

Determinants of Student Research Quality in Madrasah Aliyah: Student Characteristics, School Environment, and Learning Process

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Abstract

Student research programs in Madrasah Aliyah (MA) have been developed to strengthen scientific literacy and higher-order thinking skills, yet the quality of student research outputs remains uneven. This study examined the effects of student characteristics, school environment, and learning process on perceived student research quality, while also testing the mediating role of learning process. A quantitative associative-predictive design was employed involving 67 students from MAN IC Lombok Timur who had conducted research. Data were collected through a five-point Likert questionnaire and analyzed using PLS-SEM. The results showed that student characteristics had the strongest positive effect on perceived research quality ($\beta = 0.611$; $p < 0.001$), followed by school environment ($\beta = 0.310$; $p = 0.018$). School environment also significantly predicted learning process ($\beta = 0.673$; $p < 0.001$), whereas learning process did not significantly affect perceived research quality ($\beta = -0.001$; $p = 0.994$) and did not mediate the effects of the two predictors. These findings indicate that students' academic self-efficacy, intrinsic motivation, self-regulation, and supportive school climate are associated with higher perceived research quality. At the same time, the non-significant role of learning process suggests that general classroom practices may not adequately capture the research-specific mentoring needed to support student research. The findings should be interpreted in light of the study's self-reported and cross-sectional design.

Keywords: Research Quality; Student Characteristics; School Environment; Learning Process; PLS-SEM

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INTRODUCTION

In recent years, several Madrasah Aliyah (MA) in Indonesia have begun developing research programs as part of strategies to improve educational quality and strengthen learner profiles oriented toward 21st-century skills. These programs are designed not only to enhance students' scientific literacy but also to cultivate scientific character and higher-order thinking skills (Ahmad et al., 2020; Nasir, 2021). Research initiatives among MA students have become increasingly relevant as an effort to prepare graduates who are adaptive to global challenges, particularly amid the demands of Industrial Revolution 4.0 and Society 5.0 that emphasize innovation and data-driven problem solving (Purwanto et al., 2023). These programs represent a form of research-based learning (RBL), which has been shown to significantly increase students' self-rated research competences across disciplines, including skills in

reviewing literature, methodology, reflection, and communication (Thiem et al., 2023). Understanding what determines the quality of student research outputs requires a framework that accounts for the interplay between individual characteristics and contextual factors. Bronfenbrenner's bioecological model (Bronfenbrenner & Morris, 2006) provides such a framework, positing that developmental outcomes emerge from progressively complex interactions between the developing individual (person characteristics) and the immediate environment (microsystem), mediated by proximal processes over time. In the context of student research, student characteristics represent person-level factors, the school environment constitutes the microsystem, and the learning process reflects the proximal processes through which environmental influences are transmitted to outcomes.

However, the implementation of student research programs does not always produce quality outputs. Many student research products are found to be simplistically descriptive, lacking systematic rigor, or failing to fully meet scientific standards (Muskitta et al., 2023). Common weaknesses observed in MA student research include poorly formulated research questions, limited methodological understanding, superficial data analysis, and inadequate citation practices, reflecting challenges similar to those documented in secondary school research programs across Southeast Asian contexts (Bakar et al., 2010). These quality concerns are not unique to Indonesian madrasah; research on mentoring student research in secondary schools has identified that without structured supervision and explicit research skill development, student outputs tend to remain at descriptive rather than analytical levels (Cebesoy & Karisan, 2022). This condition raises questions about the factors influencing the quality of MA student research outputs, necessitating more in-depth study to understand its determinants holistically.

Several studies indicate that student research quality can be influenced by various factors, ranging from personal student characteristics such as motivation and self-efficacy to external environments including school support and the quality of learning processes. Research has consistently demonstrated that academic self-efficacy is one of the strongest predictors of academic achievement across various educational contexts (Doménech-Betoret et al., 2017; Honicke & Broadbent, 2016). Self-efficacy beliefs shape students' effort regulation, persistence in the face of difficulty, and use of metacognitive strategies, all of which are critical for completing research tasks successfully (Pajares & Schunk, 2001; Zimmerman, 2000). Intrinsic motivation and self-regulation further contribute to academic performance, with self-regulated learners demonstrating greater capacity for planning, monitoring, and evaluating their own learning processes (Pintrich, 2004; Schunk & Greene, 2018; Schunk & DiBenedetto, 2020).

At the environmental level, school climate has been identified as a significant predictor of student academic outcomes. Wang and Degol (2016) provided a comprehensive review demonstrating that school climate encompasses academic, community, safety, and institutional dimensions, each contributing to student psychosocial adjustment and achievement. Reynolds et al. (2017) further showed that school climate affects academic achievement through students' psychological identification with the school. Maxwell (2016) found that school building condition, social climate, and student attendance mediate the relationship between physical environment and achievement. Regarding learning processes, inquiry-based and research-based learning approaches have been shown to develop students' research

competences when effectively implemented with appropriate teacher mentoring and scaffolding (Cebesoy & Karisan, 2022; Pedaste et al., 2015). However, the effectiveness of such processes depends significantly on the quality of research supervision and mentoring, which differs substantially from general classroom instruction (Crawford, 2000).

An important conceptual distinction must be drawn between research-based learning (RBL) as a general pedagogical approach and research supervision or mentoring as a structured program component. Research-based learning refers to classroom-level instructional strategies that incorporate research principles into teaching, such as inquiry-based activities, project-based methods, and evidence-based discussions (Pedaste et al., 2015; Thiem et al., 2023). Research supervision and mentoring, by contrast, involves dedicated, individualized guidance through the stages of an authentic research project, including problem identification, methodological decision-making, data collection oversight, and iterative feedback on written outputs (Willison & O'Regan, 2007). This distinction is critical because the learning process construct in this study primarily captures general classroom pedagogical practices rather than research-specific mentoring activities, a measurement choice whose implications are examined in the Results and Discussion section.

Despite this body of evidence, several gaps remain. First, prior studies have predominantly examined individual predictors (e.g., self-efficacy → achievement; school climate → performance) without modeling the simultaneous and integrated effects of student-level, environment-level, and process-level factors on research-specific outcomes. Second, most existing research has focused on general academic achievement rather than on the quality of student research products specifically, which involves distinct competencies such as problem formulation, methodological reasoning, and scientific writing. Third, no study to date has tested the mediating role of learning process in transmitting the effects of student characteristics and school environment on perceived research quality within the unique context of Islamic secondary school research programs (madrasah), where the integration of religious and scientific education creates a distinctive learning ecosystem.

It is also important to distinguish between the objective quality of student research products and perceived research quality. Objective quality refers to externally evaluated research outputs judged against explicit criteria or rubric-based standards, whereas perceived research quality refers to students' self-assessments of the clarity, rigor, and adequacy of their own research work. The present study focuses on perceived research quality; therefore, the findings should not be interpreted as direct evidence about objectively rated research quality.

Despite increasing attention to student research competencies, empirical studies at the secondary school level remain limited, particularly in Indonesian Islamic education settings. A preliminary study at the same institution (Iqbal et al., 2026) examined associations between eleven demographic and academic characteristics and perceived research quality categories using chi-square analysis, finding no statistically significant associations. While this finding suggested that demographic factors alone do not account for variation in perceived research quality, the study was limited to categorical analysis and did not examine the predictive roles of psychological constructs, environmental factors, or learning processes. The present study extends

that exploratory work by developing and testing a theoretically grounded structural model based on Bronfenbrenner's bioecological framework.

This study aimed to address these gaps by developing and testing an integrative predictive model examining the effects of student characteristics (X1), school environment (X2), and learning process (M) on perceived student research quality (Y) in the context of Madrasah Aliyah. Drawing on Bronfenbrenner's bioecological framework, the study hypothesized that: (H1) student characteristics positively predict perceived research quality; (H2) school environment positively predicts perceived research quality; (H3) learning process mediates the effect of student characteristics on perceived research quality; and (H4) learning process mediates the effect of school environment on perceived research quality. The relationship model was analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM), selected for its suitability with relatively small sample sizes, complex structural models, and prediction-oriented research objectives (Hair et al., 2019, 2022). The novelty of this study lies in three aspects: (a) it models the simultaneous direct and indirect pathways through which person-level, environment-level, and process-level factors influence research-specific outcomes rather than general academic achievement; (b) it provides the first empirical test of learning process as a mediator in the student characteristics-school environment-research quality relationship; and (c) it contextualizes these relationships within the distinctive educational ecosystem of Islamic boarding school research programs in Indonesia.

METHOD

Research Design

This quantitative study employed an associative-predictive approach, aiming to identify and explain predictive relationships between independent variables (student characteristics and school environment), mediator variable (learning process), and dependent variable (perceived student research quality). The relationship model constructed in this study was analyzed using PLS-SEM analysis. The PLS-SEM approach was selected based on several considerations. According to Hair et al. (2019), PLS-SEM is appropriate when analysis involves testing theoretical frameworks from a prediction perspective, when structural models are complex with many constructs and indicators, and when the research objective is to understand complexity by exploring theoretical extensions of established theories. Additionally, PLS-SEM works well with relatively small sample sizes and does not require data normality assumptions (Hair et al., 2022). The hypothesized conceptual framework, grounded in Bronfenbrenner's bioecological model (Bronfenbrenner & Morris, 2006), is presented in Figure 1.

The model posits that person-level factors (student characteristics) and microsystem factors (school environment) directly predict perceived research quality, while also exerting indirect effects through proximal processes (learning process). All constructs in this study were specified as reflective measurement models, meaning that the indicators are assumed to be caused by the underlying latent construct (Hair et al., 2022). This specification is appropriate for Perceived Research Quality (Y), School Environment (X2), and Learning Process (M), where indicators represent manifestations of the respective constructs. For Student Characteristics (X1), the reflective specification was adopted because the four sub-dimensions (academic self-efficacy, intrinsic motivation, self-regulation, and discipline) are theoretically

interrelated aspects of students' academic disposition that covary together. However, the heterogeneous content of X1 may also be compatible with a formative or higher-order construct specification, which is discussed as a methodological consideration in the Discussion section.

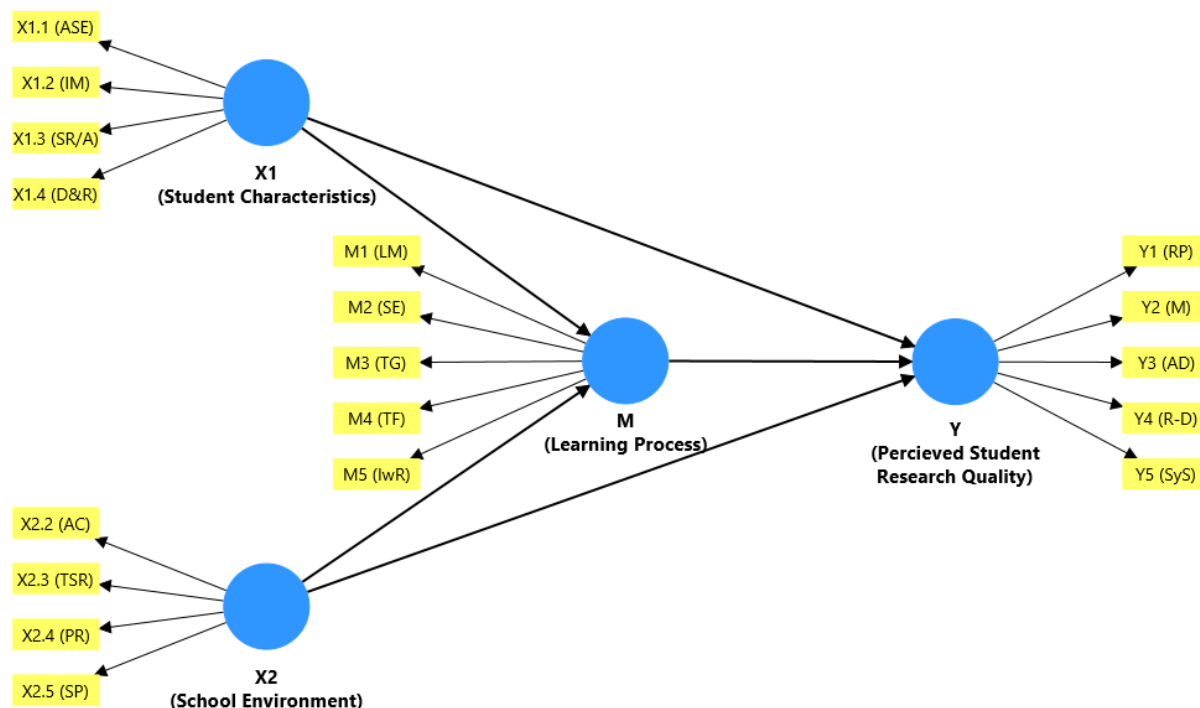


Figure 1. Hypothesized Conceptual Framework

Population and Sample

The target population of this study comprised all students of MAN IC Lombok Timur. The online questionnaire was distributed to all students who were identified as potential respondents. A total of 124 students accessed and completed the questionnaire. Respondents who had never conducted research ($n = 57$) were excluded based on the predetermined inclusion criterion, yielding a final analytical sample of $N = 67$ students (response rate from targeted students: 67%). No missing data were present in the final dataset. Participants were predominantly female ($n = 48$; 71.6%) and enrolled in Grade XII ($n = 51$; 76.1%), followed by Grade XI ($n = 12$; 17.9%) and Grade X ($n = 4$; 6.0%). All participants had completed at least one research project as part of the school's research program.

The dataset used in this study was previously analyzed in Iqbal et al. (2026), which employed chi-square analysis to examine associations between demographic characteristics and perceived research quality categories. The present study utilizes the same respondents but addresses entirely different research questions through a distinct theoretical framework (Bronfenbrenner's bioecological model), different independent variables (latent constructs of student characteristics, school environment, and learning process measured through multi-item scales), and a different analytical method (PLS-SEM with mediation analysis). This approach follows established practice in educational research where the same dataset is analyzed through complementary methodological lenses to provide a more comprehensive understanding of the phenomenon (Hair et al., 2022).

The sample was determined using convenience sampling with the inclusion criterion that respondents were students who had conducted research. This sampling

approach was appropriate given the specific nature of the research context, where only students with research experience could provide valid responses regarding research quality determinants. Regarding sample size adequacy for PLS-SEM, Hair et al. (2022) recommend a minimum sample size based on the "10-times rule," which requires at least 10 observations per the maximum number of arrows pointing at any latent variable in the model. In this study, the maximum number of arrows pointing at any endogenous variable is three ($X1 \rightarrow Y$, $X2 \rightarrow Y$, $M \rightarrow Y$), requiring a minimum of 30 observations. The sample of 67 exceeds this threshold. Additionally, Kock and Hadaya (2018) proposed the inverse square root method, which provides a more precise minimum sample size estimation for PLS-SEM based on desired statistical power. Applying the inverse square root method with a significance level of 0.05 and a minimum R^2 of 0.25 (medium effect size) at 80% statistical power, the minimum required sample size is approximately 51 observations (Kock & Hadaya, 2018). The present sample of 67 exceeds this computed minimum, providing adequate statistical power for detecting medium-to-large effects in the PLS-SEM model. Nevertheless, the relatively small sample size from a single institution is acknowledged as a limitation of this study.

Variables and Operational Definitions

This study involved four main variables. First, Perceived Student Research Quality (Y/RQ) refers to students' perceptions of the extent to which their research products meet academic standards in terms of analysis depth, methodological accuracy, writing systematics, and relevance to the researched problem. Indicators include: problem formulation clarity, method accuracy, analysis and discussion, references and data, and writing systematics. Second, Student Characteristics (X1/SC) refers to students' perceptions of their personal and academic traits that influence learning approaches and participation in research activities. Indicators include: academic self-efficacy, intrinsic motivation, self-regulation, and discipline and responsibility. Third, School Environment (X2/SE) refers to students' perceptions of the overall physical, social, and academic conditions that support or hinder student research activities. Indicators include: supporting facilities, academic climate, teacher-student relationships, peer relationships, and school policies. Fourth, Learning Process (M/LP) refers to students' perceptions of interactive activities among teachers, students, and learning media directed toward developing understanding, skills, and scientific attitudes. Indicators include: active methods, student engagement, teacher guidance, teacher feedback, and integration with research.

Instruments

Data were collected using a self-developed questionnaire comprising 38 items distributed across four constructs: Perceived Student Research Quality (Y; 10 items), Student Characteristics (X1; 8 items), School Environment (X2; 10 items), and Learning Process (M; 10 items). Each construct included both favorably and unfavorably worded items to reduce acquiescence bias. The instrument used a five-point Likert scale format (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree). Table 1 presents the instrument specification, including constructs, indicators, number of items, and sample items.

Content validity was established through expert judgment involving three experts: two specialists in research methodology and one teacher at the research site. Each expert independently rated all 38 items across four evaluation aspects – content

relevance, language clarity, item contextualization, and comprehensibility – using a four-point scale (1 = Not Relevant/Clear, 2 = Less Relevant/Clear, 3 = Relevant/Clear, 4 = Very Relevant/Clear). Content validity was quantified using Aiken's V coefficient (Aiken, 1985), computed as $V = \sum s / [n(c-1)]$, where s is the difference between each rater's score and the lowest possible score, n is the number of raters, and c is the number of rating categories. A coefficient of $V \geq 0.75$ was adopted as the threshold for acceptable item validity.

Results indicated that all 38 items across the four constructs met the validity threshold: Perceived Research Quality (10 items; V range = 0.750–0.944, mean V = 0.889), Student Characteristics (8 items; V range = 0.778–0.944, mean V = 0.892), School Environment (10 items; V range = 0.778–0.944, mean V = 0.897), and Learning Process (10 items; V range = 0.833–0.972, mean V = 0.908). Across all constructs, the average V coefficients for each evaluation aspect were satisfactory: content relevance (0.863), language clarity (0.918), contextualization (0.915), and comprehensibility (0.891). These results provide quantitative evidence that the instrument possessed adequate content validity as judged by the expert panel. Pilot testing was not conducted prior to the main data collection, which is noted as a limitation; however, the favorable V-Aiken indices support the appropriateness of the items for the target population. Future studies should complement expert validation with cognitive pretesting or pilot administration to further strengthen instrument quality.

Table 1. Instrument Specification

Construct	Indicator	Items	Sample Favorable Item	Sample Unfavorable Item
Perceived Research Quality (Y)	Problem formulation clarity (RP)	Y1, Y2	"My research problem formulation is clear and easy to understand" (Y1)	"I often feel confused when explaining my research problem formulation" (Y2)
		Y3, Y4	"The research method I used is appropriate for the problem studied" (Y3)	—
	Method accuracy (M)			
	Analysis & discussion (AD)	Y5, Y6	"I am able to connect research findings with relevant theories or references" (Y5)	"The discussion in my research report tends to be brief and unclear" (Y6)
	References & data (R-D)	Y7, Y8	"The references I used come from clear and reliable sources" (Y7)	—
	Writing systematics (SyS)	Y9, Y10	"My research report follows the writing rules applicable at school" (Y9)	"The structure of my research report is still disorganized" (Y10)
Student Characteristics (X1)	Academic self-efficacy (ASE)	X1.1, X1.2	"I am confident in my ability to complete research well" (X1.1)	—

Construct	Indicator	Items	Sample Favorable Item	Sample Unfavorable Item
	Intrinsic motivation (IM)	X1.3, X1.4	"I feel enthusiastic about doing research even without pressure from teachers" (X1.3)	"I do research only because it is required, not because of interest" (X1.4)
	Self-regulation (SR/ A)	X1.5, X1.6	"I take the initiative to find reading sources or data for research" (X1.5)	—
	Discipline & responsibility (D&R)	X1.7, X1.8	"I always complete research tasks on time" (X1.7)	"I often delay completing the research parts that are my responsibility" (X1.8)
School Environment (X2)	Supporting facilities (SF)	X2.1, X2.2	"The school provides facilities that support research activities" (X2.1)	"I have difficulty doing research because school facilities are inadequate" (X2.2)
	Academic climate (AC)	X2.3, X2.4	"My school has a learning atmosphere that encourages students to think critically" (X2.3)	—
	Teacher-student relationships (TSR)	X2.5, X2.6	"Teachers are approachable for discussing research" (X2.5)	—
	Peer relationships (PR)	X2.7, X2.8	"My friends are willing to cooperate in research" (X2.7)	"I rarely receive support from friends when working on research" (X2.8)
	School policies (SP)	X2.9, X2.10	"The school supports student research programs through official activities" (X2.9)	—
Learning Process (M)	Active methods (LM)	M1, M2	"Teachers often use project-based or experimental methods" (M1)	—
	Student engagement (SE)	M3, M4	"Teachers give students opportunities to discuss and express opinions in class" (M3)	"I am rarely encouraged to seek additional information on my own" (M4)
	Teacher guidance (TG)	M5, M6	"Teachers guide me regularly in	—

Construct	Indicator	Items	Sample Favorable Item	Sample Unfavorable Item
			completing research" (M5)	
	Teacher feedback (TF)	M7, M8	"Teachers provide input that helps improve my research report" (M7)	—
	Integration with research (IwR)	M9, M10	"Teachers often connect lesson material with student research activities" (M9)	"The research I conduct is rarely connected with classroom learning" (M10)

Data Collection

Data collection was conducted in August 2025 using a questionnaire constructed in a five-point Likert scale format. The instrument was distributed online using the Google Forms platform, with informed consent provided at the beginning of the form. Respondents were informed about the voluntary nature of participation, the purpose of the study, and the confidentiality of their responses. This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki for research involving human participants. Although no formal ethical clearance was obtained from an institutional review board, the study adhered to the following ethical safeguards: (a) official permission to conduct the study was granted by the school administration of MAN IC Lombok Timur; (b) informed consent was obtained from all participants at the beginning of the online questionnaire, with clear information about the voluntary nature of participation and the right to withdraw at any time; (c) all responses were collected anonymously through Google Forms, with no personally identifiable information recorded; and (d) the collected data were stored securely and used exclusively for research purposes. The study involved minimal risk, as participation was limited to completing a self-report questionnaire with no sensitive personal information collected. The absence of formal institutional ethical clearance is acknowledged as a limitation, and future studies should obtain ethics committee approval prior to data collection.

To reduce common method bias associated with self-report data, several procedural remedies were implemented: (a) respondent anonymity was guaranteed, (b) item order was varied across constructs, and (c) both favorably and unfavorably worded items were included in each construct (Podsakoff et al., 2003). Statistical assessment of common method bias was conducted using the full collinearity VIF approach (Kock, 2015), with results reported in the Results section.

Data Analysis

Data analysis employed PLS-SEM with the assistance of SmartPLS 4.1 software. Model evaluation was conducted in two stages: (1) measurement model (outer model) evaluation covering loading factor, composite reliability, Cronbach's alpha, rho_A, Average Variance Extracted (AVE), and discriminant validity using the Heterotrait-Monotrait (HTMT) ratio of correlations (Henseler et al., 2015); and (2) structural model (inner model) evaluation covering R², f² effect size, Q²predict predictive relevance, inner model collinearity (VIF), model fit (SRMR), and path coefficients with their significance levels. Bootstrapping procedures with 5,000 subsamples were used to

assess the significance of path coefficients. Mediation analysis was conducted following the bootstrapping approach recommended by Hair et al. (2022), with indirect effects assessed through bootstrapped 95% bias-corrected confidence intervals. A mediation effect was considered significant if the confidence interval did not include zero.

RESULTS AND DISCUSSION

Measurement Model Evaluation

Prior to hypothesis testing, the measurement model was evaluated to ensure the reliability and validity of the constructs. Following Hair et al. (2022), the assessment included indicator reliability (outer loadings), internal consistency reliability (Cronbach's α , composite reliability ρ_c and ρ_A), convergent validity (AVE), and discriminant validity (HTMT). One indicator from the School Environment construct (X2.1, Supporting Facilities) was removed prior to the final analysis due to an unacceptably low outer loading (0.136), well below the minimum threshold of 0.40 (Hair et al., 2022). The final model comprised 17 indicators across four constructs.

Table 2. Outer Loadings, Reliability, and Convergent Validity

Construct	Indicators (loadings)	α	rho_A	CR	AVE
Y	Y1=.800; Y2=.853; Y3=.758; Y4=.821; Y5=.813	0.868	0.875	0.905	0.655
X1	X1.1=.701; X1.2=.722; X1.3=.493*; X1.4=.748	0.595*	0.618	0.765	0.454*
X2	X2.2=.757; X2.3=.874; X2.4=.737; X2.5=.845	0.818	0.834	0.880	0.648
M	M1=.717; M2=.686; M3=.855; M4=.904; M5=.540	0.797	0.840	0.863	0.565

Note. * indicates values below the recommended threshold. All outer loadings are significant at $p < 0.01$.

As shown in Table 2, most indicators met the recommended thresholds. All outer loadings exceeded 0.70 except for three indicators: M5 (Integration with Research, 0.540), X1.3 (Self-Regulation/ Autonomy, 0.493), and M2 (Student Engagement, 0.686). Following Hair et al. (2022), indicators with loadings between 0.40 and 0.70 should only be removed if their deletion leads to increased composite reliability or AVE above the threshold. Since removing these indicators did not substantially improve their respective construct's AVE or composite reliability, and all loadings were statistically significant ($p < 0.01$), they were retained to preserve content validity.

For internal consistency, three constructs (Y, X2, M) demonstrated satisfactory Cronbach's α values above 0.70. The Student Characteristics construct (X1) showed a lower α of 0.595; however, Cronbach's α is known to underestimate reliability for constructs with few indicators or heterogeneous item content (Hair et al., 2022). The composite reliability ρ_c for X1 (0.765) exceeded the minimum threshold of 0.70, indicating acceptable internal consistency. Convergent validity was adequate for three constructs ($AVE > 0.50$). The AVE for X1 (0.454) fell marginally below 0.50; however, Fornell and Larcker (1981) noted that when composite reliability exceeds 0.60, convergent validity may still be considered adequate. This limitation is further addressed in the Discussion section.

Table 3 presents the HTMT ratios. Most construct pairs demonstrated satisfactory discriminant validity with HTMT values below 0.90. However, the HTMT

ratio between Y (Perceived Research Quality) and X1 (Student Characteristics) was 1.036, exceeding the 0.90 threshold, with a bootstrapped 95% confidence interval of [0.892, 1.179] that included 1.0. This indicates a serious discriminant validity concern and suggests that the two constructs may partially reflect a shared self-evaluative response tendency rather than clearly distinct latent variables. Given that both constructs were measured through single-source self-report data, the strong association between X1 and Y should therefore be interpreted cautiously. The HTMT between X2 and M (0.895) was close to but below the 0.90 threshold, with a bias-corrected CI upper bound of 0.994, indicating acceptable though borderline discriminant validity.

Table 3. Discriminant Validity – Heterotrait-Monotrait Ratio (HTMT)

	M	X1	X2	Y
M				
X1	0.672			
X2	0.895	0.750		
Y	0.617	1.036*	0.731	

Note. * HTMT value exceeds the conservative threshold of 0.90 (Henseler et al., 2015). HTMT < 0.90 indicates discriminant validity. Bootstrapped 95% CI for Y↔X1: [0.892, 1.179].

Common Method Bias Assessment

To assess common method bias, the full collinearity VIF approach recommended by Kock (2015) was employed. In this approach, all latent variables in the model are simultaneously regressed against a common variable, and VIF values exceeding 3.3 indicate potential CMB contamination. The inner model VIF values ranged from 1.356 to 2.427 (Table 4), all below the 3.3 threshold, suggesting that common method bias is unlikely to be a serious concern in this study.

Table 4. Inner Model Collinearity (VIF)

Path	VIF	Threshold
X1 → M	1.356	< 5.0 (Hair et al., 2022)
X2 → M	1.356	< 3.3 (Kock, 2015)
X1 → Y	1.409	
X2 → Y	2.427	
M → Y	2.366	

The standardized root mean square residual (SRMR) for the estimated model was 0.101, slightly above the commonly cited 0.08 threshold (Hu & Bentler, 1999). However, the SRMR threshold of 0.08 was originally developed for covariance-based SEM and its direct applicability to PLS-SEM remains debated (Henseler et al., 2016). Hair et al. (2022) cautioned against rigid application of goodness-of-fit thresholds in PLS-SEM and recommended evaluating model fit in conjunction with other criteria. Given that the bootstrap-based 99% confidence interval upper bound for SRMR was 0.103, the observed SRMR value falls within the expected range for the data, suggesting acceptable approximate model fit.

Structural Model Evaluation

The structural model was evaluated after confirming adequate measurement properties. The coefficient of determination (R^2) for Perceived Research Quality (Y) was 0.662 (R^2 adjusted = 0.646), indicating that 66.2% of its variance was explained by the model. For Learning Process (M), R^2 was 0.577 (R^2 adjusted = 0.564). Both values

exceed the threshold of 0.50 considered substantial in behavioral research (Cohen, 2013; Hair et al., 2022).

Table 5. Structural Model Results – Direct Effects

Path	β	M	SD	t	p	95% CI	f ²	Decision
X1 → Y	0.611	0.624	0.089	6.844	< 0.001	[0.443, 0.794]	0.784	Supported
X2 → Y	0.310	0.292	0.131	2.373	0.018	[0.025, 0.540]	0.118	Supported
X1 → M	0.149	0.152	0.095	1.561	0.119	[-0.028, 0.347]	0.039	Not supported
X2 → M	0.673	0.678	0.082	8.241	< 0.001	[0.507, 0.822]	0.790	Supported
M → Y	-0.001	0.013	0.150	0.007	0.994	[-0.279, 0.307]	0.000	Not supported

β = path coefficient (original sample); M = sample mean; SD = standard deviation; CI = percentile bootstrap confidence interval (5,000 subsamples); f² = effect size (0.02 = small, 0.15 = medium, 0.35 = large (Cohen, 2013)).

The results of hypothesis testing are presented in Table 5. Student Characteristics (X1) had the strongest direct positive effect on Perceived Research Quality ($\beta = 0.611$, $p < 0.001$), with a large effect size ($f^2 = 0.784$). School Environment (X2) also positively and significantly predicted Perceived Research Quality ($\beta = 0.310$, $p = 0.018$), with a small-to-medium effect size ($f^2 = 0.118$). School Environment was a strong predictor of Learning Process ($\beta = 0.673$, $p < 0.001$, $f^2 = 0.790$), whereas Student Characteristics did not significantly predict Learning Process ($\beta = 0.149$, $p = 0.119$). Notably, Learning Process did not significantly predict Perceived Research Quality ($\beta = -0.001$, $p = 0.994$, $f^2 \approx 0.000$), indicating a near-zero direct effect.

Table 6. Indirect Effects (Mediation Analysis)

Indirect Path	β	M	SD	t	p	95% CI	Decision
X1 → M → Y	-0.0002	-0.002	0.027	0.006	0.995	[-0.064, 0.050]	Not mediated
X2 → M → Y	-0.0007	0.012	0.105	0.007	0.995	[-0.183, 0.227]	Not mediated

Note. CI = percentile bootstrap 95% confidence interval (5,000 subsamples). Mediation is established when CI does not include zero (Hair et al., 2022).

Table 6 presents the mediation analysis results. Neither indirect path was statistically significant. The indirect effect of X1 on Y through M was -0.0002 (95% CI [-0.064, 0.050]), and the indirect effect of X2 on Y through M was -0.0007 (95% CI [-0.183, 0.227]). Both confidence intervals included zero, indicating that Learning Process did not mediate the relationships between Student Characteristics or School Environment and Perceived Research Quality. Given that the direct effect of M on Y was essentially zero ($\beta = -0.001$), these null mediation findings are mathematically consistent: mediation requires a significant relationship between the mediator and the outcome variable (Hair et al., 2022).

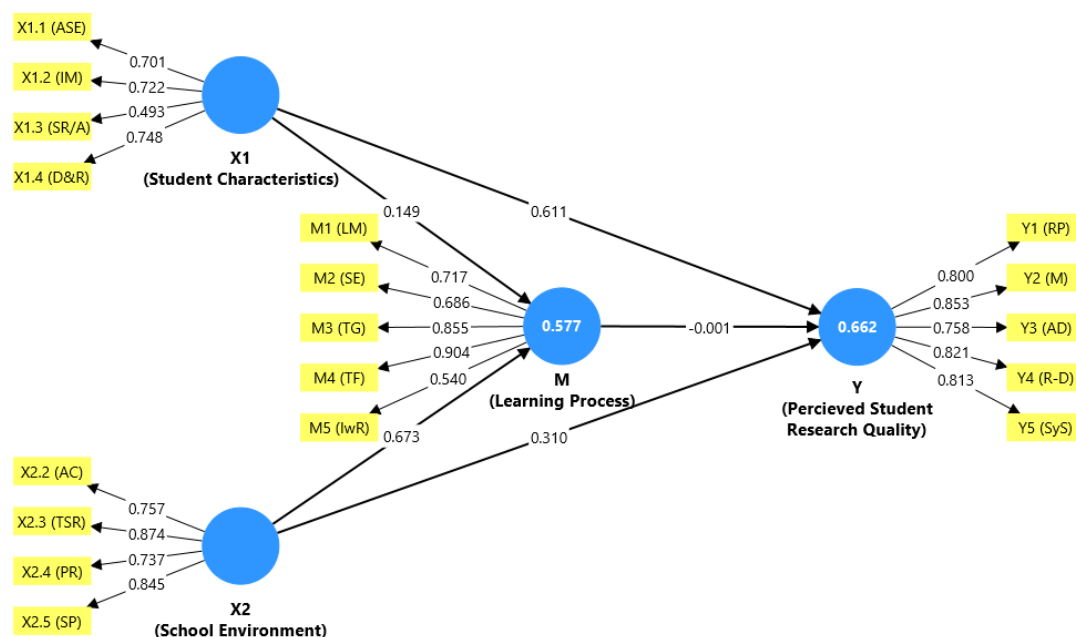


Figure 2. Structural Model Results with Path Coefficients and R² Values

Predictive Relevance

The model's predictive relevance was assessed using PLSpredict (Shmueli et al., 2019). At the latent variable level, Q² predict values were 0.509 (M) and 0.620 (Y), both substantially above zero, indicating that the model predictions outperform a naïve benchmark. Cross-validated predictive ability testing (CVPAT) (Sharma et al., 2023) confirmed that the PLS-SEM model significantly outperformed the indicator average (IA) benchmark overall (average loss difference = -0.158, $t = 4.487$, $p < 0.001$), demonstrating meaningful predictive power. Compared to the linear model (LM) benchmark, the PLS-SEM model showed a non-significant advantage (average loss difference = -0.020, $t = 1.188$, $p = 0.239$), suggesting comparable predictive performance.

Table 7. Summary of Hypothesis Testing

H	Hypothesis	β (p)	f ²	Result
H1	Student Characteristics positively predict Perceived Research Quality	0.611 (< 0.001)	0.784	Supported
H2	School Environment positively predicts Perceived Research Quality	0.310 (0.018)	0.118	Supported
H3	Learning Process mediates the effect of Student Characteristics on Perceived Research Quality	-0.0002 (0.995)	—	Not supported
H4	Learning Process mediates the effect of School Environment on Perceived Research Quality	-0.0007 (0.995)	—	Not supported

Discussion

Student Characteristics as the Dominant Predictor of Perceived Research Quality (H1 Supported)

The finding that Student Characteristics was the strongest predictor of Perceived Research Quality ($\beta = 0.611$, $f^2 = 0.784$) aligns with extensive literature on the role of self-efficacy and intrinsic motivation in academic achievement. Bandura's self-efficacy

theory posits that individuals with higher self-efficacy set more challenging goals, invest greater effort, and persist longer in the face of difficulties (Bandura, 1997). In the context of student research, students who believe in their ability to conduct research are more likely to engage deeply with the research process and report higher perceived quality of their outputs.

This finding is consistent with Honicke and Broadbent's (2016) meta-analysis, which reported a significant positive relationship between academic self-efficacy and academic performance across diverse educational contexts. Similarly, Zimmerman (2000) emphasized that self-efficacy operates as a key motivational belief that influences self-regulated learning behaviors, which are prerequisite to complex academic tasks such as research. Within the Indonesian Islamic boarding school (madrasah) context, this finding suggests that personal characteristics—particularly self-confidence and intrinsic motivation—may be more critical than institutional factors in shaping students' perceptions of their research competence.

This finding is further corroborated by recent evidence. Olivier et al. (2019) conducted a study of 223 effect sizes and found a moderate positive relationship between self-efficacy and academic performance, reinforcing that self-efficacy remains one of the most robust predictors of student outcomes across educational levels. Nauzeer and Jaunky (2021) further confirmed through their meta-analysis that motivation and self-regulatory traits collectively explain a substantial proportion of variance in academic performance, with self-efficacy emerging as the strongest individual predictor. Dent and Koenka (2016) similarly demonstrated through a meta-analysis that self-regulated learning strategies are positively associated with academic achievement across childhood and adolescence, with the strength of this association varying by developmental stage and strategy type. These converging findings underscore the centrality of psychological attributes in predicting academic outcomes, consistent with the present study's results.

From Bronfenbrenner's bioecological perspective, this finding highlights the primacy of person-level factors (demand, resource, and force characteristics) in determining developmental outcomes. The large effect size indicates that individual differences in self-efficacy, motivation, self-regulation, and discipline account for a substantial proportion of variance in perceived research quality, even when environmental factors are controlled.

This finding also complements the results reported by Iqbal et al. (2026), who found that none of the eleven demographic characteristics (gender, age, grade level, monthly allowance, subject preferences, prior school background, and academic specialization) were significantly associated with perceived research quality at the same institution. Taken together, the two studies suggest that it is not students' background demographics but rather their psychological attributes—particularly self-efficacy and intrinsic motivation—that meaningfully predict how they perceive their research competence.

School Environment as a Significant Predictor (H2 Supported)

School Environment significantly predicted Perceived Research Quality ($\beta = 0.310$, $p = 0.018$), though with a notably smaller effect than Student Characteristics. This finding supports Wang and Degol's (2016) conceptualization of school climate as a multidimensional construct that influences student outcomes through academic climate, teacher-student relationships, and institutional support. The result also aligns with Reynolds et al. (2017), who demonstrated that school-level factors contribute

meaningfully to academic effectiveness, though typically with smaller effect sizes than individual-level factors.

Importantly, after removing the Supporting Facilities indicator (X2.1) due to its very low loading (0.136), the School Environment construct was primarily captured by academic climate, teacher-student relationships, peer relationships, and school policies. The negligible contribution of physical facilities suggests that in the context of MAN IC Lombok Timur—an Islamic boarding school with relatively standardized facilities—it is the relational and policy dimensions of the school environment that matter most for supporting student research. This interpretation is consistent with Thapa et al. (2013), who argued that the social and academic dimensions of school climate typically have stronger effects on student outcomes than physical infrastructure.

Recent empirical work has strengthened this conclusion. Erdem and Kaya (2024) conducted a comprehensive meta-analysis and confirmed a significant positive relationship between school climate and academic achievement, with teacher-student relationships emerging as the most influential climate dimension. Izaguirre et al. (2023) additionally found that school climate predicted perceived academic performance through its effects on positive psychological variables including resilience and emotional intelligence, highlighting the psychosocial pathways through which school environment influences student outcomes. These findings are consistent with the pattern observed in this study, where relational and policy dimensions of school environment were more predictive than physical infrastructure.

Within Bronfenbrenner's framework, the school environment represents the microsystem in which daily interactions occur. The significant but moderate effect suggests that while the institutional environment facilitates research activity, its influence on perceived research quality is partially mediated through its impact on individual characteristics—a finding supported by the strong correlation between X1 and Y ($r = 0.769$) and the significant $X2 \rightarrow M$ path.

The Null Mediation Effect of Learning Process (H3 and H4 Not Supported)

Perhaps the most noteworthy finding of this study is that Learning Process did not mediate the relationships between either predictor and Perceived Research Quality. The direct effect of M on Y was essentially zero ($\beta = -0.001$, $p = 0.994$), despite School Environment being a strong predictor of Learning Process ($\beta = 0.673$, $p < 0.001$). This pattern—where the a-path ($X2 \rightarrow M$) is significant but the b-path ($M \rightarrow Y$) is not—constitutes what Zhao et al. (2010) term an "absent mediation" or "no-effect nonmediation," indicating that the mediator is not part of the causal mechanism linking the predictor to the outcome.

Several theoretical explanations may account for this null finding. First, a construct-measurement mismatch may exist: the Learning Process construct measured general classroom pedagogical practices (active methods, student engagement, teacher guidance, feedback), whereas Perceived Research Quality assessed students' perceptions of their research products. Research competence at the secondary school level may depend more on specialized research mentoring and dedicated research training than on general classroom learning processes (Crawford, 2000; Pedaste et al., 2015). In other words, the type of learning process that matters for research quality may not be adequately captured by indicators of general instructional quality. This interpretation is supported by Healey and Jenkins (2009), who distinguished between teaching that is research-led (focusing on research content) and

teaching that is research-based (engaging students in authentic inquiry), arguing that only the latter directly develops research competencies. Similarly, Brew (2013) emphasized that the nexus between teaching and research is not automatic but requires deliberate pedagogical design that aligns classroom activities with research processes. Fauth et al. (2019) provided further evidence that teacher competence affects student achievement through the mediating role of teaching quality, but only when teaching quality is measured with domain-specific indicators aligned with the outcome variable. This finding reinforces the interpretation that the learning process construct in this study, which measured general pedagogical practices, may not have captured the specific instructional dimensions relevant to research skill development.

Second, the near-zero $M \rightarrow Y$ path in the presence of a strong $X2 \rightarrow M$ path suggests that while school environment shapes learning processes, these classroom-based processes do not translate into better-perceived research outcomes. This is consistent with Willison and O'Regan's Research Skill Development framework, which argues that research skills require explicit scaffolding beyond regular coursework (2007). Students at MAN IC Lombok Timur may engage in high-quality classroom learning without this translating to perceived research competence because research is a distinct activity requiring specialized skills not developed through standard pedagogy.

Third, the strong direct effects of $X1$ and $X2$ on Y may have already captured the variance that would otherwise be explained through the mediation pathway. When the direct predictors are highly explanatory ($R^2 = 0.662$), little additional variance remains for the mediator to explain, a statistical phenomenon known as the absorption effect (Rucker et al., 2011).

Methodological Considerations and Limitations

Several methodological limitations warrant discussion (see Table 7). First, the HTMT ratio between Y and $X1$ (1.036) exceeded the 0.90 threshold, indicating a serious discriminant validity concern. This overlap likely reflects the shared self-evaluative nature of both constructs: Student Characteristics items assessed students' self-perceptions of their academic attributes, while Perceived Research Quality items assessed their self-perceptions of research output quality. As a result, the magnitude of the $X1 \rightarrow Y$ relationship may be inflated by shared method variance and conceptual overlap. Future studies should therefore incorporate objective measures of research quality (e.g., rubric-based expert assessment), multi-source ratings, and further item refinement to strengthen construct separation.

Second, the AVE of $X1$ (0.454) fell marginally below the 0.50 threshold, reflecting the heterogeneous content of the Student Characteristics construct, which encompasses four distinct but related sub-dimensions (self-efficacy, intrinsic motivation, self-regulation, and discipline). While the composite reliability ($\rho_c = 0.765$) provides adequate evidence of internal consistency, future studies may benefit from refining the measurement of student characteristics by developing more homogeneous sub-scales or employing a higher-order construct specification.

Third, the cross-sectional design precludes causal interpretation. The term "predictor" is used throughout this paper in a statistical sense, reflecting associative-predictive relationships rather than causation. Longitudinal designs would be needed to establish temporal precedence and to determine whether changes in student characteristics or school environment lead to subsequent changes in perceived research quality.

Fourth, the study relied entirely on self-report measures, which are susceptible to common method bias, social desirability, and self-assessment accuracy limitations. Although the full collinearity VIF analysis suggested that common method bias was not a serious concern (all VIF < 3.3), the reliance on self-reported perceived research quality rather than objective assessment remains a fundamental limitation. Podsakoff et al. (2012) further cautioned that procedural remedies alone may not fully eliminate common method variance in cross-sectional self-report studies, and recommended the use of multi-source data collection designs in future research. The single-site sample from MAN IC Lombok Timur (N = 67) also limits generalizability to other madrasah or school contexts. Amsalu and Belay (2024) demonstrated that multi-site studies using structural equation modeling tend to yield more robust estimates of school climate effects, suggesting that future replication across multiple madrasah institutions would strengthen the generalizability of these findings.

CONCLUSION

This study examined the determinants of perceived student research quality in a Madrasah Aliyah context using PLS-SEM analysis with a sample of 67 students from MAN IC Lombok Timur. Two of the four hypotheses were supported. Student Characteristics emerged as the strongest predictor of Perceived Research Quality ($\beta = 0.611$, $f^2 = 0.784$), followed by School Environment ($\beta = 0.310$, $f^2 = 0.118$). Together, these predictors explained 66.2% of the variance in perceived research quality. Contrary to expectations, Learning Process did not mediate the relationship between either predictor and perceived research quality, suggesting that general classroom learning processes may operate through different mechanisms than those directly relevant to student research competence.

RECOMMENDATION

Based on the findings, several evidence-based recommendations can be proposed for practitioners, school administrators, and future researchers. For practitioners, the strong influence of student characteristics indicates that interventions aimed at strengthening self-efficacy and intrinsic motivation may be the most effective approach for improving students' perceived research quality. In this regard, schools should consider implementing structured research mentoring programs that gradually build students' confidence through scaffolded and progressive research tasks. Because the learning process did not show a mediating effect, the development of research skills should be addressed as a distinct pedagogical domain rather than assumed to emerge automatically from general classroom instruction. For school administrators, the significant effect of the school environment suggests that creating a supportive academic climate, promoting accessible teacher-student research relationships, and establishing explicit policies that encourage student research can positively shape perceived research outcomes. Moreover, the minimal contribution of physical facilities, as reflected by the removal of indicator X2.1, implies that investments in relational support and policy development may be more impactful than infrastructure improvements alone. For future researchers, this study points to several important directions, including replication with larger and multi-site samples to improve generalizability, the inclusion of objective measures of research quality such as expert-rated rubrics alongside self-report instruments to address concerns about discriminant validity

between Y and X1, the use of longitudinal or quasi-experimental designs to examine causal relationships more rigorously, the exploration of alternative mediators such as research-specific mentoring quality, peer research collaboration, or research self-regulation as possible mechanisms linking school environment to research quality, and the refinement of the Student Characteristics instrument to achieve stronger convergent validity, particularly by increasing the average variance extracted above 0.50.

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Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Muhammad Iqbal	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓
Ahmad Zainul Irfan	✓	✓				✓		✓	✓	✓	✓	✓		
Muzakkir	✓		✓	✓		✓	✓			✓	✓		✓	
Khaerul Anam	✓		✓	✓	✓		✓			✓		✓	✓	

C : Conceptualization

M : Methodology

So : Software

Va : Validation

Fo : Formal analysis

I : Investigation

R : Resources

D : Data Curation

O : Writing - Original Draft

E : Writing - Review & Editing

Vi : Visualization

Su : Supervision

P : Project administration

Fu : Funding acquisition

Conflict of Interest Statement

Authors state no conflict of interest.

Informed Consent

We have obtained informed consent from all individuals included in this study through the online questionnaire platform.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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