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PRE-SERVICE TEACHERS' CLASSROOM MANAGEMENT PRACTICES AND PERCEIVED SCIENCE PROCESS SKILLS IN MADRASAH IBTIDAIYAH

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Abstract : *Developing students' science process skills is a key goal of inquiry-based science education, but empirical research on how pre-service teachers' classroom management methods enhance these skills is scarce, particularly in Islamic primary education. This study investigated how pre-service teachers' classroom management strategies influenced their perceptions of students' science process skills. A quantitative cross-sectional approach was used, with 52 pre-service teachers enrolling in or having completed a teacher professional education program. A structured questionnaire was used to collect data on classroom management methods and students' perceived science process skills, which were then analyzed using descriptive statistics and simple linear regression. Classroom management practices positively impact students' science process skills ($\beta = 0.715$, $t = 7.224$, $p < 0.001$). Effective classroom management leads to higher perceptions of students' ability to plan investigations, conduct observations, analyze data, draw conclusions, and communicate findings. These findings contribute to the classroom management literature by emphasizing its pedagogical function in promoting inquiry-based science learning from the perspective of pre-service teachers. Practically, the study emphasizes the necessity of improving classroom management competences in teacher education programs to better prepare future teachers to enable science learning and increase students' science process skills.*

Keywords : *Classroom Management; Pre-Service Teachers; Science Process Skills; Teacher Education.*

Abstrak : *Mengembangkan keterampilan proses sains siswa adalah tujuan utama pendidikan sains berbasis inkuiri, namun penelitian empiris tentang bagaimana metode manajemen kelas guru pra-jabatan meningkatkan keterampilan ini masih langka, khususnya di pendidikan dasar Islam. Penelitian ini menyelidiki bagaimana strategi pengelolaan kelas guru pra-jabatan mempengaruhi persepsi mereka terhadap keterampilan proses sains siswa. Pendekatan kuantitatif cross-sectional digunakan, dengan 52 guru pra-jabatan yang mendaftar atau telah menyelesaikan program pendidikan profesional guru. Kuesioner terstruktur digunakan untuk mengumpulkan data tentang metode pengelolaan kelas dan keterampilan proses sains yang dirasakan siswa, yang kemudian dianalisis menggunakan statistik deskriptif dan regresi linier sederhana. Praktik pengelolaan kelas berpengaruh positif terhadap keterampilan proses sains siswa ($\beta = 0.715$, $t = 7.224$, $p < 0.001$). Pengelolaan kelas yang efektif mengarah pada persepsi yang lebih tinggi terhadap kemampuan siswa dalam merencanakan penyelidikan, melakukan observasi, menganalisis data, menarik kesimpulan, dan mengkomunikasikan temuan. Temuan ini berkontribusi pada literatur manajemen kelas dengan menekankan fungsi pedagogisnya dalam mempromosikan pembelajaran sains berbasis inkuiri dari perspektif guru pra-jabatan. Secara praktis, penelitian ini menekankan perlunya peningkatan kompetensi pengelolaan kelas dalam program pendidikan guru untuk lebih mempersiapkan guru masa depan agar memungkinkan pembelajaran sains dan meningkatkan keterampilan proses sains siswa.*

Kata Kunci : *Manajemen Kelas; Calon Guru; Keterampilan Proses Sains; Pendidikan Guru.*

INTRODUCTION

Science education has increasingly shifted from emphasizing content acquisition to fostering students' ability to think and work scientifically. Consequently, science process skills (SPS) including observing, formulating hypotheses, planning investigations, interpreting evidence, and communicating findings are widely recognized as fundamental competencies for developing scientific literacy and preparing learners for the demands of the twenty-first century (Abrahams & Reiss, 2012; Hartono et al., 2022; Juhji, 2016; Mafarja et al., 2026). These competencies are also strongly aligned with international educational agendas, including the OECD Learning Compass 2030 and Sustainable Development Goal 4 (Quality Education), which emphasize inquiry, critical thinking, collaboration, and problem-solving as essential learning outcomes (Calma & Davies, 2026; Hasanah et al., 2026). Nevertheless, evidence from international assessments such as the Program for International Student Assessment (PISA) continues to indicate that many students experience difficulties with scientific reasoning and inquiry-based problem-solving, highlighting the importance of improving instructional practices that support science process skills from the primary education level.

The classroom management has evolved from a discipline-oriented concept into a broader pedagogical competence that shapes the quality of learning environments. Contemporary classroom management involves organizing instructional activities, establishing positive teacher–student relationships, facilitating active participation, and creating supportive conditions that enable students to engage meaningfully in scientific inquiry (Temel Aslan & Ertaş Kılıç, 2022; Weber et al., 2018). These competencies are particularly important in science learning because inquiry-based instruction requires teachers to manage experiments, collaborative discussions, investigations, and classroom interactions simultaneously (Munawwaroh & Adeoye, 2024; Nadira et al., 2026; Yakin et al., 2025). For pre-service teachers, classroom management becomes a critical professional competency during teacher preparation, as inadequate classroom management may hinder the implementation of student-centered science learning despite sufficient subject knowledge.

The importance of classroom management is even more pronounced in *Madrasah Ibtidaiyah*, where science learning is expected to cultivate scientific literacy while reflecting the values and educational characteristics of Islamic primary education. This dual responsibility requires pre-service teachers to create learning environments that encourage curiosity, collaboration, and inquiry without neglecting classroom order and positive social interaction. However, previous studies have reported that many pre-service teachers experience difficulties translating pedagogical knowledge into effective classroom

management practices, particularly during science instruction, which demands high levels of student engagement (Lamanauskas & Augienė, 2017; Oleson & Hora, 2014; Whitcomb et al., 2023). These challenges may influence how future teachers perceive students' opportunities to develop science process skills in the classroom.

Although classroom management has received considerable attention in educational research, several important gaps remain. Existing studies have predominantly examined its relationship with academic achievement, classroom climate, student behavior, learning motivation, or teacher effectiveness (Ikhsan et al., 2021; Martin & Sass, 2010). Comparatively fewer studies have explored classroom management in relation to science process skills, and those that do generally focus on experienced teachers or students in general elementary school settings (Hartono et al., 2022; Safaah et al., 2017; Yulihapsari et al., 2023). Furthermore, limited empirical evidence exists on how pre-service teachers perceive the relationship between their classroom management practices and students' science process skills, particularly in the context of *Madrasah Ibtidaiyah*. This gap is important because teacher preparation is the stage at which pedagogical competencies are established and refined before entering professional practice.

Addressing this gap, the present study investigates the effect of pre-service teachers' classroom management practices on their perceptions of students' science process skills in *Madrasah Ibtidaiyah*. Rather than measuring students' science process skills directly, this study examines how pre-service teachers perceive the extent to which effective classroom management supports students' abilities to observe, investigate, analyze evidence, draw conclusions, and communicate scientific findings during science learning. Thus, effective classroom management may provide a supportive environment for students to engage in scientific inquiry.

This study contributes to the literature in three significant ways. First, it extends classroom management research by examining its relationship with perceived science process skills, an outcome that has received comparatively limited scholarly attention. Second, it provides empirical evidence from the underexplored context of Islamic primary education, thereby enriching the literature on science pedagogy in *Madrasah Ibtidaiyah*. Third, by focusing on pre-service teachers rather than experienced educators, this study offers new insights into how pedagogical competencies developed during teacher education may shape perceptions of inquiry-oriented science learning. The findings are expected to inform teacher education programs by highlighting the importance of integrating evidence-based classroom management strategies into pre-service teacher preparation to strengthen inquiry-based science instruction and support students' scientific learning experiences.

METHOD

This study employed a quantitative cross-sectional research design to examine the relationship between pre-service teachers' classroom management practices and their perceptions of students' science process skills. A quantitative approach was selected because the study sought to test the predictive relationship between the two variables using statistical analysis and to provide empirical evidence regarding the pedagogical role of classroom management in science learning. The research was conducted in the context of Madrasah Ibtidaiyah (Islamic primary schools), where science education integrates inquiry-based learning with Islamic values. This context was deliberately selected because it represents a distinctive educational environment in which pre-service teachers undertake teaching practice and develop essential pedagogical competencies, including classroom management, to facilitate effective science instruction.

The participants consisted of 52 pre-service teachers enrolled in, or who had completed, the Pre-Service Teacher Professional Education program in Elementary School Teacher Education during the 2023–2024 academic year. Participants were recruited using simple random sampling to ensure that every eligible pre-service teacher had an equal probability of selection. Data were collected through an online self-administered questionnaire distributed over a one-month period. The questionnaire comprised two constructs. The first measured classroom management practices through six dimensions: 1) establishing positive teacher–student relationships, 2) implementing classroom rules and routines, 3) applying reinforcement and corrective strategies appropriately, 4) providing constructive feedback, 5) managing classroom disruptions effectively, and 6) promoting students' active participation in learning. The second construct measured pre-service teachers' perceptions of students' science process skills, including students' abilities to plan scientific investigations, conduct systematic observations, analyze data, draw evidence-based conclusions, and communicate scientific findings. All questionnaire items were rated using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

To ensure the quality of the measurement instrument, content validity was established through expert evaluation involving specialists in science education and educational measurement, who reviewed the relevance, clarity, and representativeness of each item. Internal consistency reliability was assessed using Cronbach's alpha, yielding a coefficient of 0.85, indicating good reliability for research purposes. Before hypothesis testing, the dataset was screened for completeness and examined to verify the assumptions underlying linear regression, including normality, linearity, homoscedasticity, independence of residuals, and the absence of influential outliers. Descriptive statistics were first used to summarize respondents' demographic characteristics and the distributions of

variables. Subsequently, simple linear regression analysis was conducted to determine the extent to which classroom management practices predicted pre-service teachers' perceptions of students' science process skills. Statistical significance was evaluated using the t-test with a significance level of 0.05. All statistical analyses were performed using IBM SPSS Statistics. Ethical principles were maintained throughout the study by obtaining informed consent from all participants prior to data collection, ensuring voluntary participation, protecting respondents' anonymity and confidentiality, and reporting findings only in aggregate form.

RESULT AND DISCUSSION

1. Results

a) Classical Assumption Test

The classical assumption tests in this study include tests for normality, linearity, multicollinearity, and heteroscedasticity. The normality test is used to ensure that the residuals are normally distributed, while the linearity test aims to confirm the existence of a linear relationship between classroom management practices and perceptions of students' science process skills. The multicollinearity test is conducted to identify potential excessive correlation among predictor variables, whereas the heteroscedasticity test is used to ensure that residual variance remains relatively constant across all levels of the independent variables. Meeting these assumptions serves as the basis for ensuring the validity of the regression model and the valid interpretation of estimation results and significance tests.

A normality test is performed using the Kolmogorov-Smirnov test to assess whether the data in this study meet the assumption of normality. This test assesses whether the residuals in the regression model follow a normal distribution. The normality test results are presented in Table 1 below.

Table 1: Normality Test through Kolmogorov-Smirnov Test

		Unstandardized Residual
N		52
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	6.88501181
Most Extreme Differences	Absolute	.102
	Positive	.102
	Negative	-.066
Test Statistic		.102
Asymp. Sig. (2-tailed)		.200[c,d]
a. Test distribution is Normal.		
b. Calculated from data.		

Table 1 shows the results of the Kolmogorov-Smirnov Test for unstandardized residuals (N = 52). The test yielded a D-statistic of 0.102 and an asymptotic significance (Asymp. Sig.) of 0.200, which is above the 0.05 significance level. It indicates that the residuals are normally distributed, which aligns with the assumptions of the regression analysis. Although Lilliefors Significance Correction was applied, a p-value greater than 0.05 indicates that the residuals do not deviate significantly from normality, allowing further analysis.

A linearity test was performed using analysis of variance (ANOVA) to assess the assumption of linearity between pre-service teachers' classroom management practices and their perceptions of students' science process skills. Establishing linearity is a prerequisite for applying simple linear regression, as it confirms that the relationship between the independent variable (classroom management practices) and the dependent variable (perceived students' science process skills) is appropriately represented by a linear model. The results of the linearity test are presented in Table 2.

Table 2: Linearity Test through ANOVA Test

			Sum of Squares	df	Mean Square	F	Sig.
Perceptions of students' science process skills * Classroom Management by Pre-Service Teachers	Between Groups	(Combined)	3937.353	25	157.494	4.081	.000
		Linearity	2523.196	1	2523.196	65.380	.000
		Deviation from Linearity	1414.156	24	58.923	1.527	.147
	Within Groups		1003.417	26	38.593		
	Total		4940.769	51			

Table 2 presents the results of the ANOVA-based linearity test conducted prior to regression analysis. The findings indicate a statistically significant linear relationship between pre-service teachers' classroom management practices and their perceptions of students' science process skills, as evidenced by the significant linearity component ($F = 65.380$, $p < 0.001$). Furthermore, the deviation from linearity was not statistically significant ($F = 1.527$, $p = 0.147$), indicating that the observed relationship did not substantially depart from linearity. These results confirm that the assumption of linearity was satisfied, supporting the use of simple linear regression to examine the predictive effect of classroom management practices on pre-service teachers' perceptions of students' science process skills.

Following confirmation that the assumption of linearity was satisfied, a simple linear regression analysis was conducted to examine whether pre-service teachers' classroom management practices significantly predicted their perceptions of students' science process skills. The regression analysis estimated the direction and magnitude

of the predictive relationship, while statistical significance was evaluated using the t-test at the 0.05 significance level.

Table 3: Multicollinearity Test

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	26.667	11.279		2.364	.022		
	Classroom Management by Pre-Service Teachers	.737	.102	.715	7.224	.000	1.000	1.000

a. Dependent Variable: Perceptions of students' science process skills

Table 3 presents the results of the simple linear regression analysis examining the effect of pre-service teachers' classroom management practices on their perceptions of students' science process skills. The analysis revealed a statistically significant positive relationship between the two variables. The unstandardized regression coefficient ($B = 0.737$, $t = 7.224$, $p < 0.001$) indicates that a one-unit increase in classroom management practices is associated with a 0.737-unit increase in pre-service teachers' perceptions of students' science process skills. Furthermore, the standardized regression coefficient ($\beta = 0.715$) suggests a strong positive predictive relationship between the variables. This result shows that differences in classroom management practices are reflected in pre-service teachers' perceptions of students' science process skills. These findings indicate that more effective classroom management practices are associated with higher perceived levels of students' science process skills, supporting the study hypothesis.

The heteroscedasticity test ensures that the regression model meets the assumption of homoscedasticity, namely that the variance of the residuals does not vary across the entire range of the independent variable. This test is important to confirm that the residuals are distributed consistently and that the regression estimates can be interpreted appropriately. A model that satisfies this assumption indicates that the residual variation remains relatively stable across the observed values of the independent variable. The results of the heteroscedasticity test are shown in Figure 1 below.

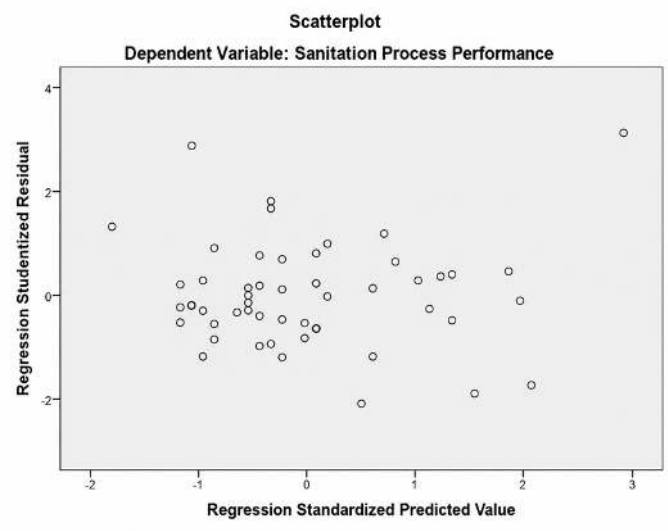

Figure 1: Heteroscedasticity Test through Scatterplot

Based on Figure 1 above, the data points appear to be scattered randomly and do not form a particular pattern. The random distribution of points and their uniform spread around the horizontal line indicate that there is no heteroscedasticity in this model. Thus, the assumption of homoscedasticity is met: the variance of the residuals remains consistent across the range of the independent variables, so the regression model is valid and suitable for further analysis.

b) Simple Linear Regression Test

A simple linear regression analysis was conducted to examine the extent to which pre-service teachers' classroom management practices predicted their perceptions of students' science process skills. The regression model was evaluated using the correlation coefficient (R), the coefficient of determination (R^2), the adjusted coefficient of determination (Adjusted R^2), and the standard error of the estimate to assess the model's strength, explanatory power, and overall fit. The results of the regression model are presented in Table 4.

Table 4: Summary of Regression Models

Model	R	R Square	Adjusted R-Square	Std. Error of the Estimate
1	.715[a]	.511	.501	6.954

a. Predictors: (Constant), Pre-service teachers' classroom management practices

Table 4 presents the results of the regression model. The correlation coefficient (R = 0.715) indicates a strong positive association between pre-service teachers' classroom management practices and their perceptions of students' science process skills. The coefficient of determination (R^2 = 0.511) indicates that classroom

management practices accounted for 51.1% of the variance in students' perceived science process skills, while the adjusted coefficient of determination (Adjusted R^2 = 0.501) suggests that the model retained substantial explanatory power after adjustment for sample size. The standard error of the estimate (6.954) indicates an acceptable level of prediction error, suggesting that the regression model provides a reasonably good fit to the observed data. However, nearly half of the variance remains attributable to factors not included in the model.

Table 5 presents the results of the analysis of variance (ANOVA) for the simple linear regression model examining the effect of pre-service teachers' classroom management practices on their perceptions of students' science process skills. In regression analysis, the ANOVA test evaluates the overall significance of the regression model by determining whether classroom management practices explain a statistically significant proportion of the variance in the dependent variable. The results are presented in Table 5.

Table 5: Results of Analysis of Variance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2523.196	1	2523.196	52.184	.000[b]
	Residual	2417.573	50	48.351		
	Total	4940.769	51			

a. Dependent Variable: Perceptions of students' science process skills

b. Predictors: (Constant), Classroom Management by Pre-Service Teachers

Table 5 presents the ANOVA results for the simple linear regression model. The regression model was statistically significant ($F(1, 50) = 52.184$, $p < 0.001$), indicating that pre-service teachers' classroom management practices explained a significant proportion of the variance in their perceptions of students' science process skills. The regression sum of squares (2523.196) accounted for a substantial share of the total variance compared with the residual sum of squares (2417.573), indicating that the model provided a meaningful fit to the observed data. These findings support the proposed regression model and indicate that classroom management practices were a significant predictor of pre-service teachers' perceptions of students' science process skills.

Table 6 presents the regression coefficients for the simple linear regression model examining the effect of pre-service teachers' classroom management practices on their perceptions of students' science process skills. The regression coefficients were used to estimate the direction, magnitude, and statistical significance of the predictive relationship between the independent and dependent variables.

Table 6: Regression Coefficient

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	26.667	11.279		2.364	.022
	Classroom Management by Pre-Service Teachers	.737	.102	.715	7.224	.000
a. Dependent Variable: Perceptions of students' science process skills						

Based on Table 6, the regression analysis revealed a statistically significant positive relationship between pre-service teachers' classroom management practices and their perceptions of students' science process skills. The unstandardized regression coefficient (B = 0.737) indicates that a one-unit increase in classroom management practices was associated with a 0.737-unit increase in perceived students' science process skills. This relationship was statistically significant ($t = 7.224$, $p < 0.001$). Furthermore, the standardized regression coefficient ($\beta = 0.715$) suggests a strong positive predictive relationship between the two variables. These findings indicate that more effective classroom management practices are associated with higher pre-service teachers' perceptions of students' science process skills, supporting the proposed research hypothesis.

2. Discussion

The present study examined the relationship between pre-service teachers' classroom management practices and their perceptions of students' science process skills in the context of *Madrasah Ibtidaiyah*. The findings demonstrate that more effective classroom management practices are positively associated with higher perceptions of students' science process skills. Although the study relied on pre-service teachers' perceptions rather than direct assessments of students' competencies, the results suggest that classroom management is perceived as an essential pedagogical foundation for facilitating inquiry-oriented science learning. These findings reinforce the view that effective classroom management extends beyond maintaining classroom discipline and instead serves as a mechanism for creating learning environments that encourage students to actively observe, investigate, analyze evidence, and communicate scientific ideas.

This finding is consistent with the broader literature emphasizing the pedagogical function of classroom management in promoting meaningful learning. Jerome Freiberg et al. (2020) argue that classroom management should be understood as a comprehensive strategy for establishing productive learning environments rather than merely controlling student behavior. Similarly, Marzano (2003) reported that effective classroom management contributes to higher levels of student engagement and academic

achievement by maximizing instructional time and minimizing classroom disruptions. In science education, inquiry-based learning requires students to actively participate in experimentation, collaborative discussion, and evidence-based reasoning (Awaliah S et al., 2025; Biddell et al., 2022; Gawo & Tafesse, 2024). Consequently, classroom environments characterized by clear expectations, effective organization, and positive teacher–student interactions are more likely to provide opportunities to develop science process skills.

The findings also support previous studies demonstrating that effective classroom management promotes active student participation and engagement during science learning. Yadav (2022) found that well-managed classrooms encourage greater student involvement and reduce disruptive behaviors, thereby creating conditions that facilitate critical and creative thinking. Likewise and Koran (2018) emphasized that classroom management strategies are essential for supporting inquiry-oriented science instruction because they encourage collaboration, structured investigation, and sustained student participation. From a social constructivist perspective, these conditions enable students to construct scientific understanding through interaction, exploration, and collaborative problem-solving, all of which represent fundamental components of science process skills.

An important contribution of this study lies in its focus on pre-service teachers. While previous research has predominantly examined classroom management among experienced teachers (Martin & Sass, 2010) in Fajriyah et al., (2026), relatively little attention has been given to teachers who are still developing their pedagogical competencies during teacher preparation. This distinction is important because classroom management competence is not automatically acquired through content knowledge but develops through professional preparation, teaching practice, and reflective experience (Ballantyne, 2024; Kolajo, 2025; Mundiri et al., 2025). The findings, therefore, suggest that strengthening classroom management competencies during teacher education may enhance pre-service teachers' confidence in facilitating inquiry-based science learning and in creating classroom environments that support students' scientific engagement.

Theoretically, this study extends the classroom management literature by positioning it as a pedagogical competency that supports inquiry-oriented science instruction rather than solely as a behavioral management strategy. Existing research has primarily associated classroom management with academic achievement, classroom climate, student motivation, and behavioral outcomes (Husna & Mundiri, 2023; Olivier et al., 2024). The present study broadens this perspective by demonstrating that effective

classroom management is also associated with pre-service teachers' perceptions of students' science process skills. Although these findings are perception-based, they provide empirical support for the proposition that instructional organization, positive classroom interaction, and effective learning management are important conditions for inquiry-based science education, particularly in Islamic primary schools.

The findings also have practical implications for teacher education. Since classroom management was perceived as an important factor in supporting science process skills, teacher education institutions should more explicitly integrate it into science pedagogy courses and teaching practicum experiences. Rather than emphasizing classroom discipline alone, professional preparation programs should equip pre-service teachers with strategies for managing collaborative investigations, facilitating scientific discussions, providing constructive feedback, organizing inquiry activities, and maintaining active student engagement throughout the learning process. Reflective teaching, peer observation, microteaching, and mentoring during school placements may further strengthen these competencies before teachers enter professional practice.

Despite these contributions, several limitations should be acknowledged. First, the study employed a cross-sectional design, which limits the conclusions regarding causal relationships between classroom management practices and students' perceived science process skills. Second, the sample size was relatively small and involved only pre-service teachers, which may limit the generalizability of the findings to broader educational contexts. Third, the dependent variable was measured through pre-service teachers' perceptions rather than direct assessments of students' science process skills. Consequently, the findings should be interpreted as reflecting teachers' perceptions of students' scientific learning rather than objective measures of students' competencies. Future studies should incorporate larger, more diverse samples, longitudinal or experimental research designs, and direct assessments of students' science process skills to provide stronger evidence of the effectiveness of classroom management in supporting inquiry-based science learning. In addition, future research should examine other pedagogical variables including teacher self-efficacy, pedagogical content knowledge, instructional quality, and student engagement that may jointly influence the development of science process skills.

The findings indicate that effective classroom management constitutes an important pedagogical competency that pre-service teachers perceive as supporting students' opportunities to engage in scientific inquiry. By highlighting the role of classroom management within science education in *Madrasah Ibtidaiyah*, this study contributes to a more comprehensive understanding of how teacher preparation can

strengthen inquiry-oriented learning and better equip future teachers to facilitate meaningful science education.

CONCLUSION

This study examined the relationship between pre-service teachers' classroom management practices and their perceptions of students' science process skills in Madrasah Ibtidaiyah. The findings indicate that more effective classroom management practices are positively associated with higher perceptions of students' opportunities to develop science process skills during inquiry-based science learning. These findings reinforce the view that classroom management functions not only as a strategy for maintaining an orderly classroom but also as a pedagogical competency that supports active learning, scientific inquiry, and student engagement. The study contributes to the literature by extending research on classroom management to the context of Islamic primary education and by highlighting the importance of pre-service teacher preparation in fostering learning environments that are conducive to the development of science process skills.

The findings have important implications for teacher education programs, suggesting that classroom management should be more explicitly integrated into science pedagogy, microteaching, and teaching practicum to better prepare future teachers for inquiry-oriented instruction better. Nevertheless, the findings should be interpreted in light of several limitations, including the relatively small sample size, the cross-sectional design, and the use of pre-service teachers' perceptions rather than direct assessments of students' science process skills. Future research should involve larger, more diverse samples, employ longitudinal or experimental designs, and incorporate objective measures of students' science process skills, while examining additional pedagogical factors, such as teacher self-efficacy, pedagogical content knowledge, and instructional quality, to provide a more comprehensive understanding of science learning in primary education.

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