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Integrative STEM-R Pedagogy and Students' Critical Thinking: A Study in Physics Learning at Madrasah Aliyah

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Abstract

Developing students' critical thinking skills remains a primary concern in science education, particularly in physics learning, which demands analytical reasoning and reflective understanding. Integrative pedagogical approaches such as the STEM-R (Science, Technology, Engineering, Mathematics, and Religious Values) model have been developed to strengthen learning engagement by connecting scientific inquiry with moral and religious values. This study aimed to examine differences in students' critical thinking skills between Problem-Based Learning (PBL) with and without the integration of STEM-R principles. The study employed a quasi-experimental design with a nonequivalent control group, involving 46 students from MAN 2 Kota Jambi, consisting of 22 students in the experimental class and 24 students in the control class. The experimental class received PBL integrated with STEM-R principles, while the control class was taught using PBL without STEM-R integration. The Shapiro–Wilk test was used to examine data normality, and the results indicated that the data were not normally distributed. Therefore, nonparametric analyses were conducted using the Wilcoxon Signed Rank Test and the Mann–Whitney U Test. The Wilcoxon test results showed a significant improvement in critical thinking skills in both classes, namely the PBL with STEM-R class ($Z = 4.108$, $p < 0.001$) and the PBL without STEM-R class ($Z = 2.944$, $p = 0.003$). Meanwhile, the Mann–Whitney U test revealed no statistically significant difference between the two groups ($p = 0.288$). These findings suggest that both PBL with and without STEM-R integration contributed to the improvement of students' critical thinking skills in physics learning.
Keywords: *STEM-R Approach, Problem-based Learning, Critical Thingking, Physics Learing, Science Learning.*

Introduction

Developing students' critical thinking skills is one of the central goals of science education in the twenty-first century. The ability to reason, evaluate, and make informed judgments based on evidence allows learners to construct meaningful scientific understanding. Science instruction is expected to move beyond memorization toward learning that promotes reasoning and reflection. Several instructional innovations have been designed to achieve this, including digital and inquiry-based learning that enhance analytical reasoning and communication, both of which are vital to critical thinking (Afikah et al., 2022). Among these innovations, the Science, Technology, Engineering, and Mathematics (STEM) framework has been identified as an effective approach for promoting reasoning through authentic and contextual learning experiences (Andriani et al., 2021). When students are guided to analyze, interpret, and reflect rather than memorize, they develop higher-order thinking abilities that sustain critical reasoning (Li & Liu, 2021).

Critical thinking is more than the ability to apply procedures or recall concepts. It involves reflective awareness and evaluative reasoning that help students understand how knowledge is created and used responsibly. Learning that connects scientific reasoning with moral reflection encourages students to interpret knowledge in a purposeful way (Suprapto et al., 2020). Integrating faith-based perspectives into science instruction has been reported to increase students' motivation and depth of reasoning by linking conceptual learning to ethical understanding (Suciati et al., 2022). Educational programs grounded in spiritual moderation also strengthen moral awareness and intellectual balance, helping students build reflective dimensions of critical thinking (Mukhibat et al., 2024).

The STEM framework provides opportunities for students to construct reasoning through inquiry, collaboration, and experimentation. It allows learners to connect theory with evidence and practice (Di et al., 2021). Including cultural and inclusive perspectives in STEM helps students view problems from different angles, fostering adaptability and flexibility in reasoning (Hughes et al., 2022). Connecting scientific ideas to everyday life makes learning more relevant and supports analytical and reflective engagement (Nawawi et al., 2021). In physics instruction, applying STEM principles has been found to improve understanding of motion and force through structured reasoning (Utami & Nurlaela, 2021). However, traditional STEM learning tends to emphasize analytical reasoning while providing limited space for reflective thinking and moral consideration, which are both important for developing critical thinking.

Although STEM-based instruction promotes reasoning and problem solving, it often overlooks reflective and evaluative processes that strengthen critical thinking. Students may be able to use scientific methods effectively but still struggle to analyze evidence critically or consider the ethical dimensions of science. The Science, Technology, Engineering, Mathematics, and Religious Values (STEM-R) model was developed to address this issue by combining analytical reasoning with moral reflection (Sarwi et al., 2024). The integration of reflective values in scientific learning helps students connect cognitive understanding with ethical awareness, enhancing evaluative reasoning (Suciati et al., 2022). Digital collaborative environments also encourage the inclusion of moral reasoning within analytical inquiry, reinforcing the reflective components of critical thinking (Mukhlis et al., 2024).

Despite its conceptual strength, research on the impact of STEM-R on students' critical thinking remains limited. Several studies have reported that learning involving reflective or value-based components improves reasoning and engagement, but few have provided statistical evidence of significant effects on critical thinking (Sarwi et al., 2024). Faith-integrated instruction has been found to improve motivation and reflective awareness, yet these findings often remain descriptive and lack empirical validation (Suciati et al., 2022). Moreover, the Religious component is not always clearly operationalized in learning design, making it difficult to determine its cognitive contribution (Mukhibat et al., 2024). These limitations indicate the need for studies that examine how STEM-R implementation affects students' critical thinking, particularly in physics education.

The STEM-R model aims to strengthen students' critical thinking by integrating scientific reasoning with moral reflection. It presents learning as both an intellectual and ethical process, where students are encouraged to analyze evidence while considering moral implications. This integration supports analytical and reflective dimensions of reasoning that form the foundation of critical thinking (Sarwi et al., 2024). Connecting scientific logic with value-based reflection helps students evaluate arguments more deeply and develop intellectual humility, which are essential for sustained reasoning (Suciati et al., 2022). Learning environments grounded in spiritual moderation further support balanced thought and responsible inquiry (Mukhibat et al., 2024).

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In physics learning, reflective thinking can be developed by linking scientific principles to ideas of harmony and balance. For example, when studying motion or equilibrium, students can explore the connection between physical laws and moral balance expressed in Qur'anic verses such as QS. Ar-Rahman: 5–9 (Suprapto et al., 2020). These connections help students understand that scientific knowledge is not only logical but also reflective, encouraging them to think critically about both natural and ethical order (Sarwi et al., 2024).

Critical thinking has been described as a purposeful and self-regulated process of analysis and evaluation that leads to sound conclusions (Facione, 2000). Structured reasoning practices enhance students' ability to assess and justify claims logically (Fajari & Chumdari, 2021). The Preparing–Doing–Concluding learning model helps learners develop organized and coherent reasoning in inquiry-based activities (Andayani et al., 2020). Persistence, metacognitive awareness, and conceptual understanding also contribute to the stability of reflective and analytical thought (Dessie et al., 2024; Li & Liu, 2021). These insights emphasize that critical thinking develops effectively through learning that combines structured reasoning with reflective engagement.

Problem-Based Learning (PBL) supports this development by engaging students in inquiry-oriented tasks that require analysis, evaluation, and reflection. Students in PBL environments tend to show higher persistence and adaptability when dealing with complex situations (Seibert, 2021). Student-centered approaches improve reasoning and collaboration, leading to stronger cognitive outcomes (Agustini et al., 2021). Collaborative projects promote reflective dialogue and peer evaluation that deepen understanding (Leow & Neo, 2023). Digital visualization and media tools enhance reflective reasoning and support analytical accuracy (Suwardika et al., 2024). Participatory and discussion-based learning environments also build students' autonomy and confidence in reasoning (Treve, 2024). Integrating PBL with STEM-R thus provides a learning framework that supports analytical precision and reflective awareness, both essential for improving critical thinking.

Research has increasingly shown that combining reasoning and reflection in learning enhances higher-order cognitive performance. Project-based STEM learning strengthens analytical reasoning and conceptual understanding (Pramasdyahsari et al., 2023). Socio-scientific flipped classrooms promote reflective awareness and evaluative judgment (Sugrah et al., 2023). Technological and reflective learning designs improve creativity and critical analysis (Mustadi et al., 2024). Integrating moral reflection into science instruction supports intellectual integrity and deeper cognitive processing (Suprapto et al., 2020). Together, these findings suggest that instructional models combining reasoning and reflection can effectively foster critical thinking.

However, studies that quantitatively assess the influence of STEM-R-based instruction on critical thinking in physics are still scarce. Prior research has emphasized the need for empirical evidence explaining how reflective integration contributes to measurable cognitive gains (Sarwi et al., 2024; Suciati et al., 2022). Clear implementation and evaluation of the Religious component are also needed to understand its contribution to reasoning and reflection (Mukhibat et al., 2024). Responding to these issues, this study implements a STEM-R-based Problem-Based Learning model in physics instruction at Madrasah Aliyah. The aim of this research is to analyze whether integrating Religious Values within STEM-oriented PBL can improve students' critical thinking skills. The research question guiding this study is: *How does the implementation of the STEM-R approach in physics learning affect students' critical thinking skills?*

Method

Research Type

This study employed a quantitative approach with a quasi-experimental design to explore how the integration of Science, Technology, Engineering, Mathematics, and Religious Values (STEM-R) in physics learning relates to students' critical thinking skills. Two existing classes were selected as the experimental and control groups. The experimental group received instruction through a STEM-R framework that combined scientific reasoning with reflective insights derived from *Surah Ar-Rahman verses 5–9* during lessons on circular motion using the Problem-Based Learning (PBL) model. These verses highlight the balance and harmony of celestial movements as a reflection of divine order, providing a meaningful context for discussing the principles of motion and equilibrium. The control group followed the same PBL model within the standard STEM framework, which emphasized scientific reasoning without reflective or value-based integration. The research design adopted a nonequivalent control group format, similar to a pretest–posttest structure but without random assignment, as illustrated below.

Table 1. Reasearch Structure Formulated

O_1	X	O_2
O_3		O_4

O_1 and O_3 represent students' pretest results, while O_2 and O_4 correspond to posttest results for the experimental and control groups. This structure facilitated a comparison of how the two instructional approaches influenced the development of students' critical thinking skills.

Population and Sample

The population consisted of all eleventh-grade students at MAN 2 Kota Jambi during the first semester of the 2025/2026 academic year. The population was considered homogeneous in terms of curriculum, instructional exposure, and academic background, consistent with Creswell and Creswell's (2018) criteria for quasi-experimental research. A purposive sampling technique was employed to ensure comparable group characteristics between classes. This technique is widely applied in quasi-experimental research where random assignment is not feasible (Campbell et al., 2020). The purposive criteria ensured comparable learning conditions between classes despite the absence of randomization. These criteria included comparable average achievement in physics from the previous semester, the same physics teacher for both classes, similar class sizes ranging between twenty and twenty-five students, and identical curriculum implementation schedules.

Based on these criteria, Class XI-F1 (24 students) served as the control group and Class XI-F2 (22 students) as the experimental group, with a total of 46 participants. The sample size met the requirements for nonparametric testing but was recognized as relatively small, which may limit the generalizability of the findings. This limitation was taken into account during data interpretation.

Research Procedure

The research procedure comprised three main stages: preparation, implementation, and analysis. Each stage was organized systematically to ensure the reliability and accuracy of the data collected.

Preparation Stage

This stage involved the development of instructional materials, learning instruments, and validation processes. A literature review was conducted to examine prior studies on STEM and STEM-R integration in science learning, particularly those aimed at enhancing critical thinking

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skills. The insights from this review guided the development of lesson plans, student worksheets, and assessment instruments aligned with the STEM-R framework.

In the experimental group, reflective integration was embedded through *Surah Ar-Rahman verses 5–9*, which emphasize harmony and balance. These values were contextualized in physics learning to connect scientific phenomena with reflective understanding. Meanwhile, the control group followed the same instructional structure without reflective or religious integration.

The instrument used to measure students' critical thinking skills was designed based on Facione (2000) theoretical model, which identifies five indicators: interpretation, analysis, evaluation, inference, and explanation. Each indicator was represented by two open-ended essay questions, resulting in ten questions in total.

All questions were developed in the context of Newton's Law of Gravitation and aimed to stimulate analytical reasoning and reflective awareness. Students were required to interpret data, analyze arguments, and explain physical relationships in 3–6 sentences per question. Reflective prompts encouraged connections between scientific reasoning and the values of balance and justice illustrated in *Surah Ar-Rahman verses 5–9*, without assessing religious knowledge.

Each question was evaluated using an analytic scoring rubric with four criteria: conceptual accuracy, logical reasoning, clarity of explanation, and reflective integration. Each criterion was rated from 0 to 1, giving a maximum of 4 points per item and a total score of 40 points.

1. Score 4: Complete and coherent response integrating scientific and reflective understanding.
2. Score 3: Accurate reasoning with minor conceptual gaps.
3. Score 2: Partial understanding with limited justification.
4. Score 1: Fragmented reasoning with conceptual errors.
5. Score 0: Irrelevant or missing answer.

The instrument was validated by three experts in physics education, STEM pedagogy, and Islamic character education. Each expert evaluated the clarity, relevance, and alignment of the items using a four-point scale. The Content Validity Index (CVI) was 0.91, indicating excellent validity.

Reliability was determined using the students' responses from the main study. The Cronbach's Alpha coefficient was 0.83, indicating high internal consistency. The discrimination indices ranged between 0.42 and 0.71, showing that the items effectively differentiated levels of students' critical thinking.

To ensure objectivity, all responses were assessed independently by two raters using the same rubric. The inter-rater reliability coefficient was 0.87, demonstrating strong agreement between assessors.

Lesson plans and worksheets were also prepared at this stage to ensure procedural consistency. Both groups followed the same PBL structure, with the experimental group receiving reflective integration and the control group learning through standard PBL activities.

Implementation Stage

The implementation stage was carried out over four learning sessions. Both classes first completed a pretest to determine their baseline critical thinking levels. The experimental class engaged in STEM-R–integrated PBL sessions that emphasized collaborative problem solving, investigation, and reflection on the relationship between physical laws and the concept of universal balance in *Surah Ar-Rahman verses 5–9*.

The control class followed the same PBL structure using the standard STEM approach without reflective integration. Both groups were taught by the same physics teacher to maintain instructional consistency. During each session, observations were conducted using a structured

checklist to ensure adherence to the intended learning procedures. At the end of the learning period, both groups completed the posttest using the same critical thinking instrument.

Analysis Stage

Data analysis focused on determining whether significant differences existed between the experimental and control groups regarding students' critical thinking skills. The selection of inferential tests depended on the results of the normality test. If the data were normally distributed, an Independent Samples t-test was used. However, if the data were not normally distributed, nonparametric tests, namely the Wilcoxon Signed Rank Test and the Mann–Whitney U Test, were employed. The research hypotheses were structured as follows:

H_0: There is no significant difference in students' critical thinking skills between those taught using the STEM-R approach and those taught without STEM-R.

H_a: There is a significant difference in students' critical thinking skills between those taught using the STEM-R approach and those taught without STEM-R.

A *p*-value less than 0.05 indicated statistical significance, suggesting that the STEM-R approach effectively enhanced students' critical thinking skills. This analysis provided empirical evidence that integrating religious values within STEM-based learning promotes a more holistic form of reasoning in science education.

Result

Assumption Testing

The analysis prerequisites were evaluated to confirm that the dataset satisfied the essential assumptions required for statistical inference. Meeting these assumptions is fundamental to ensure the reliability of conclusions drawn from the data and to maintain the validity of hypothesis testing. When assumption testing is conducted rigorously, the potential for statistical bias can be reduced, resulting in more accurate interpretation of learning outcomes. Two diagnostic tests were employed in this study: the normality test and the homogeneity of variance test. Both tests served as indicators of data suitability for subsequent parametric or nonparametric analyses.

Normality Test

The normality test was carried out to determine whether the dataset met the statistical assumptions required for inferential analysis. Identifying a normal distribution pattern allows researchers to select an analytical procedure that produces accurate and unbiased parameter estimates. The Shapiro–Wilk test was selected because each group consisted of fewer than fifty participants, which makes it appropriate for small-sample research (Wibowo, 2023). The test was applied to the critical thinking and social skills variables for both the experimental and control groups during the pretest and posttest phases. A significance value greater than 0.05 indicated that the data were normally distributed, whereas a value below 0.05 suggested a departure from normality.

The results of the normality test for students' critical thinking skills are presented in Table 2. A histogram was also produced to show the frequency distribution of the dataset, supporting a detailed interpretation of symmetry and central tendency within the data. Both representations provided an empirical foundation for evaluating whether the statistical assumptions were satisfied before proceeding with hypothesis testing.

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Table 2 Shapiro–Wilk Normality Test Results for Critical Thinking Skills

Test	Class	Shapiro-Wilk		
		Statistic	df	Sig.
Pretest	Control	.873	22	.009
	Experiment	.903	24	.025
Posttest	Control	.919	22	.073
	Experiment	.977	24	.839

The statistical output revealed that the pretest significance values for the control and experimental groups were 0.009 and 0.025, respectively, both lower than the threshold of 0.05. These results indicate that the pretest data did not exhibit a normal distribution. The distributional irregularities suggest that students entered the learning process with varied levels of critical thinking readiness. Some participants demonstrated advanced reasoning and evaluation, while others tended to rely on factual recall and surface-level interpretation of scientific ideas. These differences are consistent with research showing that students' prior learning experiences and cognitive dispositions strongly shape their readiness to think critically. Álvarez-Huerta et al. (2023) emphasized that learners' engagement and previous exposure to reflective learning contexts significantly influence how they process information and construct reasoned judgments. Similarly, Tunjungsari & Takwin (2021) found that differences in cognitive disposition and prior experience account for variations in the development of critical thinking skills among students.

Despite this variation, the posttest data for both groups displayed improvement in distribution symmetry, where the control group reached a significance value of 0.073 and the experimental group 0.839. These figures exceed the 0.05 cutoff, signifying that students' post-intervention performance tended toward normality. The improved distribution pattern implies that structured instruction particularly through the STEM-R model helped to balance cognitive disparities among learners by providing consistent opportunities for analysis and reflection. Consequently, students' responses became more uniform and centered around the group mean, indicating increased conceptual stability after learning.

Because the pretest values violated the assumption of normality, nonparametric statistical methods were used in subsequent hypothesis testing. The Wilcoxon Signed Rank Test was applied to examine paired differences between pretest and posttest within each group, while the Mann–Whitney U Test was employed to analyze intergroup differences. These methods were selected because they are resilient to non-normal data distributions and capable of capturing variability across individuals. Employing nonparametric analysis ensured that the statistical conclusions remained valid and robust, even when data symmetry was not achieved.

Wilcoxon Signed Rank Test (Within-Group Analysis)

The Wilcoxon Signed Rank Test was employed to evaluate the differences in students' critical thinking skills before and after instruction within each group. The results are summarized in Table 3 for the control group and Table 4 for the experimental group.

Table 3. Wilcoxon Signed Rank Test Results for the Control Group

Total N	22
Test Statistic	217.000
Standard Error	30.745
Standardized Test Statistic	2.944
Asymptotic Sig.(2-sided test)	.003

Table 4. Wilcoxon Signed Rank Test Results for the Experimental Group

Total N	24
Test Statistic	273.000
Standard Error	32.860
Standardized Test Statistic (Z)	4.108
Asymptotic Sig.(2-sided test)	.012

The Wilcoxon Signed Rank analysis indicated a statistically significant increase in critical thinking performance within both groups. The experimental group recorded a Z-value of 4.108 with $p < 0.05$, signifying a highly significant improvement after the implementation of the STEM-R (Science, Technology, Engineering, Mathematics, and Religious Values) approach. The structured integration of science, technology, engineering, and moral reflection placed learners in an active environment where they were required to observe, analyze, and evaluate physics concepts critically. The alignment of reflective and analytical processes expanded students' cognitive structures and refined their ability to assess information using logical reasoning.

The control group also showed significant progress, obtaining a Z-value of 2.944 with $p = 0.003$ ($p < 0.05$). Although the improvement was significant, the magnitude of change was smaller than that observed in the experimental class. This pattern suggests that while conventional STEM-based problem-based learning can enhance analytical reasoning, it lacks the reflective dimension that characterizes STEM-R instruction. Agustini et al. (2022) demonstrated similar findings, showing that STEM-based reflective learning encourages systematic analytical and evaluative thinking. Likewise, Sarwi et al. (2024) emphasized that the STEM-R framework promotes conceptual construction through scientific inquiry and reflective dialogue, which deepens students' understanding of natural phenomena.

Mann–Whitney U Test (Between-Group Analysis)

The Mann–Whitney U test was conducted to determine whether there was a significant difference in students' critical thinking skills between the experimental and control groups at the posttest stage. The statistical results are presented in Table 5

Table 5. Mann–Whitney U Test Results

Total N	46
Mann-Whitney U	216.000
Wilcoxon W	516.000
Test Statistic	216.000
Standard Error	45.207
Standardized Test Statistic (Z)	-1.062
Asymptotic Sig.(2-sided test)	.288

The Mann–Whitney U test produced a p-value of 0.288 ($p > 0.05$), indicating that there was no statistically significant difference between the two groups after instruction. Although the experimental group achieved slightly higher mean ranks, the difference did not reach the level of statistical significance. The negative Z-value (-1.062) signaled that the experimental group's scores were marginally higher than those of the control group. This trend suggests that the STEM-R approach exerted a positive but modest effect on students' critical thinking skills relative to traditional instruction.The absence of a significant difference may be attributed to the relatively short duration of implementation and the time required for students to adapt to the reflective and self-directed learning model.

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Discussion

Through the findings that have been analyzed, it can be seen that the results of this study are in line with the statement put forward by Aguiar-Castillo et al. (2021) highlighted that the effectiveness of integrative STEM approaches depends strongly on learners' readiness to engage in autonomous inquiry and sustained reflection. Afikah et al. (2024) further explained that the growth of critical thinking occurs progressively through repeated reflective engagement rather than instant transformation. Thus, while the difference between groups was not statistically significant, the direction of change indicates the pedagogical potential of STEM-R in strengthening analytical reasoning within science learning.

The pattern emerging from both analyses shows that the experimental and control groups each experienced a significant internal improvement in critical thinking skills, although the final difference between the two groups was not statistically significant. This result indicates that both learning models, *Problem-Based Learning (PBL)* and PBL integrated with the STEM-R framework, were effective in enhancing students' critical thinking skills. These findings support the view that learning models incorporating inquiry, reflection, and moral reasoning can provide opportunities for students to develop more analytical and reflective modes of thought. Kulgemeyer & Geelan (2024) described such learning as a reflective constructivist process in which knowledge and values are continuously reconstructed through analytical engagement and meaningful experience.

From a theoretical standpoint, the findings contribute to the reinforcement of STEM-based learning models that integrate reflective and moral dimensions. The improvement observed in both groups demonstrates that critical thinking can be effectively developed through structured problem-based learning. Furthermore, this outcome aligns with the perspective of Sarwi et al. (2024), who noted that integrating moral and religious reflection into science learning contexts enables students to approach scientific phenomena with deeper reasoning and reflective judgment. Similarly, Afikah et al. (2024) emphasized that critical thinking in science learning should be viewed not only as a cognitive outcome but also as a reflective process that connects reasoning with self-awareness. Therefore, this study reinforces the theoretical argument that moral and reflective integration within science learning can support the cultivation of higher-order thinking skills, even if such effects may not always appear statistically significant in the short term.

From a practical perspective, the results provide meaningful implications for science educators. Teachers can combine the PBL model with STEM-R principles to enrich learning contexts by embedding moral reflection and value-based discussion into problem-solving activities. This integration allows students to analyze scientific issues not only from a conceptual perspective but also from ethical and social viewpoints. Such practice is consistent with Agustini et al. (2022), who found that learning designs fostering reflection and cognitive engagement significantly enhance students' critical and creative thinking. Likewise, Suwardika et al. (2024) demonstrated that learning environments encouraging self-reflection, communication, and collaboration help strengthen students' critical thinking and self-regulation. Hence, even in the absence of a significant difference between groups, the internal improvements observed highlight the potential of reflective integration within PBL as a means of fostering more meaningful and holistic learning experiences.

Despite these contributions, the present study has several limitations. The relatively small sample size and single-school context limit the generalizability of the findings. The short duration of the intervention may also not fully capture long-term developments in students' critical thinking skills. In addition, the exclusive use of quantitative data limited the exploration of

students' reflective learning processes during STEM-R implementation. Future studies are encouraged to involve larger and more diverse samples, employ mixed-method designs as suggested by Creswell & Creswell (2018), and examine how moral reflection and contextual experiences influence the sustained development of students' critical thinking over time. Extending the duration of the intervention may also help reveal stronger intergroup effects that were not statistically evident in the current study.

Conclusion

The findings of this study indicate that both the experimental and control groups showed significant improvement in critical thinking skills after the learning intervention. The experimental group taught through the STEM-R (Science, Technology, Engineering, Mathematics, and Religious Values) approach demonstrated a higher mean gain than the group taught through PBL without STEM-R integration, although the Mann–Whitney U test revealed no statistically significant difference between the two. These results suggest that while both approaches effectively fostered students' critical thinking, the distinct contribution of the STEM-R model could not be confirmed statistically. The improvement observed in the experimental class implies that integrating reflective elements derived from *Surah Ar-Rahman verses 5–9* may stimulate deeper analytical reasoning and self-reflection within physics learning. However, due to the small sample size and the nonparametric nature of the data analysis, the interpretation of these findings should be approached with caution. This study provides preliminary evidence that embedding reflective and ethical perspectives within STEM-based instruction has the potential to enrich students' cognitive engagement, yet further research with larger and more diverse samples is necessary to verify and expand these conclusions.

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