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Fostering students' scientific and religious literacy through STREM-based transformative learning

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Abstract

This study aims to examine the effectiveness of STREM-based learning in enhancing the students' scientific and religious literacy in the Basic Natural Science course. STREM – which refers to science, technology, religion, engineering, and mathematics – was used to teach 30 second-year-students of Islamic Education study program at STIT Muhammadiyah Banjar – a private teacher training school in Indonesia. Adopting the mixed-method approach, we used the pre-test and post-test to collect the quantitative data, while the qualitative data were gathered through interviews, observations, and student reflections. The results showed significant improvements in students' scientific literacy (scored from 62.35 to 78.20) and religious literacy (scored from 58.10 to 74.65). Thematic analysis revealed that STREM-based learning could foster students' critical thinking and encouraged deep spiritual reflection by linking scientific content with Islamic values. The integration of science and religion created a transformative learning experience, making the course more engaging and meaningful. These findings suggest that the STREM approach can serve as an effective model in Islamic higher education to develop holistic student competencies.

Keywords: Islamic education, religious literacy, scientific literacy, STREM-based learning, transformative learning

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INTRODUCTION

Scientific literacy is a crucial competency in the 21st century that enables individuals to understand, analyze, and apply scientific concepts to real-life situations (Osborne & Allchin, 2024). In the context of Islamic education, however, scientific literacy is often perceived as distinct from religious values. This separation may hinder the development of a holistic worldview that unites scientific reasoning with spiritual understanding (Sahil et al., 2024).

In the Islamic Education study program, a course of Basic Natural Science aims not only to build students' understanding of scientific phenomena, but also to promote reflection on these phenomena in the light of Islamic teachings (Adiyono et al., 2024; Mansir et al., 2024). However, many students feel that the material is disconnected from their spiritual identity. This separation can reduce their' engagement with science and create a perception that science is irrelevant to religious life. If it is left unaddressed, it can lead to students' alienation from science and lower their interest in scientific research. In addition, this separation also exacerbates a narrow understanding of science, which is only seen from a rational perspective without considering ethical and spiritual values.

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Therefore, an integrative approach such as the STREM (Science, Technology, Religion, Engineering, and Mathematics) model that connects science with spirituality is needed. This approach will provide a more holistic understanding, encourage deeper learning, and create a society that is not only scientifically intelligent but also has a strong moral foundation (Assalihee et al., 2024; Choeroni et al., 2023). The STREM helps students seeing natural phenomena—such as astronomy, ecosystems, and climate change—not only as scientific content but also as signs of God's creation. This integration fosters both analytical thinking and religious awareness.

Previous studies have primarily focused on cognitive outcomes of science education, often neglecting the role of religious values in the learning process (Handayani & Agustina, 2021; Sanusi et al., 2022). Furthermore, empirical research on the implementation of the STREM model in higher education, especially within Islamic teacher training institutions, remains limited.

This study aims to fill the research gap by implementing STREM-based learning in the Basic Natural Science course and evaluating its impact on students' scientific and religious literacy. This study investigates how an integrative approach that combines scientific inquiry with Islamic values can foster meaningful and transformative learning experiences in Islamic higher education. Based on this objective, the research is guided by the following questions: (1) to what extent does STREM-based learning improve students' scientific literacy in the Basic Natural Science course?; (2) to what extent does STREM-based learning enhance students' religious literacy?; and (3) how do students perceive the integration of science and religion through the STREM-based learning experience?

RESEARCH METHOD

This study employed a mixed-methods approach with a case study design to examine the effectiveness of STREM-based learning in improving scientific and religious literacy among students of the Islamic Education study program at STIT Muhammadiyah Banjar. This approach enabled a comprehensive analysis by combining quantitative measurement with qualitative insights from students' learning experiences.

Participants

The participants were 30 second-semester students enrolled in the Basic Natural Science course. The sample was selected using purposive sampling based on their involvement in the implementation of the STREM-based learning intervention.

Learning intervention procedure

The intervention consisted of a structured learning program that integrated the five components of STREM—Science, Technology, Religion, Engineering, and Mathematics—into the Basic Natural Science curriculum. The learning activities were designed to promote critical thinking, collaborative inquiry, and spiritual reflection. The implementation phase lasted for six weeks and included project-based tasks, guided discussions, and thematic exploration of scientific topics through Islamic perspectives.

Data collection techniques and data analysis

This study employed both quantitative and qualitative data collection techniques to provide a comprehensive understanding of the STREM-based learning implementation. Quantitative data were collected through pre-test and

post-test instruments that measured students' scientific and religious literacy, using validated indicators and expert-reviewed items. Meanwhile, qualitative data were obtained through in-depth interviews, classroom observations, and students' reflective journals to capture students' experiences, engagement, and spiritual reflections.

The quantitative data were analyzed using SPSS version 26, including normality and homogeneity tests followed by a paired-sample t-test to determine the significance of changes in literacy scores. The qualitative data were analyzed thematically through inductive coding to identify patterns and insights related to students' cognitive and spiritual development throughout the learning process. To clarify the procedures used in this study, the data collection techniques and corresponding analysis methods are summarized in Table 1.

Table 1. Data collection techniqes and analysis methods

Data Type	Collection Techniques	Analysis Methods
Quantitative	- Pre-test and post-test instruments to assess scientific and religious literacy - Instruments validated by expert judgment and based on established indicators	- Paired sample t-test using SPSS v26
Qualitative	- In-depth interviews with students - Classroom observations - Analysis of students' reflective journals	- Thematic analysis using inductive coding - Identification of patterns related to cognitive and spiritual growth

By integrating both data types, this method provided a holistic understanding of how STREM-based learning influenced students' development of scientific and religious literacy.

RESULTS AND DISCUSSION

Quantitative data analysis results

STREM-based learning in the Basic Natural Science course showed significant improvement in students' scientific and religious literacy. This result is based on statistical analysis using SPSS version 26, which includes normality test, homogeneity test, and paired t-test to measure the difference between pre-test and post-test. The normality test result is presented in Table 2.

Table 2. Normality test result

Variables	Test	p-value	Test	p-value
Scientific Pre-Test	0.064	0.200	0.965	0.345
Scientific Post-Test	0.078	0.200	0.972	0.406
Religious Pre-Test	0.058	0.200	0.963	0.312
Religious Post-Test	0.065	0.200	0.970	0.376

The normality test results for scientific and religious pre-test and post-test data showed that all variables were normally distributed. Based on the Kolmogorov-Smirnov and Shapiro-Wilk tests, the p values for all variables (scientific pre-test and post-test, and religious pre-test and post-test) are greater

than 0.05, which means there is no indication of deviation from normal distribution. Specifically, the scientific pre-test (p = 0.965, p = 0.064), scientific post-test (p = 0.972, p = 0.078), religious pre-test (p = 0.963, p = 0.058), and religious post-test (p = 0.970, p = 0.065) showed results consistent with the assumption of normality. Therefore, these data qualify for further statistical analysis, such as paired t-tests, which require normally distributed data.

Table 3. Homogeneity test result

Variables	Levene's Test p-value
Scientific Pre-Test	0.391
Scientific Post-Test	0.432
Religious Pre-Test	0.418
Religious Post-Test	0.482

Table 3 presents the results of the homogeneity test using Levene's Test showed that the variance between groups in all variables (scientific and religious pre-test and post-test) was homogeneous. The p values for the scientific pre-test (0.391), scientific post-test (0.432), religious pre-test (0.418), and religious post-test (0.482) are all greater than 0.05, indicating that there is no significant difference in variance between the tested groups. Thus, the data met the assumption of homogeneity of variance, which allowed further analysis, such as paired t-tests, to proceed without any problems related to differences in variance between groups.

Table 4. Paired sample t-test result

Variables	Mean Difference	t-value	df	p-value
Scientific Literacy	15.85	-10.345	29	< 0.001
Religious Literacy	16.55	-9.876	29	< 0.001

The paired sample t-test results showed a significant difference between the pre-test and post-test scores on both scientific and religious literacy variables (See Table 4). For scientific literacy, the mean difference was 15.85, with a t-value of -10.345 and a p-value <0.001, indicating that the increase in scientific literacy after STREM-based learning was very significant. Similarly, in religious literacy, the mean difference score was 16.55, with a t-value of -9.876 and p-value <0.001, indicating a significant increase in religious literacy. These two results show that STREM-based learning succeeded in improving both students' scientific and religious literacy significantly.

Table 5. Results of statistical analysis of scientific and religious literacy

Variables	Pre-Test Score	Post-Test Score	t	p	F (Levene)	p (Levene)
Scientific Literacy	62.35	78.20	-10.345	< 0.001	1.234	> 0.05
Religious Literacy	58.10	74.65	-9.876	< 0.001	1.412	> 0.05

Table 5 shows the results of the statistical analysis that revealed a significant increase in both variables. The mean score of scientific literacy

increased from 62.35 in the pre-test to 78.20 in the post-test with a *t* value of -10.345 and $p < 0.001$, indicating this difference is highly significant. Meanwhile, religious literacy also showed an increase from an average score of 58.10 to 74.65 with a *t* value of -9.876 and $p < 0.001$. The results of the homogeneity test using Levene's Test showed that the data had homogeneous variances ($p > 0.05$) for both variables, so the analysis could be continued.

The results of quantitative analysis prove the effectiveness of STREM-based learning in improving students' scientific and religious literacy. Data validity is supported by normality test that shows normal distribution ($p > 0.05$,) and homogeneity test that ensures consistent data variance in pre-test and post-test groups. Overall, the STREM approach not only succeeded in improving students' scientific understanding, but also strengthened the internalization of religious values in the context of Islamic-based science learning. This improvement shows the relevance of science and religion integration as a contextual and significant transformative learning approach in Islamic education.

Qualitative data analysis results

A STREM-based learning approach was applied to the Basic Natural Science course to integrate students' scientific and religious literacy. Qualitative data were obtained through in-depth interviews, observations, and analysis of students' reflective documents. Thematic analysis was conducted to identify patterns and main themes that emerged from students' learning experiences. qualitative results are organized in Table 6.

Table 6. Qualitative analysis results

Aspect Analysis	Key Findings	Student Quote
Understanding Scientific Concepts	Students show improved understanding of scientific concepts such as ecosystems, energy, and climate change.	*"I find it easier to understand concepts like astronomy, ecosystems, because they are directly linked to the greatness of Allah."*
Spiritual Reflection	Learning encourages deep reflection on the greatness of God through natural phenomena, strengthening the values of tawhid and gratitude.	*"Through this approach, I realized that science is not just about numbers and theories, but also evidence of God's greatness."*
Interest and Engagement	Students are more motivated and engaged in learning through interactive project-based methods and real-life application of concepts.	*"When I was assigned a project on climate change and its relation to human responsibility according to Islam, I became more enthusiastic about learning."*
Harmony of Science and Religion	Students felt that the STREM approach helped them understand that science and religion are mutually supportive and relevant in their lives.	*"Sometimes we felt that science and religion were separate, but now I can see that they support each other."*

The results of the study show that STREM-based learning significantly improved students' scientific literacy. The pre-test and post-test scores demonstrated a notable increase, with the mean rising from 62.35 to 78.20 ($p <$

0.001). This finding supports previous studies emphasizing the effectiveness of integrative approaches in enhancing scientific understanding (Pribadi, 2024; Pribadi et al., 2025; Pribadi & Widodo, 2025; Sarwi et al., 2024). The integration of real-life phenomena with spiritual reflection encouraged students to understand scientific concepts such as ecosystems, climate change, and astronomy more deeply. This indicates that contextual learning with religious relevance can make scientific topics more accessible and meaningful.

The study also found a significant increase in religious literacy, with students' mean scores rising from 58.10 to 74.65 ($p < 0.001$). Through STREM-based learning, students engaged in reflective activities that linked scientific discussions to Qur'anic values and Islamic teachings. Students reported that understanding scientific content as signs of Allah's greatness helped them strengthen their sense of tauhid and religious consciousness. These findings align with Hidayati et al. (2024), who emphasized that scientific literacy, when integrated with faith-based reflection, fosters a balanced development of both cognitive and spiritual dimensions in learners.

Qualitative findings from interviews, observations, and reflective journals revealed that students responded positively to the integration of science and religion. Four themes emerged: enhanced understanding of scientific content, deeper spiritual reflection, increased engagement, and recognition of harmony between science and faith. One student reflected, *"Science is not just theory—it helps me appreciate the greatness of Allah."* This suggests that STREM-based learning fostered a transformative experience, consistent with the principles of transformative learning theory (Falaq et al., 2022), in which students experience personal and intellectual growth through critical reflection and spiritual insight.

CONCLUSION

This study demonstrated that the integration of STREM (Science, Technology, Religion, Engineering, and Mathematics) into the Basic Natural Science course significantly enhanced students' scientific and religious literacy. Quantitative findings showed substantial improvements in both areas, with statistical evidence supporting the effectiveness of the STREM-based learning approach. Qualitative analysis further revealed that students experienced deeper engagement, improved conceptual understanding, and increased spiritual awareness by connecting scientific concepts with Islamic values.

The results affirm that STREM-based learning provides a meaningful and transformative educational experience for students in Islamic higher education. It not only bridges the gap between science and faith but also nurtures critical thinking, reflection, and religious consciousness—key attributes for future educators. In light of these findings, it is recommended that Islamic education institutions adopt and further develop the STREM model in relevant courses. Lecturer training and instructional material development are essential to support effective implementation. Future research should explore the long-term impact of STREM learning, its application at various educational levels, and its adaptability across different disciplines to broaden its educational potential.

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