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Improving Science Literacy through STEMQ-based E-Modules through Flipbooks at MA Al-Ihsan Kalijaring Jombang

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ABSTRACT
This study aims to analyze the effectiveness of STEMQ-based e-modules in improving students' science literacy at Madrasah Aliyah Al-Ihsan Kalijaring, Jombang. The method used is a pre-experiment with a pretest-posttest design on a single group, involving eleventh-grade students as the sample. Data was collected through a science literacy test that measured students' understanding of optical material before and after using the STEMQ-based e-module. The results showed that the use of the STEMQ-based e-module can improve students' science literacy, particularly in understanding scientific concepts related to optical material. Additionally, the integration of Qur'anic values into the e-module had a positive impact on strengthening students' religious character, supporting holistic learning. The study also found that while most students showed improvement, there was variation in the results, indicating the need for more attention to students with lower science literacy abilities. Overall, the STEMQ-based e-module was proven effective in improving science literacy in the pesantren environment and can serve as a relevant learning medium for 21st-century educational needs. This study contributes to the development of STEM-based learning that integrates religious values in pesantren education.

***Keywords**: Science Literacy; STEMQ-based E-Modules; flipbooks.*

INTRODUCTION
Improving science literacy is one of the main objectives of 21st-century education. Science literacy encompasses not only the ability to understand scientific concepts but also the ability to apply this knowledge in everyday life (Fuadi et al., 2020). In Indonesia, students' science literacy skills are still relatively low, based on the results of the 2018 Programme for International Student Assessment (PISA), where Indonesia ranked 70th out of 78 countries (OECD, 2019). This highlights the need for innovations in teaching that can enhance students' science literacy, especially in madrasah aliyah environments.

MA Al-Ihsan Kalijaring Jombang, as an educational institution located near a pesantren, faces challenges in improving students' science literacy. Based on initial observations, limitations in learning facilities, such as a lack of interactive media and limited access to digital learning resources, are major obstacles. However, science literacy is essential for students to understand the relationship between science, technology, and daily life (Pratiwi et al., 2019). Therefore, learning media that can bridge this gap while aligning with the pesantren context is needed.

One solution that can be implemented is the development of STEMQ-based e-modules (Science, Technology, Engineering, Mathematics, Qur'an). The STEMQ approach integrates STEM with Qur'anic values, aiming to provide a holistic, relevant, and contextual learning experience (Baehaqi et al., 2024). Previous studies have shown that the STEM approach can enhance science literacy and 21st-century skills (Astuti et al., 2023). However, the integration of Qur'anic values into the STEM approach has not been widely studied, making this research novel in integrating religious aspects into science learning.

Furthermore, the use of e-modules has been found effective in enhancing learning interactivity and student engagement (Asfirah et al., 2024). STEMQ-based e-modules not only provide technology-based learning materials but also include activities that engage students in science, technology, engineering, and mathematics that are relevant to their everyday lives in the pesantren environment. Thus, this e-module is expected to overcome the limitations of conventional learning media and improve students' science

literacy.

This study aims to analyze the improvement in students' science literacy at MA Al-Ihsan Kalijaring Jombang through the implementation of STEMQ-based e-learning media using a flipbook. This research supports previous studies emphasizing the importance of technology-based learning innovations (Tamrin & Masykuri, 2024) and expands the understanding of integrating Qur'anic values in the STEM approach. The results of this study are expected to contribute to the development of relevant and contextual learning models in the pesantren environment.

METHOD

Research Design

This study uses the One Group Pre-test Post-test Design, involving a single group of subjects whose science literacy is tested before (pre-test) and after (post-test) the learning process using STEMQ-based e-modules in a Flipbook format. The difference between the pre-test (O_1) and post-test (O_2) results reflects the impact of the treatment (X).

Research Location

The research is conducted at MA Al-Ihsan Kalijaring Jombang, a pesantren facing challenges in integrating technology into physics learning, particularly on the topic of optics.

Research Variables

- Dependent Variable**:** Students' science literacy (the ability to understand, apply, and evaluate scientific concepts).
- Independent Variable**:** STEMQ-based e-modules with Flipbook format.

Population and Sample

- Population: Class XI IPA students at MA Al-Ihsan Kalijaring Jombang for the 2024/2025 academic year.
- Sample: 34 students from Class XI IPA.

Data Collection Technique

- Science Literacy Test: Pre-test and post-test using 15 questions based on PCAP, with three indicators: scientific inquiry, problem-solving, and scientific reasoning.

Data Analysis Technique

- Descriptive Statistical Analysis: To describe the students' learning outcomes.
- Improvement Analysis (N-Gain): To measure the improvement in science literacy using the equation (Meltzer, 2002 in Prihatiningtyas, 2020):

$$\langle g \rangle = \frac{\langle S_{post} \rangle - \langle S_{pre} \rangle}{100\% - \langle S_{pre} \rangle}$$

Criteria for N-Gain (improvement in students' understanding of concepts) can be seen in the table below.

Table 1 Categorization of Gain Values

Gain Value Interval (N-Gain)	Category
N-Gain ≥ 0,7	High
0,3 ≤ N-Gain < 0,7	Moderate
N-Gain < 0,3	Low

RESULT AND DISCUSSION

Result

This study aims to analyze the improvement in students' science literacy at MA Al-Ihsan Kalijaring after using STEMQ-based e-modules with Flipbook. The data from the pre-test, post-test, and N-gain calculations are presented in Table 1 below:

Table 2 Pre-test, Post-test, and N-gain Results

No	Nama	Pretest	Postest	N-gain	Category
1	Respondent 1	33	60	0.40	Moderate
2	Respondent 2	60	66	0.15	Low
3	Respondent 3	62	75	0.34	Moderate
4	Respondent 4	40	53	0.22	Low
5	Respondent 5	33	66	0.49	Moderate
6	Respondent 6	26	62	0.49	Moderate
7	Respondent 7	26	53	0.36	Moderate
8	Respondent 8	66	78	0.35	Moderate
9	Respondent 9	33	73	0.60	Moderate
10	Respondent 10	67	80	0.39	Moderate
11	Respondent 11	26	72	0.62	Moderate
12	Respondent 12	66	73	0.21	Low
13	Respondent 13	46	66	0.37	Moderate
14	Respondent 14	53	78	0.53	Moderate
15	Respondent 15	60	80	0.50	Moderate
16	Respondent 16	40	60	0.33	Moderate
17	Respondent 17	53	72	0.40	Moderate
18	Respondent 18	46	46	0.00	Low
19	Respondent 19	60	75	0.38	Moderate
20	Respondent 20	40	53	0.22	Low
21	Respondent 21	40	53	0.22	Low
22	Respondent 22	53	82	0.62	Moderate
23	Respondent 23	40	40	0.00	Low
24	Respondent 24	62	66	0.11	Low
25	Respondent 25	40	60	0.33	Moderate
26	Respondent 26	62	66	0.11	Low
27	Respondent 27	67	80	0.39	Moderate
28	Respondent 28	62	66	0.11	Low
29	Respondent 29	40	73	0.55	Moderate
30	Respondent 30	40	53	0.22	Low
31	Respondent 31	53	84	0.66	Moderate
32	Respondent 32	66	82	0.47	Moderate
33	Respondent 33	46	75	0.54	Moderate
34	Respondent 34	53	75	0.47	Moderate

The average pre-test score was 48.79, while the average post-test score was 66.76. These results indicate an improvement in students' science literacy after the implementation of the STEMQ-based e-modules. Based on the N-gain, the category of science literacy improvement was predominantly in the Moderate category (68%), with some students in the Low category (32%).

The following graph shows the distribution of students based on the N-gain categories:

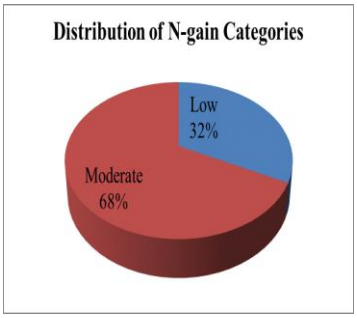

Figure 1. Distribution of N-gain Categories

Figure 1 shows that the number of students with moderate science literacy improvement is 23, accounting for 68%, while the number of students in the low category is 11, representing 32%.

Discussion

This study demonstrates an improvement in students' science literacy after learning with the STEMQ-based e-module using Flipbook. Based on the analysis, the average N-Gain score falls within the moderate category, with some students categorized as low. This finding indicates that the STEMQ-based e-module is effective in enhancing students' science literacy, although the degree of improvement varies.

The results support previous studies showing that STEMQ-based e-modules are effective in improving students' science literacy by integrating the concepts of science, technology, engineering, mathematics, and the Qur'an. This approach allows students to understand the material more holistically and in ways relevant to their daily experiences, as suggested by Masykur et al. (2024). Moreover, the use of Flipbook as an interactive learning medium significantly contributes to students' engagement. This tool employs appealing visual elements to facilitate understanding of complex concepts, making learning more effective and enjoyable (Prihatiningtyas et al., 2023). With the combination of STEMQ-based e-modules and Flipbook technology, students not only learn scientific concepts but are also motivated to explore their practical applications in real life.

The analysis results reveal variations in N-Gain improvement among students. For instance, some students, such as Respondent 11 and Respondent 22, achieved a high N-Gain of 0.62, indicating that STEMQ e-modules are highly effective for students who can relate the material to real-world experiences and possess critical thinking skills. Conversely, other students, such as Respondent 18 and Respondent 23, showed an N-Gain of 0.00, indicating no improvement. These variations may stem from several factors.

First, students' initial abilities influence their potential for improvement; for example, students with high pre-test scores, such as Respondent 18 (46) and Respondent 23 (40), have less room for improvement compared to those with lower pre-test scores. Second, limited time and guidance pose challenges, particularly for students less familiar with technology or self-directed learning methods, who may require more intensive assistance to comprehend the material (Paramita & Wardan, 2024). Third, the relevance and context of the material to students' experiences also affect learning outcomes. Students who find the material less relevant to their daily lives tend to have lower motivation to learn (Ulya et al., 2016). Therefore, adapting teaching approaches and providing guidance are necessary to optimize the effectiveness of STEMQ e-modules for all students.

The use of STEMQ-based e-modules has made a significant contribution to learning in pesantren environments, particularly through the integration of Qur'anic values, which adds a relevant dimension. Research by Fatimah & Sumarni (2024) highlights that this integration not only enhances scientific understanding but also helps shape students' religious character, a primary goal of pesantren education. This finding underscores the relevance of STEMQ-based learning in the context of religious education.

The implementation of technology in STEM-based learning has shown a significant positive impact on science literacy. This approach has demonstrated an effect size of 57.6% in improving students' literacy skills, emphasizing the role of digital tools in enhancing learning outcomes (Febriyani et al., 2024). However, the success of this approach heavily depends on the readiness of students and teachers to use learning technology. Readiness is a critical factor, especially in implementing digital media in MA

institutions located within pesantren environments, which often face technical challenges and limited facilities.

This study has several implications. First, STEMQ-based e-modules have proven to be an effective alternative for improving science literacy, particularly in optics material. Second, students in the low N-Gain category require more intensive guidance to maximize their learning outcomes. Third, further development is needed to enhance the interactivity of e-modules, such as by incorporating augmented reality (AR) features, to provide a more immersive learning experience.

However, this study has limitations, including the small sample size, which only involves one school, making it necessary to generalize the findings cautiously. Additionally, the limited time for implementing e-modules in the learning process may affect their effectiveness, which should be considered in future research.

CONCLUSIONS

This study demonstrates that the STEMQ-based e-module is effective in enhancing students' science literacy in pesantren, particularly on optical topics. The integration of Qur'anic values within the e-module not only aids in understanding scientific concepts but also strengthens students' religious character, fostering holistic learning. The success of the e-module is significantly influenced by students' ability to connect the material with real-life experiences and the support provided by teachers. However, students with low N-Gain scores require additional attention in terms of learning methods and more interactive technologies.

This research opens opportunities for technological advancements, such as augmented reality (AR), to enhance interactivity. Further studies with larger populations are needed to strengthen the validity of the findings. The results of this study contribute to the development of STEM-based learning in pesantren by integrating science, technology, and religious values.

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