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Measuring the Impact of Islamic Values-Based Scientific Literacy on Scientific Competency of Madrasah Teachers

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Abstract. Based on the Programme for International Student Assessment (PISA) 383, 382, 403 assessment, the scientific literacy level of students in Indonesia remains relatively low. This study seeks to ascertain the outcomes of scientific competency assessments and scientific literacy when combined with Islamic principles, as well as its impact on the science, technology, engineering and mathematics (STEM) approach employed in education. The study was carried out from February to November 2023 and included quantitative research methods. The instruments employed in this investigation encompassed observation and test sheets. The research findings on the STEM approach have a substantial influence on the scientific competence and scientific literacy of prospective madrasah instructors. This impact was determined by the independent samples t-test with equal variances. If the significance (2-tailed) is less than 0.05, then the hypothesis is accepted. In this study, the independent samples t-test was used to assess both scientific competence and scientific literacy. It was found that the values obtained indicated equal variances. The significance level was assumed to be less than 0.05, indicating that the hypothesis, which indicates that there is an influence, is accepted. In addition, the control class had an average score of 67.52% on the scientific competency pre-test and a score of 70.85% on the post-test. The experimental class, on the other hand, had a pre-test score of 66.63% and a post-test score of 79.00%. The average score for the scientific literacy test in the control class was 57.63% before the test and 74.90% after the test. In the experimental class, the pre-test score was 61.70% and the post-test score was 77.30%. The statistics clearly indicate a notable disparity in the mean score between the pre-test and post-test scores for both competence and scientific literacy in the experimental class trial. The implementation of the STEM approach resulted in a significant improvement in the average score of prospective teachers (post-test),

indicating a positive impact on the scientific competence and literacy of prospective madrasah teachers.

Keywords: Scientific competence; scientific literacy; Islamic values; STEM

1. Introduction

Education has a crucial function as a hub of excellence in shaping the human character and a significant impact on cultivating individuals with high quality and potential. Education provides individuals with a profound understanding of knowledge, skills, and attitudes, with the ultimate goal of enhancing their well-being and contributing to the betterment of their religion, nation, and country (Rokhman et al., 2014). Education is a collaborative process whereby students and teachers work together to explore their abilities and potential in the classroom. It can also be regarded as the efforts made by educators to teach and improve morals, and provide intellectual training to students (Sholihah et al., 2018; Panggabean & Sitorus, 2021; Grajeda et al., 2024). According to Toomey (2023), education is the act of modifying behaviour by integrating new knowledge into current ideas and attitudes. Therefore, it is a crucial aspect of human existence that should not be disregarded (Hakim et al., 2023). The primary objective of Indonesia's national education system is to facilitate the development of students' full potential as individuals who possess a strong belief in and reverence for God, display virtuous behaviour, sustain physical well-being, obtain knowledge, showcase proficiency, promote originality, cultivate self-reliance, and ultimately develop into accountable individuals. The effectiveness of achieving educational goals will depend on the implementation of the educational process. The assessment of the education process is based on two factors: the excellence of its components and the effectiveness of its administration (Ilham, 2019).

Enhancing the calibre and potential of each individual can be achieved through education. This demonstrates that there is a significant level of interest in human resource development, particularly in the current period of globalisation. The challenges that may arise can undoubtedly be resolved by the presence of human capital or the inherent abilities of individuals, particularly in the younger demographic. In the field of education, such as in madrasah schools, it is necessary for prospective educators to possess a high level of scientific competence in order to carry out the process of teaching effectively and efficiently and helping learners to acquire knowledge. This will ensure that the material is easily comprehensible and enjoyable for students (Revola et al., 2023). It is necessary to maintain a balance between the methods and the outcomes of learning (Junaedi, 2019). Put simply, the level of scientific expertise possessed by potential madrasah teachers will greatly influence the quality of their education (Anggraeni & Akbar, 2018).

Prospective teachers, who will later serve as facilitators, must guarantee that learners have a pleasurable experience throughout the learning process, drawing upon their knowledge and expertise. In order to ensure successful outcomes, it is imperative for potential teachers to possess strong scientific proficiency since this directly influences the learning process of pupils (Khairiah & Sirajuddin, 2019; Fakhrurrazi et al., 2022). Insufficient mastery of scientific competency among

prospective instructors can limit their pedagogical competence, resulting in suboptimal conveyance of science concepts and pupils' failure to comprehend the offered content (Suharni, 2021). The significance of competence for aspiring madrasah teachers is evident. This is to ensure that they possess the necessary knowledge and comprehension, enabling students to grasp and comprehend the essence of education. Moreover, it fosters a sense of commitment within themselves to generate positive outcomes consistently for both themselves and their immediate surroundings (Tambak et al., 2023). Astari et al. (2022) identified a number of essential scientific competences, including (a) problem-solving skills, (b) science topic knowledge, (c) science literacy, and (d) mastery of science process skills.

Regrettably, the degree of scientific literacy among Indonesian learners remains generally deficient. The science literacy ranking of Indonesian students according to the PISA is as follows: 383 for 2009, 382 for 2012, and 403 for 2015 (Hardinata et al., 2019). The poor science literacy score suggests that Indonesian pupils have a limited understanding of science education. Science education and religious instruction are inherently interconnected. Physicists Charles A. Coulson and Harold K. Schilling have stated that the methodologies employed in science and religion share many similarities (Johnson, 2016). Integration can be achieved in the subject. Ian G. Barbour, widely recognised as the pioneer of global integration, conveyed a similar sentiment. He is a physicist and agnostic scientist who developed four models to describe the connection between science and religion, namely conflict, independence, dialogue, and integration (Barbour, 2002, p. 44).

Integrating Islamic beliefs into science learning activities is beneficial as it helps students recognise the Qur'an as the source of scientific knowledge. Furthermore, it safeguards students' convictions and intellectual pursuits in the context of contemporary progress. Fakhrurrazi et al. (2024) affirm that incorporating Islamic principles into scientific education is an appropriate approach to enhance students' faith and commitment. The Islamic ideals being discussed involve the integration or connection of verses from the Qur'an into the educational content. The teachings of the Qur'an will undoubtedly cultivate individuals of exceptional quality, thereby enabling the realm of education to generate a generation characterised by profound spirituality. Observations conducted at various Islamic Universities in Bengkulu Province have revealed empirical evidence that the Madrasah Ibtidaiyah Teacher Education study programme continues to utilise the Kerangka Kualifikasi Nasional Indonesia (KKNI) curriculum for scientific courses. In terms of the learning process, it incorporates teaching materials that are aligned with Islamic principles. Additionally, it is noteworthy that the majority of students achieve a grade B (Good) in science courses. Since 2020, teaching materials that combine science with Islamic principles have been employed following research undertaken by a lecturer at UIN Famawati Sukarno Bengkulu. The research focused on establishing learning modules for integrated scientific courses that incorporate Islamic values. The results were derived from conducting face-to-face interviews with the study programme coordinator and one of the Integrated Science instructors for the primary education study programme in Bengkulu Province.

Based on the aforementioned observations, it is evident that the teaching process has been effectively implemented by utilising teaching resources in the form of research-based learning modules. A follow-up study is required to assess the scientific competency of potential madrasah instructors at Islamic universities in Bengkulu Province, specifically in terms of their skills in Islamic values-based scientific literacy. This task must be completed in order to assess the scientific proficiency of potential teachers prior to their transition into future instructors as well as equipping aspiring madrasah instructors with the necessary skills to meet the current demands of the times effectively.

Based on field research, it has been observed that current students, in general, have a deficiency in scientific literacy abilities, particularly in the context of science education. Hence, it is imperative for potential madrasah instructors to possess scientific competency, particularly strong scientific literacy, as they would assume the crucial position of educators responsible for comprehending the subject matter they teach. Zuraini et al. (2021) assert that the effectiveness of a teaching process hinges on the teacher's multifaceted position as an educator, facilitator, administrator, and motivator for students in their learning (Payton, 2021). The success of the student learning process is influenced by the teaching activities conducted by teachers (Insani, 2021).

This study aims to measure the extent of competence possessed by prospective madrasah teachers through the science, technology, engineering and mathematics (STEM) approach in the madrasa teacher candidature. The problem formulations are (a) How are the results of the scientific competency test of prospective madrasah teachers integrated with scientific literacy based on Islamic values through the STEM approach? and (b) Is there any impact of the scientific competence of madrasah teacher candidates integrated with Islamic values-based scientific literacy to the STEM approach?

2. Theoretical Review

The essence of science is commonly understood as the epistemology of science, which refers to the methods and principles used to acquire scientific knowledge and the underlying values and beliefs associated with its growth. Nevertheless, multiple studies indicate that students across different educational levels, spanning from kindergarten to university, generally lack a comprehensive comprehension of the essence of science (Lederman, 1992). Moreover, Nurcholish argues that the conflict between religion and social science mostly stems from their contrasting approaches in interpreting and elucidating the state of affairs or objective truth (Lahaji & Faisal, 2023). Social science differs from religion in two key aspects when it comes to explaining reality. Firstly, social science is genuinely committed to explaining reality. Secondly, many social sciences focus on developing a paradigm; however, the scientific methods employed have not yet been able to fully address empirical problems that remain unresolved (Wallerstein, 2001). The rivalry between religion and science manifests in two ways: firstly, social science compares itself to religion, and secondly, social science presents itself as an alternative option for constructing a *weltanschauung* (McGrath, 2020; Kurniawan et al., 2022).

Furthermore, STEM endeavours to inspire and engage students in advanced cognitive processes such as critical thinking. The key components include teamwork, self-directed learning, project-based learning, challenge-based learning, and research (Twiningsih & Elisanti, 2021). STEM education may cultivate highly skilled individuals who are well-prepared to tackle the demands of the contemporary global era. This is because STEM effectively addresses the requirements of individuals with aptitude in the domains of science, technology, engineering, and mathematics.

The teacher's strong scientific literacy abilities will foster student interest in learning. Curiosity about a particular subject or activity sparks an individual's interest in learning, leading them to desire to explore and engage in it (Yunitasari & Hanifah, 2020; Zubaedi et al., 2020). The students' intrinsic motivation to study will undoubtedly facilitate the teachers' delivery of instructional content (Rahayu et al., 2023). Indeed, students' enthusiasm for learning in the field of science varies, as many students are more inclined towards non-abstract subjects. This can be attributed to teachers' lack of strong scientific literacy skills, making it challenging to deliver material effectively, particularly in the domains of physics, chemistry, and biology. To address and resolve these issues, one can employ the STEM approach as a means of learning. Ibtida et al. (2020) and Twiningsih and Elisanti (2021) propose that STEM, as an interdisciplinary educational approach, is a method that allows educators to examine science from multiple viewpoints. This approach leverages Internet technology to enhance scientific literacy. Science can be defined as a systematic and organised collection of knowledge that is acquired through certain techniques (Fatimah & Mufti, 2014).

STEM education fosters scientific attitudes (Fasasi, 2017) and promotes student engagement in the learning process (Subali, 2018). By integrating STEM, students can enhance their understanding of science by establishing connections between scientific concepts and the immediate environment in which they live. Multiple further studies have demonstrated that STEM education can enhance students' scientific literacy, as evidenced by the research conducted by Ariningtyas et al. (2017), Maesaroh et al. (2021), and Hariyadi et al. (2023). Prasetyo (2017) defines natural science as a branch of knowledge. Science is a constituent of the broader field of STEM . The STEM methodology was initially employed by the National Science Foundation (NSF) throughout the 1990s. The STEM method serves multiple functions such as instructing students in the integration of four distinct disciplines: science, technology, engineering, and mathematics. The aim is to enable students to address problems that are relevant to their own experiences or real-world situations (Rodriguez et al., 2021). Kang and Peters (2019) define STEM literacy as the collective understanding, mindset, and abilities of an individual to recognise and elucidate natural phenomena, and to make informed inferences based on the empirical evidence pertaining to STEM subjects. An individual's comprehension is derived from the attributes of STEM, which encompass human knowledge, investigation, and design. STEM influences the material, knowledge, and culture of the surrounding environment. Zaki et al. (2020) argue that those who aspire to participate actively in STEM matters and approach these with a

constructive, empathetic, and thoughtful mindset demonstrate a desire to be responsible and thoughtful citizens.

In the context of science education, the process of learning closely resembles the experience of directly engaging with the natural environment and comprehending it through scientific methods (Rubiana & Dadi, 2020). Science is an academic discipline that investigates the natural occurrences and events occurring in the world (Azhar, 2022). Science education plays a crucial role in learning as it directly pertains to the systematic exploration of nature. Learning science is more than just acquiring factual knowledge and concepts; it involves a process of discovery that is rooted in scientific principles relevant to human existence (Suharyati, 2022). The role of teachers in implementing STEM in scientific education is expected to inspire students to comprehend their own condition and the natural world in which they live. This, in turn, enables them to impart lessons and knowledge that can be practically implemented in society (Vennix et al., 2018).

Science teachings encompass the fundamental elements of products, processes, attitudes, and technology. Thus, the process of acquiring scientific knowledge should be conducted through scientific inquiry. For effective scientific inquiry, science learning should be conducted by proficient educators with strong scientific literacy abilities (Bellova et al., 2022). Science, as a school topic, offers pupils the opportunity to play a significant role and gain valuable experience. Science learning is anticipated to involve an understanding and admiration of the natural world, which is considered the fundamental element for achieving scientific literacy (Donohue et al., 2020). Nevertheless, aspiring teachers and educators frequently experience uncertainty regarding the extent of knowledge required to incorporate Islamic beliefs effectively into science education. In order to integrate scientific competence with Islamic values-based scientific literacy, it is necessary to have an understanding of the study undertaken by researchers.

3. Research Methodology

This study applied a quantitative research methodology and employed the quasi-experimental design research method. This experimental design represents a progression from traditional experimental design; however, it also presents difficulties in its execution. This design includes a control group, but it lacks the ability to regulate extraneous variables adequately that could impact the implementation of the experiment. However, this design exceeds the pre-experimental design. A quasi-experimental design is utilised in situations where it is difficult to obtain a control group for the purpose of conducting research. This study assessed the scientific competency of students in the elementary education programme at Islamic universities in Bengkulu Province. The assessment was conducted using a science literacy approach that incorporated Islamic values. The study included four districts in Bengkulu Province: Rejang Lebong, Bengkulu City, South Bengkulu, and Kaur. This study's objective was to determine the scientific proficiency of potential madrasah instructors through the utilisation of the STEM methodology.

The samples in this study were second- and third-year students for both for the experimental and control classes. They were selected by applying purposive sampling. This is a one data source sampling technique with several implications. The primary reason for selecting purposive sampling is that the sampled students have completed their internship practice at school. The instruments used in this study were observation sheets and tests. The test questions in this study were in the form of multiple choice questions comprising as many as 50 questions. The data analysis used descriptive quantitative analysis with statistics assisted by the SPSS 22 application.

Table 1
Design of the Research

Group	Pre-test	Treatment	Post-test
Experiment	X^1	O	X^2
Control	Y^1	-	Y^2

Description of Research Location
UIN Fatmawati Sukarno Bengkulu
UIN FAS Bengkulu is a state Islamic university located in Bengkulu City, Indonesia. UIN FAS Bengkulu has undergone a transition or institutional change from Institut Agama Islam Negeri Bengkulu (IAIN Bengkulu) and has now received an Accreditation B (Good) from the Ministry of Higher Education. Initially, the university was a satellite campus of IAIN Raden Patah Palembang and then evolved into the Bengkulu College of Islamic Studies (STAIN). Subsequently, the institution's designation was altered to Bengkulu State Islamic Institute (IAIN) in accordance with Presidential Regulation No. 51 of 2012. Currently, it has been permanently renamed as Fatmawati Sukarno State Islamic University or UIN FAS Bengkulu. The transformation of IAIN Bengkulu into UIN Fatmawati Sukarno (UIN FAS) Bengkulu, based on RI Perpress No. 45 of 2021 on May 11, 2021, is the outcome of the collective efforts of the academic community and all stakeholders in Bengkulu Province. It is situated on Raden Fatah Street, in Pagar Dewa Village, Selebar District, Bengkulu City. UIN FAS Bengkulu presently possesses four faculties offering 24 undergraduate study programmes, six master's degree study programmes, and two doctoral study programmes.

STIT AL Qur'aniyah Manna
The creation of STIT Al-Quraniyah Manna is rooted in the fundamental objective of cultivating academic and professional personnel who possess unwavering faith, devotion, and a strong commitment to the nation's welfare. The fundamental concept is delineated in the Statute of STIT Al-Quraniyah Manna, namely in Article 3 which expounds on the Principles, Functions, and Objectives of STIT Al-Quraniyah Manna. STIT Al-Quraniyah Manna is overseen and funded by a foundation that was founded on February 22, 1993, known as the Affan Foundation. Currently, in the academic year 2022/2023, there is a college called STIT Al-Quraniyah Manna situated at 13 Affan Bachsin Street, Manna South Bengkulu, Indonesia. The current chairperson of the college is Dr. Dedi Irama, M.Pd.I.

STIT AL Wasi Kaur

The College of Tarbiyah STIT Al Wasi Kaur, located in Indonesia, is the first campus to be established in Kaur Regency and is now in operation. The chairperson of the college is Mr. Mahlian, M.Pd.I. The activities revolve around the Al Wasi Kaur Campus, located in Penyandingan Village, in the Central Kaur District. The institution offers two study programmes and aims to establish itself as one of the top Islamic private colleges in Bengkulu.

IAIN Curup

IAIN Curup is situated in the Rejang Lebong Regency of Bengkulu Province, Indonesia. It is an Islamic university that operates as a public institution and falls under the jurisdiction of the Ministry of Religious Affairs of the Republic of Indonesia. Currently, there are three faculties available for undergraduate study, five study programmes for master's degrees, and two doctoral study programmes.

4. Result

Results of the Scientific Competency Test

By administering the pre-test and post-test to the experimental and control courses, the study's findings regarding the scientific competency of aspiring madrasah instructors were determined. The four Islamic universities in the province of Bengkulu provided a sample for both classes. The information was utilized to compare the experimental and control groups' madrasah teacher applicants' scores on the scientific competency examination. Furthermore, descriptive analysis—which includes describing the quantity of data, maximum value, minimum value, average value, and the like—was used to describe research data in order to ascertain the impact of the STEM approach on the scientific competency of aspiring madrasah teachers from the four Islamic Universities (PTKI) in Bengkulu Province, Indonesia. The pre-test results for the experimental class have an average value of 66.63, according to the conducted results where 40 is the lowest possible score and 87 is the maximum. The experimental class's average score on the post-test is 79.00. where 98 is the greatest possible score and 50 is the lowest. The average value of the control class pre-test scores is 67.52. where 45 was the lowest possible score and 87 was the highest possible. According to the post-test findings, the control class scored an average of 70.85, with 89 being the highest and 49 being the lowest. Prior to testing hypotheses, two prerequisite tests were administered: a normality test to determine whether the prospective madrasah teachers' pre- and post-test results were normally distributed, and a homogeneity test to determine whether the prospective madrasah teachers' scientific competence was homogeneous.

a. Normality Test

   This was utilised to ascertain the normal distribution of the research data. The significance value (sig.) for all data in the Shapiro-Wilk test is more than 0.05. Therefore, it can be inferred that the research data follows a normal distribution. Owing to the normal distribution of the data, a parametric statistical test, specifically an independent samples t-test, was conducted.

b. Homogeneity Test
This method was employed to ascertain whether the data of a research study exhibited homogeneity or not, specifically in terms of variance or variety. The homogeneity test conducted on the experimental and control classes indicates that the data is homogeneously distributed, since the significance value is greater than 0.05.

c. Independent Samples T-Test
Since the data from both the pre-test and post-test has a normal distribution, it is appropriate to conduct further analysis using parametric tests, namely the t-test, using SPSS 22. The independent t-test is utilised to determine whether there is a significant disparity in the post-test outcomes between students in the experimental class and the control class. Based on the decision rule, if the p-value (one-tailed) is less than 0.05, the null hypothesis (H0) is rejected in favour of the alternative hypothesis (Ha). Conversely, if the p-value (one-tailed) is greater than 0.05, the alternative hypothesis (Ha) is rejected and the null hypothesis (H0) is accepted.

Table 2
Independent Samples T-Test

Independent Samples Test					
	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	Df	Sig. (2-tailed)
Scientific Competence	2.473	.120	3.179	78	**.002**
			3.179	73.750	.002

According to the data in Table 2, the t-test results indicate a significance value of 0.002, which is lower than the threshold of 0.05 (sig: 0.002 < 0.05). Therefore, it can be concluded that the null hypothesis (Ho) is rejected and the alternative hypothesis (Ha) is accepted, indicating a statistically significant difference between the post-test scores of the experimental class and the control class. The post-test for the experimental class was conducted after the completion of learning utilising the STEM methodology, while the control class followed their usual learning methods. Therefore it can be concluded that there is a significant impact of the STEM approach on the integrated competence of scientific literacy in the experimental class. The results of the scientific literacy level of prospective madrasah teachers in this study were obtained through questionnaires given to experimental and control classes. The data was used to determine the scientific literacy test results of madrasah teacher candidates between the experimental and control classes. In addition, the study endeavoured to determine the impact of the STEM approach on the scientific literacy of prospective madrasah teachers from the four Islamic universities in Bengkulu Province, Indonesia.

About descriptive analysis of scientific literacy, this data analysis helps to check whether the data is in accordance with the actual data. Then it is

processed and analyzed to provide an overview of the research data, which includes the amount of data, maximum value, minimum value, average value and others. The results of descriptive statistics are as follows: (a) In the control class, based on the descriptive table of variables above, it can be seen that the results of the pre-test and post-test of the control class of 40 students, have a minimum pre-test score of 33, a maximum pre-test score of 82, and a minimum post-test score of 63, a maximum post-test score of 92. The mean pre-test was 57.63 and the mean post-test was 74.90. The requirement has a standard deviation for the pre-test of 12.573 and for the post-test of 7.629. (b) In the experimental class, based on the descriptive table of variables above, it can be seen that the results of the pre-test and post-test of the experimental class of 25 students reflect a minimum pre-test value of 36, a maximum pre-test of 83, and a minimum post-test of 50, with a maximum post-test value of 95. The mean pre-test was 61.70 and the mean post-test was 77.30. The requirement has a standard deviation for the pre-test of 11.314 and for post-test of 9.233.

Table 3

Average Scores of the Experimental and Control Groups

	Experiment Group	**Control Group**
Pre Test Score (Mean)	57.63	61.70
Post Test Score (Mean)	74.90	77.30

d. Normality Test

The goal of the normality test is to ascertain the presence or absence of the pre-test and post-test data obtained. The Shapiro-Wilk test was performed using IBM SPSS 22 in this investigation. The statistical tests conducted on the control class yielded pre-test results of 0.690 and post-test results of 0.116. In comparison, the experimental class achieved pre-test results of 0.771 and post-test results of 0.486. Thus, it may be inferred that both the control and experimental classes exhibit a normal distribution, as the p-value is greater than or equal to 0.05.

e. Homogeneity Test

The homogeneity test is employed to demonstrate that many sets of sample data from the population possess equal variances. The homogeneity test is conducted on the pre-test and post-test data collected from both the control class and the experimental class. If the significance value (sig) is greater than 0.05, the data can be considered to be the same. However, if the significance value is less than 0.05, it indicates that the data is not the same. According to the statistical analysis conducted using SPSS 27, the homogeneity test yielded a significance level of 0.429 for the post-test results. Based on these findings, it can be inferred that the post-test result of 0.429 is greater than 0.05, indicating homogeneity in the data.

Implication of STEM Approach on Scientific Competence

The t-test in this study used the independent-samples t-test because the sample used consisted of two classes. The significance for the independent samples t-test is sig < 0.05, which means Ha is accepted. However, if the significance sig > 0.05, then H0 is rejected. The research hypothesis to be tested is as follows:

H_0 = There is no impact of STEM approach on scientific literacy of madrasah teacher candidates.
H_1 = There is an impact of the STEM approach on the scientific literacy of prospective madrasah teachers. The following is the independent samples t-test using IBM SPSS 22 for Windows:

Table 4
Hypothesis Test

Independent Samples Test						
		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	T	Df	Sig. (2-tailed)
Result of Scientific Result	Equal variances assumed	.632	.429	-1.267	78	**.000**
	Equal variances not assumed			-1.267	75.322	.000

Based on the statistical test results, the significance sig. (2-tailed) of 0.00 is obtained. The significance of 0.00 is smaller than 0.05 (0.00 <0.05). Therefore the difference in the level of confidence is 5%. This means that Ho is rejected and Ha is accepted.

5. Discussion

This study aimed to assess the outcomes of a scientific competency test that was combined with scientific literacy among prospective madrasah teachers. Additionally, it sought to examine the influence of the STEM approach on the scientific competence of prospective madrasah teachers, while also integrating Islamic values-based scientific literacy. The study was conducted in Bengkulu Province, Indonesia. This study involved the selection of prospective instructors from four Islamic universities, with each university contributing a sample size of up to 20 individuals. Moreover, the sample was divided into two categories, namely the experimental group and the control group. In order to assess the scientific proficiency of potential madrasah teachers, pre- and post-tests consisting of multiple choice questions were administered, while a questionnaire sheet was used to evaluate their scientific literacy. The purpose of administering this pre-test is to ascertain whether there is a disparity in the initial scientific competency between the two classes. The post-test is designed to assess the impact of the STEM approach on scientific competence following the completion of the learning process. The findings of the independent sample t-test indicate that the sig. (2-tailed) values are 0.02 for scientific competence and 0.00 for scientific literacy. Both of these values indicate that the sig. (2-tailed) is greater than 0.05.

The data analysis reveals that the scientific competence and scientific literacy of prospective madrasah teachers in the experimental class, who were taught using the STEM approach, is superior to those in the class taught using a conventional learning approach. This indicates that the STEM approach is more effective in enhancing the scientific competence and scientific literacy of prospective madrasah teachers. The success can be attributed to the alignment of the STEM method with the criteria of 21st century learning, which include (a) an emphasis on learner-centered instruction; (b) fostering collaborative work among learners; and (c) connecting learning materials to real-life challenges. The concept of 21st century education was developed and advocated by professionals, institutions, and educational authorities in Indonesia and globally in response to these concerns and situations (Davidi et al., 2021). The STEM approach is an educational approach that aligns with the features of 21st century learning (Lestari et al., 2018).

The STEM approach enhances scientific competency and literacy by teaching the application of real-world concepts, principles, and technology to problem-solving. STEM education integrates multiple disciplines into a unified learning approach grounded in real-world applications. STEM literacy encompasses the acquisition of scientific, technological, engineering, and mathematical knowledge, which is then used to issue identification and the generation of new information. The attributes of STEM are regarded as a type of human undertaking, encompassing design, inquiry, and analytical procedures (Eliana et al., 2021). Furthermore, STEM is a multidisciplinary strategy that aids aspiring educators in their learning process. This strategy entails the utilisation of science, technology, engineering, and mathematics in a cross-school setting to enhance the proficiency and scientific knowledge of future madrasah instructors (Maulidia et al., 2019). Moreover, it has the capability to generate novel pedagogical approaches and use STEM education to address a problem. Additionally, it may assist aspiring educators in identifying, examining, and resolving difficulties, as well as comprehending the interconnectedness of various challenges (Oktaviyani et al., 2020). STEM abilities also cultivate problem-solving skills and foster a scientific mindset, making STEM integration a constant pursuit of innovation. STEM approaches play a crucial role in the field of education (Mu'minah & Aripin, 2019). Overall, the goals and advantages of the STEM learning approach are anticipated to enhance critical, creative, logical, imaginative, and productive thinking abilities, as well as fostering a sense of collaborative problem-solving.

STEM is an educational method that prioritises the interconnectedness of information, highlighting how different concepts and subjects are related to one other. Technology is utilised to generate and convey inventive remedies, serving as a means to enhance the capacity to identify and resolve problems (Utomo et al., 2020). The incorporation of the STEM approach is crucial for enhancing the scientific competence and literacy of prospective madrasah teachers. This approach enables them to contribute actively to the improvement of the learning process and facilitate better understanding among students. Additionally, it equips them with problem-solving skills to address challenges encountered during the teaching and learning process.

Acquiring scientific knowledge can enable aspiring teachers to create impactful learning opportunities. Prospective teachers with robust scientific competences may effectively design captivating and significant science education encounters for their pupils, equipping them to tackle the complexities of the contemporary world. The significance of scientific proficiency for aspiring educators can be elucidated as follows: (a) Possessing scientific knowledge enables potential teachers to comprehend and tackle distinctive individual disparities among students. The factors encompassed are physical characteristics, cognitive abilities, individual dispositions, psychological features, linguistic aptitude, and preferred methods of learning. Teachers who possess a high level of scientific competence are able to adapt their teaching approaches to meet the demands of a wide range of pupils (Sari & Mudjiran, 2020). (b) Additionally, scientific competence is a crucial component of professional competence for aspiring teachers. It empowers them to oversee and assist science learning activities efficiently, mentor students in their scientific inquiries, and execute their responsibilities as educators. Prospective teachers can deliver high-quality science education to their pupils by consistently enhancing their scientific competence (Febriana et al., 2020). (c) Additionally, scientific competence empowers prospective teachers to include Islamic beliefs into their science instruction. This integration facilitates students' comprehension of the congruity between Islam and scientific investigation, fostering a more profound comprehension of the Islamic perspective. By integrating Islamic principles into science education, aspiring educators can foster ethical decision-making, moral reasoning, and a comprehensive comprehension of the world (Ratu et al., 2022). (d) Proficiency in scientific knowledge empowers prospective teachers to cultivate and enhance higher order thinking skills (HOTS) in their students. These HOTS are crucial for cultivating creativity, innovation, and critical thinking. By integrating HOTS into science education, educators can provide students with the necessary abilities to analyse, assess, and utilise scientific knowledge critically within real-life situations (Sopian et al., 2022). (e) Furthermore, scientific competency provides aspiring teachers with the necessary skills to utilise technology proficiently in the science classroom. Technology is crucial in education during the digital era. Prospective teachers with a solid scientific competency can enhance science education by integrating technological tools and resources into their teaching, resulting in a more engaging and dynamic learning experience for pupils (Wulandari et al., 2021).

Based on the aforementioned statements, it can be inferred that possessing scientific competence is crucial for aspiring teachers as it allows them to comprehend variances among individuals, cultivate advanced cognitive abilities, incorporate Islamic principles, utilise technology proficiently, and enhance their expertise in science education. Prospective instructors must possess scientific competency, as it greatly influences the quality of their teaching and mentoring of pupils. Prospective teachers who possess scientific competence are able to educate with a solid knowledge base in their chosen area of study. With a profound comprehension of scientific principles, research methodologies, and cutting-edge advancements in the discipline, they possess the ability to enhance students' comprehension and elucidate subject matter with greater clarity and meticulousness.

Prospective instructors can cultivate critical thinking skills in students through scientific competency. They have the ability to prevent students from deconstructing material, and to encourage scrutinising scientific evidence, and discerning solid arguments. This facilitates the cultivation of crucial cognitive skills in students, which are essential for problem-solving and decision-making. Scientific competency enables potential instructors to instruct students about the scientific method. They can assist students in comprehending the procedures involved in doing research, creating experiments, gathering and analysing data, and interpreting findings. This facilitates students' comprehension of the scientific process and fosters the cultivation of research abilities that hold significance across several disciplines. Furthermore, possessing scientific competency enables potential teachers to incorporate scientific concepts effectively into the everyday lives of their students. They can demonstrate the influence of science on different domains of life, including health, environment, technology, and other areas. This facilitates students' comprehension of the significance of science in their daily lives and fosters a deeper admiration for the field of science.

Prospective teachers with scientific competency are able to assist students in developing the skills necessary to communicate scientific information effectively, therefore fostering their ability to be informed and engaged citizens. They have the ability to direct students to safeguard scientific evidence, safeguard the research process, and make decisions based on precise and dependable information. This fosters the cultivation of a rational and critical mindset in pupils, enabling them to question and scrutinise ideas without relying on baseless assumptions. Prospective teachers who possess a robust scientific competence are capable of delivering more impactful instruction, fostering critical thinking skills, and facilitating the development of a profound comprehension of science among pupils. Enhancing scientific requirements can be achieved by pursuing additional education, undergoing training, engaging in research activities, and gaining hands-on experience in the application of the scientific method. Prospective madrasah instructors must possess not only competency but also a strong foundation in scientific literacy.

Scientific literacy pertains to an individual's capacity to comprehend, assess, and employ scientific information with proficiency. It encompasses the capacity to comprehend and evaluate scientific publications, journals, books, and other sources pertaining to research and science. Scientific literacy is crucial in a progressively intricate and internationally interconnected society. Developing a strong scientific literacy enables individuals to make informed decisions by relying on scientific data, comprehend and value the scientific method, and actively engage in scientific conversations and debates. In order to enhance scientific literacy, one can undertake many courses of action, including routinely perusing scientific papers, enrolling in courses or training programmes focused on the scientific method, engaging in scientific conversations, and posing critical inquiries regarding encountered scientific knowledge.

Scientific literacy is crucial for aspiring teachers as it enables them to educate and mentor their students effectively. Scientific literacy holds significant importance for potential instructors due to several reasons: Firstly, enhancing scientific literacy will facilitate a deeper comprehension of scientific concepts, hence enabling more effective teaching. Instructors have the capacity to instruct their students on the scientific method, facilitate their comprehension of research methodologies, and foster their critical thinking skills in relation to scientific knowledge. Scientific literacy is crucial for cultivating essential critical thinking abilities, particularly in the field of education. They will also have the ability to discern bias, and pose pertinent questions. By possessing a strong scientific literacy, they will be capable of assisting their students in comprehending the significance of science in their daily lives. They will demonstrate the impact of research on their lives and dissuade people from making decisions solely on scientific data. By possessing a strong understanding of scientific concepts and principles, instructors will be capable of formulating more effective methods for imparting knowledge. They will further enhance their ability to facilitate access for their students in a more efficient manner, while also facilitating their comprehension of scientific topics. Their credibility as an educator will be further enhanced by cultivating a strong foundation in scientific literacy. They will possess the capability to furnish precise and current knowledge to their learners, thereby assisting them in enhancing their comprehension of science.

To enhance scientific literacy, aspiring educators can engage in activities such as routinely reading scientific papers, enrolling in courses or training programmes focused on scientific procedures, actively participating in scientific conversations, and posing critical inquiries regarding encountered scientific knowledge. By incorporating Islamic principles into the fields of science and technology, it is possible to develop a comprehensive and holistic knowledge system that is infused with religious values. This approach acknowledges that Islam is a comprehensive and all-encompassing system that encompasses every facet of human existence, including scientific inquiry and technological progress (Ikmal, 2018; Afriansyah et al., 2022).

The amalgamation of Islamic principles and scientific knowledge holds significant importance for multiple reasons. Firstly, the incorporation of Islamic beliefs into science enables a comprehensive approach to teaching. It acknowledges the significance of both religious and scientific knowledge in influencing an individual's comprehension of the universe. This integration facilitates the cultivation of a harmonious viewpoint among students in which faith and reason are effectively blended (Isgandi, 2021). Science offers knowledge and instruments for comprehending the natural world; however, it does not inherently offer a moral framework. By incorporating Islamic principles, science education can integrate moral and ethical aspects into scientific discourse. This promotes students' comprehension of the moral consequences of scientific progress and fosters conscientious and ethical scientific conduct.

By integrating Islamic principles with scientific study, students also gain a clear understanding of the harmonious relationship between Islam and scientific

exploration. It allows individuals to perceive science as a tool for investigating and admiring the marvels of Allah's creation. This integration facilitates the cultivation of a more profound comprehension of the Islamic worldview and fortifies their faith. The Islamic faith places great emphasis on the significance of acquiring information and comprehending the world in which we live. By amalgamating Islamic principles with scientific knowledge, students are motivated to participate actively in analytical reasoning, probing, and investigation. This integration promotes an inquisitive attitude to learning and motivates students to investigate scientific issues within an Islamic framework.

In addition, the amalgamation of Islamic principles and scientific knowledge can effectively tackle present-day problems and obstacles encountered by Muslim societies. This platform facilitates the examination of scientific breakthroughs and their consequences via an Islamic lens. This integration enables students to navigate intricate ethical challenges effectively and make well-informed judgements that are in accordance with their personal values. In summary, the incorporation of Islamic principles with scientific principles in education offers a thorough and balanced learning experience that merges religious instruction with scientific understanding. It facilitates the cultivation of a profound comprehension in students about both subjects and motivates them to incorporate Islamic principles into their scientific endeavours. This integration fosters the development of analytical thinking, moral judgement, and a comprehensive comprehension of the world.

6. Conclusion

The research findings indicate a significant disparity in the mean scores between the pre-test and post-test outcomes in the experimental class. The results indicate an increase in the competency and scientific literacy of prospective madrasa instructors in the experimental group. This suggests that the STEM approach has been demonstrated to have a substantial effect on the scientific competence and scientific literacy of prospective madrasa teachers. Therefore, the research hypothesis, which posits that the STEM approach influences the scientific competence and scientific literacy of prospective madrasa teachers, can be confirmed. This additionally substantiates the need of scientific literacy for madrasa professors in an interconnected and progressively intricate world. Teachers' possession of strong scientific literacy enables them to comprehend and value the scientific methodology, hence facilitating the ability to make more informed decisions grounded in scientific evidence.

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