning of mathematics perception. The instrument was structured to reflect dimensions associated with students' cognitive interpretations, emotional responses, and evaluative judgments regarding mathematics as an academic subject. Because perception is conceptually related to but distinct from constructs such as motivation, attitude, and self efficacy, the operationalization of the instrument was positioned to preserve conceptual specificity within the study framework.

The mathematics learning outcomes test was similarly positioned within principles of educational assessment validity. Because the dependent variable concerned actual academic achievement rather than self reported performance, the test was designed to represent curricular mathematical competence appropriate to the students' grade level. Achievement measurement requires adequate alignment between test content and intended instructional outcomes so that the resulting scores meaningfully reflect students' mathematical performance (Nitko & Brookhart, 2014). This alignment strengthens interpretive validity in using achievement scores as indicators of learning outcomes.

Reliability considerations were equally important because inferential statistical analysis assumes that observed scores reasonably reflect stable measurement rather than excessive random error. Questionnaire reliability is

particularly important in studies involving psychological constructs, as inconsistent measurement may weaken observed statistical relationships or distort predictive estimates. Similarly, achievement test reliability contributes to the dependability of academic performance measurement. Within this study, instrument use was therefore grounded in the expectation that both measurement tools satisfied acceptable educational measurement standards for quantitative analysis.

Prior to data collection, the instruments underwent expert judgment by mathematics education specialists to establish content validity. The validators evaluated the relevance, clarity, and alignment of the instrument items with the intended constructs. Following the validation process, the instruments were considered suitable for administration. Reliability testing indicated that the mathematics perception questionnaire achieved a Cronbach's alpha coefficient of 0.863, while the mathematics achievement test obtained a KR-20 coefficient of 0.695, both indicating acceptable levels of reliability for educational research.

6. Data Collection Procedures

Data collection was conducted during the 2023/2024 academic year following administrative approval and coordination with the educational institution where the study was undertaken. Because the research involved school based participants within an organized instructional setting, the data collection process was structured to minimize disruption to normal academic activities while ensuring systematic administration of the research instruments.

The data collection process involved two primary stages corresponding to the study variables. First, students completed the mathematics perception questionnaire, which was administered in a structured manner to obtain standardized responses concerning their perceptions of mathematics as an academic subject. Prior to administration, participants were provided with clear instructions regarding the purpose of the questionnaire and the expected response procedures. Because the instrument measured students' internal perceptions and subjective educational experiences, consistent administration procedures were necessary to reduce ambiguity in interpretation and response bias.

Second, data concerning mathematics learning outcomes were obtained through the administration of a mathematics achievement test appropriate to the participants' grade level. The test was administered under controlled educational conditions to ensure fairness and consistency in score generation.

As an objective academic measure, the achievement test provided quantifiable evidence of students' mathematics performance that could be examined statistically in relation to the perception data.

The collected data were subsequently organized, coded, and prepared for statistical analysis. Questionnaire responses were converted into numerical scores based on the established scoring framework of the instrument, while achievement test results were recorded as students' mathematics learning outcome scores. This preparation process ensured that both datasets were analytically compatible for inferential examination of the predictive relationship between students' mathematics perceptions and mathematics learning outcomes.

7. Statistical Analysis

The data were analyzed using descriptive and inferential statistical procedures to address the research objective. Descriptive statistics were first employed to summarize the general characteristics of the data, including the distribution of students' mathematics perception scores and mathematics learning outcome scores. Descriptive analysis served to provide an overview of participants' psychological orientation toward mathematics and their academic performance before inferential examination of the predictive relationship between the two variables.

To examine the influence of students' mathematics perceptions on mathematics learning outcomes, inferential analysis was conducted using simple linear regression. This statistical technique was selected because the study involved a direct predictive relationship between a single independent variable and a single dependent variable, making regression analysis methodologically appropriate and parsimonious (Field, 2018; Tabachnick & Fidell, 2019). The regression model was intended to determine whether variation in students' mathematics perceptions significantly predicted variation in their mathematics learning outcomes.

Prior to regression analysis, relevant statistical assumptions were considered to ensure the appropriateness of the analytical model. These assumptions included linearity of the relationship between variables, normality of residual distribution, independence of observations, and homoscedasticity of residual variance (Field, 2018). Evaluating these assumptions is essential because violations may compromise the interpretability and validity of regression estimates. Simple linear regression was then conducted to examine

whether students' mathematics perceptions significantly predicted mathematics learning outcomes. Statistical significance was assessed at the 0.05 level. The analysis focused on the regression coefficient (β), probability value (p), and coefficient of determination (R^2) to evaluate both the significance and explanatory power of the model.

RESULTS AND DISCUSSION

1. Descriptive Results

Descriptive statistical analysis was conducted to summarize the characteristics of the study variables prior to inferential examination of the predictive relationship between students' mathematics perceptions and mathematics learning outcomes. This analysis included measures of central tendency, score dispersion, and categorical distribution to provide a comprehensive empirical overview of the participants' psychological orientation toward mathematics and their academic performance.

Table 1. Descriptive Statistics of Research Variables

Variable	N	Min	Max	Range	Mean	Median	Mode	SD
Students' Mathematics Perceptions	102	34	59	25	48.40	48.00	46.00	5.45
Mathematics Learning Outcomes	102	5	95	90	50.25	52.50	42.50	21.32

As presented in table 1, students' mathematics perceptions had a mean score of 48.40 ($SD = 5.45$), with scores ranging from 34 to 59. The relatively modest standard deviation indicates that students' responses were moderately concentrated around the mean, suggesting a relatively consistent distribution of perceptions across participants. Based on the established categorization criteria, students' mathematics perceptions were generally classified as high, indicating that participants tended to hold relatively favorable views toward mathematics as a school subject.

Mathematics learning outcomes, by contrast, showed a mean score of 50.25 ($SD = 21.32$), with a much wider score range extending from 5 to 95. The substantially larger standard deviation suggests considerable variability in students' mathematics performance, indicating substantial differences in achievement levels among participants. Although some students demonstrated

strong academic performance, others performed at very low levels, producing a broad distribution of scores.

To provide a clearer understanding of students' achievement distribution, the frequency categorization of mathematics learning outcomes is presented in table 2.

Table 2. Distribution of Mathematics Learning Outcomes by Category

Score Interval	Category	Frequency	Percentage
Score < 40	Very Low	29	28.43%
40 ≤ Score < 60	Low	29	28.43%
60 ≤ Score < 75	Moderate	32	31.37%
75 ≤ Score < 90	High	11	10.79%
Score ≥ 90	Very High	1	0.98%

As shown in table 2, the distribution of mathematics learning outcomes indicates that student achievement was concentrated in the lower performance categories. More than half of the participants (56.86%) fell within the very low and low achievement categories, while only 11.77% reached high or very high performance levels. The largest proportion of students (31.37%) was classified in the moderate category. These findings confirm that, at the aggregate level, students' mathematics learning outcomes remained relatively weak despite variation across individuals.

An analytically interesting contrast emerges when these descriptive findings are considered together. While students generally reported favorable perceptions toward mathematics, their academic achievement remained predominantly low. This suggests that positive mathematics perceptions, although potentially beneficial, may not independently guarantee strong academic performance. Mathematics achievement is likely shaped by a more complex interplay of factors, including instructional quality, prior conceptual understanding, learning strategies, academic discipline, and contextual learning conditions.

Nevertheless, the existence of generally positive mathematics perceptions remains theoretically meaningful. Educational psychology literature suggests that students' perceptions influence engagement, persistence, and willingness to participate in cognitively demanding academic tasks. Accordingly, although positive perceptions may not be sufficient in themselves to ensure high achievement, they may still function as statistically

meaningful predictors of academic performance. This possibility is examined in the inferential analysis that follows.

2. Inferential Results

Inferential analysis was conducted to examine whether students' mathematics perceptions significantly predicted mathematics learning outcomes. Because the present article focuses specifically on the direct relationship between students' mathematics perceptions and academic performance, the analysis centered exclusively on the direct predictive effect of mathematics perception on mathematics learning outcomes.

Table 3. Simple Linear Regression Results (Direct Predictive Effect of Students' Mathematics Perceptions on Mathematics Learning Outcomes)

Predictor Variable	Standardized Coefficient (β)	R ²	p-value	Decision
Students' Mathematics Perceptions	0.268	0.72	0.030	Significant

As presented in table 3, students' mathematics perceptions demonstrated a positive and statistically significant predictive relationship with mathematics learning outcomes ($\beta = 0.268$, $p = 0.030$). The regression model explained approximately 7.2% of the variance in mathematics learning outcomes ($R^2 = 0.072$), suggesting that mathematics perception constituted a statistically significant but relatively modest predictor of students' mathematics achievement. Since the probability value was below the conventional significance threshold of 0.05, the null hypothesis was rejected. These findings indicate that students' mathematics perceptions significantly contributed to variation in mathematics learning outcomes, although a substantial proportion of the variance remained attributable to other factors beyond the scope of the present study.

The positive regression coefficient suggests that more favorable perceptions toward mathematics were associated with better mathematics achievement. In practical terms, students who perceived mathematics more positively tended to demonstrate higher academic performance than those who held less favorable perceptions. Although the magnitude of the effect may be interpreted as modest, the finding remains educationally meaningful because it confirms that students' internal psychological orientation toward mathematics

is not merely an affective byproduct of schooling, but a statistically relevant factor associated with academic achievement.

This inferential finding complements the descriptive results reported earlier. While the descriptive analysis revealed that students generally exhibited positive perceptions toward mathematics despite relatively low aggregate achievement, the inferential analysis clarifies that these perceptions nevertheless exerted a measurable positive influence on learning outcomes. This suggests that positive perceptions may function as a supportive, though not exclusive, contributor to academic success in mathematics.

The finding therefore provides empirical support for the proposition that students' psychological interpretations of mathematics matter educationally. Students do not engage with mathematics merely as objective content; they engage with mathematics through meanings, expectations, emotional associations, and prior interpretive experiences. These subjective orientations appear to shape academic performance in measurable ways.

3. Discussion

The present study found that students' mathematics perceptions significantly and positively predicted mathematics learning outcomes. Specifically, students who held more favorable perceptions toward mathematics tended to demonstrate better academic performance than those with less favorable perceptions. This finding reinforces the argument that mathematics achievement should not be understood solely in terms of cognitive competence or instructional exposure, but also through students' psychological interpretations of mathematics as an academic domain.

One of the most interesting findings of this study is the coexistence of relatively favorable mathematics perceptions and relatively low mathematics achievement. This pattern suggests that positive perceptions alone may be insufficient to generate strong academic performance. Students may appreciate mathematics and recognize its value while simultaneously experiencing difficulties related to conceptual understanding, prior knowledge deficits, ineffective learning strategies, demanding assessment practices, or limited instructional support. Within Islamic boarding school settings, the combination of religious and general academic responsibilities may further constrain the time available for mathematics study and practice.

This finding is theoretically consistent with expectancy value theory, which posits that students' beliefs and subjective interpretations of academic

tasks influence achievement-related behavior, persistence, effort allocation, and performance outcomes (Eccles & Wigfield, 2020). Students who perceive mathematics as meaningful, manageable, or relevant are more likely to invest cognitive and emotional effort in mathematical learning activities. In contrast, students who perceive mathematics as threatening, inaccessible, or excessively difficult may become disengaged, avoid challenging tasks, or demonstrate reduced persistence when encountering difficulty. Thus, students' perceptions function not merely as passive attitudes, but as active interpretive frameworks that shape academic behavior.

The present findings also align with control-value theory, which emphasizes the role of students' subjective appraisals in shaping emotional and academic outcomes (Pekrun, 2006). When students interpret mathematics positively, they are more likely to experience constructive emotional responses such as confidence, curiosity, and engagement, which may enhance performance. Conversely, negative perceptions may foster anxiety, helplessness, or avoidance, all of which can undermine achievement. This perspective helps explain why perception, although affective in nature, can demonstrate measurable predictive relevance in academic performance.

From the perspective of mathematics education, the findings are also consistent with scholarship emphasizing the importance of students' beliefs, affect, and mathematical identity. Hannula (2002) argues that affective orientations substantially shape students' mathematical participation, while Martino and Zan (2010) highlight that students' views of mathematics influence their willingness to engage with mathematical learning. Similarly, Boaler (2016) emphasizes that students' beliefs about mathematics can either empower or constrain learning trajectories. The present study supports these perspectives by demonstrating that students' interpretive relationship with mathematics has measurable academic consequences.

Empirical research likewise supports the observed relationship. International assessment findings have repeatedly shown associations between positive mathematics related affect and higher achievement (OECD, 2023; Von Davier, Kennedy, Reynolds, Fishbein, Khorramdel, Aldrich, Bookbinder, Bezirhan, & Yin, 2024). Students who report stronger confidence, positive engagement, and favorable academic beliefs generally perform better in mathematics than those with negative orientations. Similarly, prior educational research has reported meaningful relationships between affective constructs such as self efficacy, attitudes, motivation, and mathematics achievement

(Schukajlow, Rakoczy, & Pekrun, 2022). Although perception is conceptually distinct from these constructs, the present findings suggest that it belongs within the broader constellation of psychologically meaningful determinants of mathematics achievement.

Within the Indonesian context, the findings resonate with previous national studies indicating that internal psychological factors contribute meaningfully to mathematics performance. Research has shown that mathematics anxiety, self efficacy, motivation, and attitudes are associated with students' learning outcomes (Auliya, 2016; Leonard & Amanah, 2014). The present study extends this line of inquiry by focusing specifically on mathematics perception as a distinct predictive variable. This contribution is meaningful because perception concerns how students interpret mathematics itself not merely how motivated they feel or how confident they perceive themselves to be.

The present findings also suggest that mathematics perception should be understood as one component within a broader network of factors associated with academic achievement. While students' interpretations of mathematics appear to shape their engagement with learning, achievement outcomes are ultimately influenced by multiple interacting cognitive, instructional, and contextual variables. Consequently, the significance of mathematics perception should not be evaluated solely in isolation, but rather in relation to the broader educational conditions that support or constrain students' opportunities to learn. This perspective is consistent with educational research emphasizing that academic performance emerges from the combined influence of psychological dispositions, learning experiences, and instructional environments (Hattie, 2009; Schoenfeld, 2016).

The relatively modest explanatory contribution of mathematics perception ($R^2 = 0.072$) further supports this interpretation. Although the relationship was statistically significant, the model explained only 7.2% of the variance in mathematics learning outcomes, suggesting that achievement is influenced by multiple interacting cognitive, instructional, motivational, and contextual factors. Educational improvement efforts should therefore address both affective and cognitive dimensions of mathematics learning rather than privileging one domain exclusively.

The specific educational setting of the study also offers an important contextual interpretation. The participants were drawn from an Islamic boarding school environment characterized by dense academic schedules,

structured routines, and simultaneous engagement in religious and general education. Such contexts may shape how students experience academic fatigue, time allocation pressures, and competing learning demands. Even when students hold positive perceptions toward mathematics, these contextual constraints may limit the extent to which favorable attitudes translate into strong measurable performance. This may help explain the coexistence of positive perceptions and relatively weak achievement observed in the study.

From a pedagogical perspective, the findings suggest that mathematics educators should pay closer attention to students' interpretive experiences of mathematics. Improving achievement may require not only stronger instructional delivery, but also deliberate efforts to reshape how students perceive mathematics. Teachers may foster more positive perceptions by emphasizing conceptual understanding, reducing excessive procedural rigidity, connecting mathematics to meaningful contexts, promoting supportive classroom climates, and encouraging productive mathematical struggle rather than fear based performance orientation (Boaler, 2016; NCTM, 2014).

Several limitations should also be acknowledged. First, the study focused on a single institutional context, which may limit broader generalizability. Second, the study examined only the direct predictive role of mathematics perception, whereas mathematics achievement is likely influenced by multiple interacting psychological and contextual variables. Third, because the design was *ex post facto*, causal interpretation should be made cautiously despite the statistically significant predictive relationship observed. Future research may examine multivariable explanatory models, comparative institutional contexts, or longitudinal dynamics to better understand how mathematics perceptions develop and interact with achievement over time.

Overall, the findings affirm that students' mathematics perceptions are educationally consequential. Mathematics achievement is shaped not only by what students know, but also by how they interpret the subject they are asked to learn. Understanding and improving students' psychological relationship with mathematics may therefore represent an important pathway toward strengthening mathematics education outcomes.

CONCLUSION

This study examined the predictive influence of students' mathematics perceptions on mathematics learning outcomes among lower secondary students in an Islamic boarding school context in Indonesia. The findings

revealed that students' mathematics perceptions significantly and positively predicted mathematics learning outcomes. Students who held more favorable perceptions toward mathematics tended to demonstrate better academic performance, indicating that students' psychological interpretations of mathematics constitute a meaningful factor associated with achievement. Nevertheless, the predictive contribution observed in this study was relatively modest, suggesting that mathematics achievement is influenced by multiple factors beyond students' mathematics perceptions.

The findings also revealed an important descriptive pattern: although students generally reported positive mathematics perceptions, overall mathematics learning outcomes remained relatively low. This suggests that while favorable perceptions contribute positively to academic performance, they are not sufficient in themselves to guarantee strong achievement. Mathematics learning outcomes are likely shaped by a broader constellation of interacting cognitive, instructional, motivational, and contextual factors.

The study contributes to mathematics education literature by providing empirical evidence regarding the predictive role of students' mathematics perceptions as a distinct explanatory variable in mathematics achievement. While previous studies have predominantly examined mathematics achievement through broader affective constructs such as motivation, anxiety, attitudes, and self efficacy, the present study specifically isolates mathematics perception and demonstrates its statistically significant association with mathematics learning outcomes. This contribution helps clarify the unique role of students' interpretive understandings of mathematics within the broader network of affective factors associated with academic achievement.

From a practical perspective, the findings suggest that mathematics educators should not focus exclusively on cognitive content delivery, procedural mastery, or assessment performance. Educational interventions should also consider how students perceive mathematics as a discipline. Creating supportive classroom environments, promoting conceptual understanding, connecting mathematics to meaningful contexts, and reducing fear-based learning experiences may help cultivate more favorable mathematics perceptions that support improved academic outcomes.

Because the study was conducted within a single institutional context and employed an ex post facto design, the findings should be interpreted with appropriate caution regarding causal inference and generalizability. Future studies may extend this line of inquiry by examining multiple educational settings, incorporating broader predictive variables, or using longitudinal

designs to better understand the developmental relationship between mathematics perceptions and academic achievement.

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DECLARATIONS

- Author Contribution : SA: Conceptualization, Methodology, Instrument Development, Formal Analysis, Writing–Original Draft, Writing–Review & Editing, and Supervision.
NA: Methodology Review, Statistical Consultation, Validation, Writing–Review & Editing, and Supervision.
HBH: Theoretical Review, Academic Consultation, and Language Refinement.
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