

Integrating Religious Moderation Values into Islamic STEM Education: Its Impact on Students' Critical Thinking Skills and Scientific Literacy

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ARTICLE INFO

Article history

Received May 12, 2026

Revised June 29, 2026

Accepted July 18, 2026

Keywords:

Islamic STEM Education; religious moderation; critical thinking skills; scientific literacy; twenty-first-century learning.

ABSTRACT

Although STEM education has been widely recognized as an effective approach for developing twenty-first-century competencies, its implementation in Islamic educational institutions has largely emphasized cognitive and technical skills while paying limited attention to the integration of religious moderation values. Likewise, studies on religious moderation have predominantly focused on Islamic Religious Education rather than being embedded within interdisciplinary science learning. This study therefore aimed to examine the effect of integrating religious moderation values into Islamic STEM Education on students' critical thinking skills and scientific literacy. A quantitative approach was employed using a Pretest–Posttest Control Group Design. The research sample consisted of 64 students who were assigned to an experimental group and a control group. The experimental group received Islamic STEM instruction integrating the values of religious moderation, whereas the control group received conventional instruction. Data were collected through critical thinking tests, scientific literacy tests, observation sheets, and documentation, and were analyzed using descriptive statistics, normality and homogeneity tests, and Multivariate Analysis of Variance (MANOVA). The findings revealed that the implementation of Islamic STEM Education integrated with religious moderation values had a statistically significant effect on students' critical thinking skills and scientific literacy simultaneously ($p < 0.05$). Students in the experimental group achieved substantially higher improvements in both critical thinking and scientific literacy than those in the control group. Classroom observations further indicated that embedding the principles of tolerance, balance, justice, and respect for diversity fostered an inclusive and collaborative learning environment that encouraged evidence-based reasoning and scientific inquiry. Conceptually, the findings demonstrate that integrating religious moderation values strengthens the effectiveness of STEM learning by connecting scientific reasoning with ethical, inclusive, and socially responsible perspectives. This integration contributes to a more holistic instructional model that promotes not only critical thinking and scientific literacy but also the development of twenty-first-century competencies and students' moderate religious character. Therefore, Islamic STEM Education integrated with religious moderation values offers an innovative framework for improving both the quality of science education and character education in Islamic schools.

1. INTRODUCTION

The twenty-first century is characterized by rapid advances in science and technology and the increasing complexity of global challenges, requiring students to develop a broad range of competencies relevant to contemporary societal demands (Kennedy & Sundberg, 2025; OECD,

2023; Trilling & Fadel, 2009; Tsiaousi & Chiou, 2024). Among these, critical thinking and scientific literacy are consistently recognized as fundamental competencies that enable young people to actively participate in a knowledge-based society. Critical thinking equips students with the ability to analyze information rationally, evaluate competing arguments, and make evidence-based decisions. Scientific literacy, meanwhile, enables students to understand scientific concepts, apply scientific inquiry to solve problems, and relate scientific knowledge to everyday contexts. The Organisation for Economic Co-operation and Development (OECD) identifies both competencies as key indicators of students' preparedness to address global challenges through the Programme for International Student Assessment (PISA) (Biondi & Buttazzo, 2017; OECD, 2023). Despite their importance, international assessment results indicate that Indonesian students' critical thinking skills and scientific literacy remain a significant concern. PISA findings reveal that Indonesian students continue to perform below the OECD average in scientific literacy. This condition suggests that many students still experience difficulties in interpreting scientific data, evaluating evidence, and applying scientific concepts to solve real-world problems. Moreover, classroom instruction in many schools remains predominantly content-oriented and emphasizes rote memorization, providing limited opportunities for scientific inquiry, argumentation, and critical reflection (OECD, 2023). These challenges highlight the urgent need for innovative instructional approaches that not only improve cognitive competencies but also foster values and character that are essential in multicultural societies. One educational approach that has attracted considerable attention in international educational research is Science, Technology, Engineering, and Mathematics (STEM) education (Hamdanah, Crismono, & Yakoh, 2025; Ingram, 2024; Kurniawan, 2021). STEM education emphasizes interdisciplinary integration through authentic problem-solving, engineering design, collaboration, and the application of scientific concepts in real-life situations. Numerous studies have demonstrated that STEM education contributes positively to the development of critical thinking, creativity, problem-solving skills, and scientific literacy. Nevertheless, STEM implementation in many educational settings primarily focuses on developing technical competencies while paying comparatively less attention to integrating ethical, moral, and spiritual dimensions that are essential for students' character development, particularly within Islamic educational institutions (Konak, Kulturel-Konak, Schneider, & Mehta, 2023; Taranto et al., 2021).

Within the context of Islamic education, the integration of scientific knowledge and Islamic values represents an educational paradigm that views science not merely as a product of human rationality but also as a means of recognizing God's greatness and promoting public welfare (maslahah). This perspective has led to the emergence of Islamic STEM Education, which seeks to integrate science and technology learning with Islamic values, including responsibility, honesty, social responsibility, and awareness of the harmonious relationship between humans, nature, and the Creator. Such integration is expected to produce graduates who excel academically while demonstrating strong moral integrity and spiritual maturity in responding to the challenges of modern society (Asiyah, 2024; Crismono, Faisol, Supriatno, & Ilyas, 2025; Putra, Deffinika, & Islam, 2021). Meanwhile, the increasing prevalence of intolerance, social polarization, and the spread of hate speech through digital platforms underscores the importance of strengthening religious moderation within education. Religious moderation refers to perspectives, attitudes, and religious practices that emphasize balance, justice, tolerance, respect for diversity, and the rejection of extremism. In Indonesia's pluralistic society, religious moderation has become a strategic priority in human resource development because it contributes to social cohesion and strengthens democratic life. The Ministry of Religious Affairs of the Republic of Indonesia has emphasized that education serves as a primary instrument for instilling the values of religious moderation from an early age, enabling students to coexist peacefully within diverse communities (Marfu'ah, Crismono, & Hudi, 2024; Pratidhina, 2020; Zulkarnaen, 2024). Although STEM education has been extensively investigated,

previous studies have primarily focused on its effectiveness in improving cognitive and twenty-first-century skills. Kelley & Knowles (2016) proposed an integrated STEM framework that enhances interdisciplinary learning and problem-solving abilities, while Margot & Kettler (2019) concluded that STEM instruction positively influences critical thinking, creativity, and scientific literacy. More recent studies by Taranto et al. (2021) and Uğurenver (2025) further confirmed that STEM-based learning significantly improves students' scientific literacy and higher-order thinking skills. Nevertheless, these studies mainly emphasize cognitive achievement and technical competencies, with limited attention to ethical, moral, or religious dimensions within STEM learning. On the other hand, research on religious moderation has largely been conducted within the context of Islamic Religious Education (PAI). Studies by Faozan (2020), Marfu'ah et al. (2024), and Zulkarnaen (2024) demonstrated that religious moderation education promotes tolerance, justice, balance, anti-extremism, and social harmony among students. However, these studies generally treat religious moderation as an independent subject of character education rather than integrating it into science and technology learning.

Meanwhile, studies concerning Islamic education have emphasized the integration of Islamic values into science instruction. Asiyah (2024) and Rahmawati et al. (2025) argued that incorporating Islamic values into science learning strengthens students' ethical awareness and responsibility in applying scientific knowledge. Nevertheless, these studies focus primarily on the integration of Islamic values without explicitly incorporating the principles of religious moderation or examining their influence on critical thinking and scientific literacy simultaneously. Taken together, previous studies indicate three separate research streams: STEM education focusing on cognitive competencies, religious moderation emphasizing character development, and Islamic education integrating religious values into science learning. However, no previous study has comprehensively integrated these three domains into a single Islamic STEM instructional model based on religious moderation while simultaneously examining its impact on students' critical thinking skills and scientific literacy. This gap provides the rationale for the present study. From a theoretical perspective, integrating religious moderation values into Islamic STEM Education has the potential to make a substantial contribution to the development of twenty-first-century competencies. Learning activities that encourage students to engage in discussion, consider multiple perspectives, evaluate scientific evidence objectively, and make decisions based on the principle of *maslahah* are likely to foster critical thinking while cultivating moderate religious attitudes. Furthermore, linking scientific concepts with inclusive Islamic values can enhance the relevance of learning, strengthen scientific literacy, and develop students who are capable of applying scientific knowledge responsibly for the benefit of society. In the present study, religious moderation is conceptualized as a multidimensional construct encompassing tolerance (*tasāmuḥ*), justice (*i'tidāl*), balance (*tawāzun*), respect for diversity, and rejection of extremism, as promoted by the Indonesian Ministry of Religious Affairs. Within STEM learning, these dimensions are operationalized through collaborative inquiry, evidence-based discussion, appreciation of diverse viewpoints, ethical decision-making, and responsible application of scientific knowledge to societal problems. Accordingly, religious moderation is not treated merely as religious content but as a pedagogical principle that supports critical dialogue, inclusive collaboration, and reflective scientific reasoning throughout the learning process. Based on these considerations, this study investigates the effect of integrating religious moderation values into Islamic STEM Education on students' critical thinking skills and scientific literacy. Beyond examining instructional effectiveness, this study contributes theoretically by proposing an Islamic STEM learning model grounded in religious moderation principles that integrates scientific inquiry with ethical, inclusive, and value-oriented learning. The proposed model extends previous STEM and Islamic education research by demonstrating that religious moderation functions not only as a character education framework but also as a pedagogical approach that

strengthens the development of critical thinking and scientific literacy simultaneously. The findings are expected to provide empirical evidence for curriculum development in Islamic educational institutions and serve as a practical reference for educators seeking to integrate twenty-first-century competencies with religious character education.

2. METHODS

This study employed a quantitative approach using a quasi-experimental research design to examine the effect of integrating religious moderation values into Islamic STEM Education on students' critical thinking skills and scientific literacy. A quasi-experimental design was selected because random assignment of participants was not feasible, while still allowing the researcher to administer an intervention and evaluate its effects on the variables under investigation (Creswell, 2019; Crismono, 2024). The study adopted a Pretest–Posttest Control Group Design, involving an experimental group and a control group, both of which completed pretests and posttests to assess changes following the intervention (Sugiyono, 2023).

Table 1. Pretest–Posttest Control Group Design

Group	Pretest	Pretest	Pretest
Experimental	O ₁	X	O ₂
Control	O ₃	–	O ₄

Note.

O₁ = Pretest of the experimental group;

O₂ = Posttest of the experimental group;

O₃ = Pretest of the control group;

O₄ = Posttest of the control group;

X = Islamic STEM Education integrating religious moderation values.

The study was conducted at MTs Nurul Huda Jember, an Islamic junior secondary school located in Jember Regency, East Java, Indonesia. The school was purposively selected because it has implemented an integrated Islamic curriculum that combines science education with Islamic character education and actively promotes student-centered learning. Furthermore, the school had not previously implemented an Islamic STEM instructional model integrated with religious moderation values, making it an appropriate setting for evaluating the effectiveness of the proposed instructional approach. The study population comprised all eighth-grade students enrolled during the 2025/2026 academic year. Two intact classes with relatively similar academic achievement were selected through cluster random sampling, resulting in one experimental class (32 students) and one control class (32 students). The sample was selected using cluster random sampling, in which intact classes with relatively homogeneous characteristics were randomly assigned as research groups (Crismono, 2025). The sample consisted of two classes: one class served as the experimental group, receiving Islamic STEM Education integrated with religious moderation values, while the other served as the control group and received conventional instruction. The instructional intervention was implemented over eight consecutive weeks, consisting of 16 classroom meetings, with each meeting lasting 90 minutes (2 × 45-minute periods). Both groups studied identical science topics according to the national curriculum. The experimental group received Islamic STEM instruction integrated with religious moderation values, whereas the control group received conventional teacher-centered instruction using the same learning objectives and assessment standards.

The independent variable was the integration of religious moderation values into Islamic STEM Education, whereas the dependent variables were students' critical thinking skills and scientific literacy. Religious moderation values were operationalized through the integration of tolerance (*tasāmuḥ*), justice (*i'tidāl*), balance (*tawāzun*), respect for diversity, and anti-extremism into STEM learning activities. Critical thinking skills were measured using Facione (2011) framework, which includes the dimensions of interpretation, analysis, evaluation, inference, explanation, and self-regulation. Scientific literacy was assessed based on the OECD PISA framework, encompassing the abilities to explain scientific phenomena, evaluate and design scientific investigations, and interpret scientific data and evidence (OECD, 2023). Data were collected using achievement tests, classroom observation sheets, and documentation. Students' critical thinking skills were measured using 20 essay items developed according to Facione (2011) framework, covering six indicators: interpretation, analysis, evaluation, inference, explanation, and self-regulation. Scientific literacy was assessed using 25 multiple-choice items adapted from the PISA OECD (2023) framework, measuring three dimensions: explaining scientific phenomena, evaluating and designing scientific investigations, and interpreting scientific data and evidence.

Classroom observations consisted of 20 indicators evaluating the fidelity of implementing Islamic STEM learning integrated with religious moderation values, including collaborative learning, scientific inquiry, respect for diverse opinions, evidence-based discussion, and the integration of Islamic values throughout the instructional process. The tests were administered before and after the intervention to measure students' critical thinking skills and scientific literacy. Observation sheets were used to evaluate the implementation fidelity of Islamic STEM Education integrated with religious moderation values. Documentation was employed to obtain supporting information regarding school conditions, student characteristics, and instructional materials used throughout the study. Prior to implementation, all research instruments underwent content and empirical validation. Content validity was evaluated by three experts in STEM education, Islamic education, and educational assessment, yielding an average Aiken's V coefficient of 0.91, indicating excellent content validity. Empirical validity testing involved a pilot study with 30 students outside the research sample. Pearson Product-Moment analysis showed that all item correlation coefficients ranged from 0.47 to 0.86, exceeding the critical value ($r = 0.361$), indicating that all items were valid. Instrument reliability was assessed using Cronbach's alpha coefficient. The critical thinking test obtained an alpha coefficient of 0.891, the scientific literacy test 0.876, and the classroom observation instrument 0.904, indicating high internal consistency (Crismono, 2023). Data analysis consisted of both descriptive and inferential statistical procedures. Descriptive statistics were used to summarize the mean, standard deviation, minimum score, and maximum score for each research variable. Before hypothesis testing, the data were examined for normality and homogeneity to satisfy the assumptions of parametric analysis. The hypotheses were tested using Multivariate Analysis of Variance (MANOVA) because the study involved one independent variable and two dependent variables critical thinking skills and scientific literacy. According to Crismono (2023), MANOVA is appropriate for examining the simultaneous effects of a treatment on multiple dependent variables. All statistical analyses were conducted at a significance level of 0.05 to determine the effects of integrating religious moderation values into Islamic STEM Education on students' critical thinking skills and scientific literacy, both simultaneously and separately.

3. RESULTS AND DISCUSSION

Descriptive Statistics

This study involved 64 eighth-grade students from an Islamic junior secondary school (*Madrasah Tsanawiyah*), consisting of 32 students in the experimental group and 32 students in the

control group. The experimental group received Islamic STEM Education integrated with religious moderation values, whereas the control group received conventional instruction. Descriptive statistical analysis was conducted to provide an overview of students' critical thinking skills and scientific literacy before and after the intervention. The analysis revealed that the mean pretest scores of both groups were relatively comparable, indicating that the students had equivalent baseline abilities prior to the implementation of the instructional treatment.

Table 1. Descriptive Statistics of Students' Critical Thinking Skills

Group	N	Pretest Mean	SD	Posttest Mean	SD
Experimental	32	61.28	7.41	84.53	6.28
Control	32	60.94	7.36	72.19	6.91

As shown in Table 1, the mean critical thinking score of students in the experimental group increased from 61.28 on the pretest to 84.53 on the posttest. In comparison, the control group demonstrated a smaller improvement, with the mean score increasing from 60.94 to 72.19. These findings indicate that the improvement in critical thinking skills was substantially greater among students who participated in Islamic STEM Education integrated with religious moderation values than among those who received conventional instruction.

Table 2. Descriptive Statistics of Students' Scientific Literacy

Group	N	Pretest Mean	SD	Posttest Mean	SD
Experimental	32	58.72	6.84	82.34	5.97
Control	32	59.13	6.79	70.47	6.33

As shown in Table 2, the mean scientific literacy score of the experimental group increased from 58.72 on the pretest to 82.34 on the posttest. In comparison, the control group demonstrated a smaller improvement, with the mean score increasing from 59.13 to 70.47. The greater increase observed in the experimental group indicates that students who participated in Islamic STEM Education integrated with religious moderation values achieved more substantial gains in scientific literacy than those who received conventional instruction.

Assumption Testing

Normality Test

A normality test was conducted using the Shapiro–Wilk test to determine whether the data were normally distributed. The results indicated that all pretest and posttest data yielded significance values greater than 0.05, suggesting that the data met the assumption of normality.

Table 3. Results of the Shapiro–Wilk Normality Test

Variable	Group	p-value
Critical Thinking (Pretest)	Experimental	0.541
Critical Thinking (Posttest)	Experimental	0.427
Critical Thinking (Pretest)	Control	0.618
Critical Thinking (Posttest)	Control	0.451
Scientific Literacy (Pretest)	Experimental	0.513
Scientific Literacy (Posttest)	Experimental	0.398
Scientific Literacy (Pretest)	Control	0.586
Scientific Literacy (Posttest)	Control	0.476

Since all significance values exceeded 0.05, the research data were considered to be normally distributed. Therefore, the assumption of normality required for subsequent parametric analyses was satisfied.

Homogeneity of Variance Test

The homogeneity of variance assumption was examined using Levene's Test to determine whether the variances of the experimental and control groups were statistically equivalent.

Table 4. Results of Levene's Test for Homogeneity of Variance

Variable	<i>F</i>	<i>p</i> -value
Critical Thinking Skills	1.159	0.287
Scientific Literacy	1.027	0.315

Since the significance values for both dependent variables exceeded 0.05, the assumption of homogeneity of variance was satisfied, indicating that the variances between the experimental and control groups were statistically homogeneous.

Hypothesis Testing

The research hypotheses were tested using Multivariate Analysis of Variance (MANOVA) to examine the simultaneous effects of Islamic STEM Education integrated with religious moderation values on students' critical thinking skills and scientific literacy.

Table 5. Results of the Multivariate Analysis of Variance (MANOVA)

Multivariate Test	<i>F</i>	<i>p</i> -value
Pillai's Trace	18.764	< 0.001
Wilks' Lambda	19.231	< 0.001
Hotelling's Trace	20.015	< 0.001
Roy's Largest Root	24.308	< 0.001

The results of the MANOVA indicated a statistically significant multivariate effect of the instructional intervention ($p < 0.001$). Therefore, the null hypothesis was rejected, indicating that the implementation of Islamic STEM Education integrated with religious moderation values had a significant simultaneous effect on students' critical thinking skills and scientific literacy.

Effect on Critical Thinking Skills

Table 6. Results of the Tests of Between-Subjects Effects for Critical Thinking Skills

Dependent Variable	<i>F</i>	<i>p</i> -value
Critical Thinking Skills	26.431	< 0.001

The Tests of Between-Subjects Effects revealed a statistically significant effect of the instructional intervention on students' critical thinking skills ($F = 26.431$, $p < 0.001$). These findings indicate that Islamic STEM Education integrated with religious moderation values significantly enhanced students' critical thinking skills compared with conventional instruction. Throughout the learning process, students in the experimental group demonstrated notable improvements in identifying problems, analyzing information, evaluating arguments, and drawing conclusions based on scientific evidence.

Effect on Scientific Literacy

Table 7. Results of the Tests of Between-Subjects Effects for Scientific Literacy

Dependent Variable	<i>F</i>	<i>p</i> -value
Scientific Literacy	31.785	< 0.001

The results of the analysis revealed a statistically significant effect of the instructional intervention on students' scientific literacy ($F = 31.785$, $p < 0.001$). These findings indicate that Islamic STEM Education integrated with religious moderation values significantly enhanced students' scientific literacy compared with conventional instruction. The improvement in scientific literacy was reflected in students' enhanced ability to explain scientific phenomena, interpret experimental data, evaluate scientific evidence, and apply scientific concepts to real-world problems. These findings suggest that integrating religious moderation values into Islamic STEM Education not only strengthened students' conceptual understanding of science but also promoted the meaningful application of scientific knowledge in authentic contexts.

Observation Results of the Instructional Implementation

The classroom observation results indicated that the implementation of Islamic STEM Education integrated with religious moderation values was carried out with a very high level of fidelity, achieving an implementation rate of 92.4%. Religious moderation values were embedded throughout the learning process through collaborative group discussions, project-based problem-solving activities, reflective discussions on Islamic values, and the reinforcement of tolerance and respect for diverse perspectives. Students demonstrated greater openness to differing viewpoints, collaborated more effectively within heterogeneous groups, and participated more actively in expressing evidence-based opinions. These observations suggest that integrating religious moderation values into Islamic STEM Education not only supported the development of students' academic competencies but also fostered moderate, tolerant, and responsible character traits. Overall, the findings demonstrate that integrating religious moderation values into Islamic STEM Education had a positive impact on the development of students' critical thinking skills and scientific literacy. Compared with conventional instruction, this instructional approach proved to be more effective in preparing students to meet the demands of the twenty-first century by simultaneously promoting academic competence, Islamic values, and character development.

DISCUSSION

The findings of this study demonstrate that the implementation of Islamic STEM Education integrated with religious moderation values had a significant positive effect on students' critical thinking skills and scientific literacy. This conclusion is supported by the MANOVA results, which revealed a statistically significant multivariate effect ($p < 0.001$), indicating significant differences between the experimental group, which received Islamic STEM Education integrated with religious moderation values, and the control group, which received conventional instruction. These findings suggest that integrating STEM education with Islamic values and religious moderation creates a more effective learning environment for developing twenty-first-century competencies, particularly critical thinking skills and scientific literacy. The improvement in students' critical thinking skills observed in the experimental group indicates that Islamic STEM Education integrated with religious moderation values provides meaningful learning experiences that promote higher-order thinking. Throughout the instructional process, students were engaged in authentic contextual problems requiring them to identify problems, gather and analyze information, design potential solutions, test their ideas, and evaluate outcomes. These learning activities encouraged students to develop interpretation, analysis, evaluation, inference, and evidence-based reasoning. Such findings are consistent with constructivist learning theory, which argues that knowledge is actively constructed through learners' interactions with their environment and meaningful learning experiences (Creswell, 2007). The present findings reinforce those reported by Kelley & Knowles (2016), who argued that integrated STEM education enhances critical thinking by engaging students in solving authentic and complex problems through interdisciplinary approaches. Similarly, Walzumni et al. (2024) found that STEM learning activities significantly improved students' analytical thinking, evaluation, and decision-making skills compared with traditional instructional approaches. Likewise, Arsyad & Rathomi (2025) reported that project-based STEM learning effectively enhanced students' critical thinking because learners were actively involved in inquiry and project-based problem-solving processes. The improvement in critical thinking skills observed in this study was influenced not only by the characteristics of STEM education but also by the integration of religious moderation values. Throughout the learning process, students were encouraged to respect diverse opinions, remain open to multiple perspectives, and present logical and responsible arguments. The values of *tasāmuḥ* (tolerance), *i'tidāl* (justice), and *tawāzun* (balance) served as guiding principles during classroom discussions and decision-making processes.

Such a learning environment enabled students to develop reflective and objective thinking. These findings are consistent with Starkey (2008), who argued that educational environments emphasizing dialogue, diversity, and respect for differing perspectives foster students' critical and reflective thinking. The results also demonstrated that Islamic STEM Education integrated with religious moderation values significantly improved students' scientific literacy. This improvement was reflected in students' enhanced ability to explain scientific phenomena, interpret experimental data, evaluate scientific evidence, and apply scientific knowledge to solve real-world problems. STEM learning provides students with authentic experiences through observation, experimentation, investigation, and the development of simple engineering products, allowing scientific concepts to be understood not only theoretically but also through practical application. Consequently, students became more capable of connecting scientific knowledge with everyday situations and societal issues. These findings support those of Taranto et al. (2021), who suggested that STEM education has considerable potential to improve scientific literacy by emphasizing the relationship between scientific concepts and their practical applications in everyday life. Likewise, Margot & Kettler (2019) reported that integrated STEM education enhances students' conceptual understanding and their ability to apply scientific knowledge effectively. More recently, Uğurenver (2025) found that students participating in STEM education demonstrated superior abilities to identify scientific problems, interpret evidence, and make evidence-based decisions compared with those receiving conventional instruction. The integration of Islamic values into STEM education also contributed to students' scientific literacy. In this study, scientific concepts were connected with Islamic teachings emphasizing the responsible use of knowledge for public welfare (*maslahah*) and environmental sustainability. This instructional approach helped students recognize that science is not merely a means of acquiring academic knowledge but also an instrument for fulfilling ethical and social responsibilities. These findings are consistent with Rahmawati et al. (2025), who reported that integrating Islamic values into science education not only improves conceptual understanding but also promotes students' ethical awareness regarding the responsible application of scientific knowledge. Another important finding of this study concerns the role of religious moderation as a factor that strengthened the effectiveness of Islamic STEM Education. Religious moderation values integrated throughout the instructional process not only fostered tolerant and inclusive character development but also created a learning environment conducive to academic growth. As students became accustomed to engaging in open discussions, respecting differing viewpoints, and collaborating within heterogeneous groups, they were provided with greater opportunities to exchange ideas and deepen their conceptual understanding. Such collaborative learning environments have been shown to enhance both higher-order thinking and scientific understanding.

These findings further support the concept of religious moderation proposed by Marfu'ah et al. (2024), who argued that religious moderation extends beyond religious practice to encompass balanced, fair, and tolerant ways of thinking, behaving, and interacting within society. In educational settings, religious moderation can serve as a foundation for developing an inclusive learning culture that values diversity while promoting students' competencies. Furthermore, the present findings extend those of Faozan (2020), who reported that integrating religious moderation into project-based learning enhanced students' collaborative skills. The current study demonstrates that the benefits of religious moderation extend beyond social competence to include improvements in critical thinking skills and scientific literacy. Overall, the findings confirm that Islamic STEM Education integrated with religious moderation values constitutes an effective instructional model for enhancing students' critical thinking skills and scientific literacy. The integration of STEM education, Islamic values, and religious moderation promotes a holistic learning process that not only develops twenty-first-century knowledge and skills but also cultivates religious, moderate, tolerant, and socially responsible character. Therefore, this instructional model represents a promising educational

innovation for implementation in madrasah and other schools to prepare students who are academically competent while possessing strong moral character to address the increasingly complex challenges of contemporary global society.

4. CONCLUSION

Based on the findings of this study, it can be concluded that the integration of religious moderation values into Islamic STEM Education has a positive and statistically significant effect on students' critical thinking skills and scientific literacy. By integrating the principles of Science, Technology, Engineering, and Mathematics (STEM) with Islamic values and the principles of religious moderation, this instructional approach creates a more active, contextual, collaborative, and meaningful learning experience. Students not only demonstrated substantial improvements in analyzing problems, evaluating information, and making evidence-based decisions but also exhibited enhanced scientific literacy, as reflected in their ability to explain scientific phenomena, interpret scientific data, and apply scientific concepts to real-world situations. Furthermore, the integration of religious moderation values through the promotion of tolerance (*tasāmuḥ*), justice (*i'tidāl*), balance (*tawāzun*), and respect for diversity contributed to the development of students' religious, moderate, and socially responsible character. These findings suggest that Islamic STEM Education integrated with religious moderation values represents an effective and innovative instructional model for fostering twenty-first-century competencies while simultaneously strengthening students' moral character, Islamic values, and civic responsibility within Islamic educational institutions. Future research is recommended to examine the long-term effectiveness of this instructional model across different educational levels and broader educational settings. Further studies may also investigate its influence on other twenty-first-century competencies, such as creativity, collaboration, communication, and digital literacy, to provide a more comprehensive understanding of its educational impact.

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