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# STEMQ-Based Physics Learning Device Innovation on Light and Optical Instruments for Enhancing Science Literacy in Boarding School-Based Madrasah Aliyah

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## ABSTRACT
*Digital transformation in education is one of the Indonesian government's strategic efforts to improve the quality of learning through the Merdeka Belajar program. This research focuses on the innovation and development of STEM-Q (Science, Technology, Engineering, Mathematics, and Qur'an)-based physics learning devices on the topic of Light and Optical Instruments to strengthen students' science literacy in Madrasah Aliyah within Islamic boarding school environments. The learning devices were designed to integrate scientific concepts with Qur'anic values, providing a contextual and meaningful learning experience that aligns with students' spiritual and intellectual development. This study employed a Research and Development (R&D) approach using the 4D model, which includes the stages of Define, Design, Develop, and Disseminate. The developed learning devices consisted of lesson plans, student worksheets, and e-modules integrated into digital platforms. Validation by media, material, and learning experts showed that the devices met the criteria of very good quality in terms of content accuracy, presentation, and integration of Qur'anic values. Field implementation was conducted in three Madrasah Aliyah in Jombang involving 90 students. The practicality test indicated that the learning devices were easy to use and engaging for students. Science literacy assessment results, measured through pretest and posttest, showed a significant increase in students' science literacy with N-Gain values ranging from 0.64 to 0.67 (medium category).The results indicate that the development and implementation of STEM-Q-based physics learning devices on Light and Optical Instruments are effective in enhancing science literacy among students in Islamic boarding school-based Madrasah Aliyah.*

***Keywords***: *STEMQ; learning devices; light and optical instruments; science literacy; Islamic boarding school*

## INTRODUCTION
One of the developments occurring in the globalization era is digital transformation, which has an impact on various aspects of human life, including education. Digitalization in education brings many advances that make learning more effective, interactive, and flexible (Rahayu et al., 2022). According to Christensen et al. (2008), digital transformation in education has the potential to improve the quality of learning through the incorporation of technologies that enable wider access to information as well as more creative learning approaches.

In Indonesia, digital transformation in education is an important part of the government's efforts to improve the quality of national education. The Merdeka Belajar program, launched by the Ministry of Education and Culture, encourages the application of learning methods that are more flexible and oriented to student needs (Sherly et al., 2021). One important aspect of this program is the integration of technology in learning, which has the potential to increase the effectiveness and relevance of education at various levels and types of schools (MoEC, 2022).

However, the application of this digital transformation has not been fully distributed, especially in

educational institutions such as Islamic boarding schools. Islamic boarding schools are Islamic educational institutions that have become an integral part of character building of the education system in Indonesia (Syafe'i, 2017). Boarding school-based schools have unique characteristics, integrating religious learning with general education (Kusnandi, 2017). However, in science education, especially physics, these schools often face various challenges. Limited facilities, lack of resources, and traditional teaching methods can hinder the development of students' science literacy (Gunawan & Bahari, 2024).

Physics as a branch of science has an important role in developing critical thinking and problem-solving skills. However, physics learning in Islamic boarding schools often receives less attention than religious subjects. This has the potential to cause an imbalance in the mastery of science knowledge among pesantren students (Aziz et al., 2022). Therefore, it is important to develop solutions that can help improve physics learning in a boarding school environment.

An approach often used in school learning is the STEM approach, which integrates 21st century skills into education by adapting them to the latest curriculum components (Shofiyah et al., 2022). The main focus of STEM education is to improve students' abilities in critical thinking (Çevik, 2018), inquiry (Fraser et al., 2021), problem solving (Julià & Antolí, 2019), reasoning (Struyf et al., 2019), and creativity to address real-world problems (Wahono et al., 2020). However, in physics learning in boarding school-based schools, there is still a lack of integration between STEM and the Qur'anic approach. To overcome this, the STEM-Q (Science, Technology, Engineering, Mathematics, and Qur'an) approach was developed as an effort to combine scientific concepts with Qur'anic values. This approach aims to create learning that not only teaches science, but also integrates religious values that are relevant to students' daily lives. The integration of STEM-Q in education can increase students' learning motivation (Yusuf & Ma'rufi, 2022) and help them link science knowledge with moral and spiritual values.

The application of the STEM-Q approach in physics learning in Islamic boarding schools aims to bridge the gap between religious and science education. By integrating Qur'anic values in physics materials, students are expected to understand scientific concepts in a context that is more relevant to their lives, while increasing engagement in the learning process and reducing the sense of unfamiliarity with science materials (Yulia et al., 2019). To support this approach, technology-based e-modules are one of the learning media that allow students to access materials interactively and flexibly. E-modules equipped with text, images, videos, and quizzes can strengthen student involvement in the teaching and learning process (Prihatiningtyas & Alimah, 2021). Therefore, the development of STEM-Q-based e-modules is expected to provide practical solutions in overcoming the limitations of physics learning in Islamic boarding schools. The e-module is designed to integrate science materials with the values of the Qur'an. By using e-modules, students can learn physics with an approach that is more contextual and relevant to their religious teachings. In addition, e-modules allow learning to be done independently, providing flexibility for students to learn according to their own rhythm (Prihatiningtyas & Sholihah, 2020).

Before e-modules can be widely applied, it is important to conduct evaluation and validation to ensure their practicality and effectiveness. This evaluation involves assessment by experts in the field of education and field trials to obtain comprehensive feedback. This validation aims to ensure that the e-modules meet the necessary quality standards and can be used effectively in the intended educational environment (Gunada et al., 2023). Evaluation of e-modules covers various aspects such as content, benefits, ease of use, media suitability, visuals, and audio. This assessment helps in identifying the strengths and weaknesses of the e-module, as well as making necessary improvements before wider implementation. This is important to ensure that e-modules can provide an optimal learning experience for students (Prihatiningtyas et al., 2023).

This study aims to develop and implement STEM-Q-based e-modules to improve science literacy in boarding school-based schools in Jombang. The research includes several stages, including e-module development, validation by experts, practicality test in schools, and dissemination. With this research, it is expected to find an effective way to improve physics learning in Islamic boarding schools through an approach that integrates Qur'anic values with STEM concepts.

This research also aims to make a significant contribution in developing learning media that is innovative and relevant to the needs of students in Islamic boarding schools. By using STEM-Q-based e-modules, it is expected that students can improve their understanding of physics concepts, while still linking it to their religious teachings. In addition, this research is expected to provide new insights into the application of technology in education in a boarding school environment.

## METHOD

The method applied is research and development, an approach that focuses on creating new products and testing the effectiveness of these products (Sugiyono & Alfabeta, 2003). This development study refers to the concept of the 4-D model proposed by Thiagarajan, which consists of four main steps: define, design, develop, and disseminate (Ekantini & Wilujeng, 2018). In this study, the model was modified into a 4-P model, which includes the steps of Defining, Designing, Developing, and Disseminating. The purpose of using this model in the development of a course (Prihatiningtyas et al., 2012) is to (1) in the early stages of learning, students can know and be able to do activities related to the material that will be learned in the end, (2) create connections between each component, especially in terms of learning media, learning models, and desired learning objectives, (3) explain the steps needed in designing learning designs, (4) provide teaching about science literacy.

This research was conducted on Class XI students of Madarasah Asliyah (MA) hut environment school in Jombang in the academic year 2024/2025 as many as 90 students. The subject of the research is e-module learning media based on the STEMQ approach which was tested on grade XI students at MA X, MA Y, and MA Z in Jombang to build science literacy.

Data collection and analysis techniques

The data for this study were collected through observation, interview, and questionnaire techniques (Cln & Iro, 2013). The data analysis techniques used in this study are described as follows:

1. Media validity/feasibility test

   E-module Feasibility Test was conducted by utilizing the results of data analysis, both quantitative and qualitative, as a guide to assess the suitability of the developed media. Quantitative research uses a questionnaire with a Likert scale as the main instrument. Instructions related to scores using the Likert scale can be found in Table 1.

   **Table 1** Quantitative Analysis Score (Putra et al., 2023**).**

| No | Quantitative Analysis | Score |
|---|---|---|
| 1 | Strongly agree | 4 |
| 2 | Agree | 3 |
| 3 | Disagree | 2 |
| 4 | Strongly disagree | 1 |

   The data collected was analyzed by adding up, comparing against the desired value to produce a percentage, which can be systematically written down:

$$\text{Percentage of eligibility } (\%) = \frac{\text{Observed score}}{\text{Expected score}} x100\%$$

   The data was assessed using a quantitative descriptive analysis method represented through the distribution of scores and percentages against the predetermined rating scale categories. After being presented in percentage form, the next step is to do further description and make conclusions about each indicator. To determine the validity of learning media development, the qualification criteria can refer to Table 2 below.

   **Table 2**Conversion of Achievement Levels (Prihatiningtyas & Sholihah, 2020)

| Level of achievement | Qualification | Description |
|---|---|---|
| 90% - 100% | Very feasible | No need for revision |
| 75% - 89% | Feasible | Revised |
| 65% - 74% | Reasonably feasible | Revised |
| 55% - 64% | Less feasible | Revised |
| 0% - 54% | Not feasible | Revised |

2. Practicality test

   The purpose of the questionnaire sheet used to collect student responses to the learning media is to evaluate how practical the learning media that has been prepared is. The practicality evaluation sheet is then distributed to students with the aim of assessing whether the media has met practical criteria or still requires further adjustment, then analyzed using the following equation:

$$\text{Percentage of eligibility } (\%) = \frac{\text{Observed score}}{\text{Expected score}} x100\%$$

   The determination of the level of practicality is then carried out by referring to Table 3:

**Table 3.** User Response Criteria (Prihatiningtyas & Sholihah, 2020)

| Percentage of Weight | Letter | Value | Predicate |
|---|---|---|---|
| 86% - 100% | A | 4 | Very good |
| 76% - 85% | B | 3 | Good |
| 60% - 75% | C | 2 | Good enough |
| 55% - 59% | D | 1 | Poor |
| 0% - 54% | E | 0 | Not good |

3. Implementation Test

The method used in this research is quantitative-based pre-experimental with a one group pretest-posttest design; where students are tested before and after the application of learning e-modules based on the STEMQ approach.

Data analysis techniques in this study used descriptive statistical analysis techniques. Descriptive statistical analysis technique was used to provide an overview of the characteristics of students' science literacy achievement. Data on student science literacy results were calculated by comparing the number of scores obtained by students with the maximum number of scores then multiplied by 100%. The following is the category of the success rate of students (Riduwan, 2022).

**Table 4.** Learner Success Level Categories

| **Success Rate (%)** | **Category** |
|---|---|
| 81-100 | Very high |
| 66-80 | Good |
| 56-65 | Fair |
| 0-55 | Less |

While the increase in students' concept understanding was analyzed using the results of the pre test and post test, using the normality test (N-Gain) with the formula (Meltzer, 2002 in Prihatiningtyas, 2020):

$$Ngain = \left(\frac{\text{post test value} - \text{pre test value}}{\text{maximum value} - \text{pre test value}}\right)$$

N-Gain criteria (increasing students' concept understanding), can be seen in Table 5 below.

**Table 5.** N-gain categorization (Normalized Gain)

| **Normalized Gain** | **Category** |
|---|---|
| N-Gain ≥ 0,7 | High |
| 0,3 ≤ N-Gain < 0,7 | Medium |
| N-Gain < 0,3 | Low |

## RESULT AND DISCUSSION

This research uses the research and development (R&D) method. The development model used is 4D, namely: define, design, develop, and disseminate. The more complete explanation is as follows:

a. Define

1) Task Analysis

Task analysis aims to identify tasks and competencies that students must master in learning material about light and optical devices. Based on this analysis, it is known that learning about light and optical devices requires an understanding of physics concepts, analytical skills, and application of concepts in the context of everyday life. The integration of STEM aspects and Qur'anic values in the e-module is expected to help students understand concepts holistically and applicatively.

2) Material Analysis

The materials analyzed in this study include basic concepts about light, the properties of light, refraction, shadow formation, and the use of optical devices such as lenses, magnifying glasses, and microscopes. This material was chosen because of its relevance and application in everyday life and in accordance with the basic competencies that must be achieved by students in Islamic boarding schools. The integration of Qur'anic values is also an important element in the e-module to provide religious understanding in line with science learning.

3) Specification of Research Objectives

The purpose of this research is to develop STEM-Q-based learning e-modules that are suitable for implementation in boarding schools. The specification of this research objective includes:

a) Identifying the needs and characteristics of students in boarding schools related to STEM-Q-based learning.
b) Developing e-module content that integrates aspects of science, technology, engineering, mathematics, and contextual and relevant Qur'anic values.
c) Produce learning media that is interactive, interesting, and facilitates students' understanding of the concept of light and optical devices.
d) Testing the validity, effectiveness, and attractiveness of e-modules in the learning process in schools in the boarding school environment.

Based on the analysis of students' needs and characteristics, it was found that students in boarding schools have unique learning needs. In addition to understanding science concepts, they also need learning that not only hones academic skills, but also integrates religious values. Therefore, the development of STEM-Q-based e-modules is relevant and important to provide complete learning, both from the cognitive (Walidain & Ardianti, 2024), affective (Santosa et al., 2021), and spiritual aspects (Raharjo & Puspita, 2023).

The integration of the Qur'an in science learning, especially in light and optical devices, can provide students with a deeper and more contextual understanding. With this approach, students are expected to not only understand science concepts logically and analytically, but also be able to see the connection between science and the religious values they believe in.Overall, the results of the analysis show that the development of STEM-Q-based e-modules has great potential in improving the quality of learning, especially in boarding schools. The developed media can answer learning needs in an innovative, holistic way, and in accordance with the context of education in pesantren.

b. Design

1) Preparation of Learning Implementation Plan

The lesson plan developed in this study was used as a teacher's guide for teaching in four meetings. The details of the lesson plans used can be seen in Table 6.

**Table 6** List of learning implementation plan instruments

| Meeting | Teaching Material | Time Allocation |
|---|---|---|
| 1 | Camera | 2x45’ |
| 2 | Eye | 2x45’ |
| 3 | Microscope and Lup | 2x45’ |
| 4 | Binoculars and Periscope | 2x45’ |

2) Selection of STEMQ-Based E-Module Media with the Assistance of Flip PDF Professional

The STEMQ-based e-module is developed using Flip PDF Professional software to enhance the visual appeal and interactivity of learning. The selection of Flip PDF Professional is based on several considerations:

- Ease of Use: Flip PDF Professional allows developers to create interactive e-modules with features like flipping effects, hyperlinks, and integrated media such as videos, images, and audio that support the STEMQ concept.
- Interactive Design: The e-modules are equipped with easy navigation, appealing icons, and a design that aligns with the principles of teaching in Islamic boarding schools. The content in the e-modules is also designed considering the integration of science, technology, engineering, mathematics, and Qur’anic values.
- Accessibility and Portability: The resulting STEMQ-based e-modules can be accessed both offline and online, and are compatible with various devices such as laptops, tablets, and smartphones, making it easier for students to learn anytime and anywhere.

3) Development of Student Activity Sheets (LKPD)

The Student Activity Sheet serves as a guide for students to learn and practice understanding the concepts being studied in the subtopics covered. The researcher developed LKPD for four sessions, all of which are in the form of experimental activities.

4) Development of Science Literacy Tests

The science literacy test is designed to measure students' ability to understand scientific concepts and how these concepts are integrated with the STEMQ (Science, Technology, Engineering, Mathematics, Qur'an) approach. The test development follows these stages:

a) Analysis of Basic Competencies (KD) and Learning Objectives: The basic competencies derived from the pesantren curriculum serve as the foundation for designing test questions. These questions are connected with STEM elements and Qur'anic values.
b) Determining Question Indicators: Question indicators are designed according to Bloom's cognitive domains, which include understanding, analyzing, and applying scientific concepts in daily life while linking them to Qur'anic values.
c) Development of Test Questions: The test consists of 15 essay questions that integrate science with technology, engineering, mathematics, and Qur'anic values. These questions are arranged considering varying levels of difficulty and tailored to the characteristics of students in a pesantren environment.

5) Research Format Design

The format selection is adapted to the required format for educational media, ensuring that the media can address the issues faced in the learning process.

c. Develop

1) Validation of Learning Tools

The development phase includes evaluations by experts and practitioners, as well as testing of the developed product. The average validation results from media experts and subject matter experts are shown in Table 7.

**Table 7**Evaluation Results of Learning Tools

| No. | Type of Instrument | Assessment Aspect | Average Score | Category | Reliability (%) |
|---|---|---|---|---|---|
| 1 | Lesson Plan (RPP) | Learning Objectives | 3.97 | Very Good | 99 |
| | | Learning Activities | 3.47 | Good | 92 |
| | | Time Allocation | 3.31 | Good | 94 |
| | | Learning Instruments | 3.25 | Good | 96 |
| | | Presentation Method | 3.58 | Very Good | 91 |
| | | Language | 3.44 | Good | 95 |
| 2 | STEMQ-Based e-Module | Content Components and Feasibility | 3.30 | Good | 92 |
| | | Language Components | 3.00 | Good | 100 |
| | | Presentation Components | 3.10 | Good | 99 |
| 3 | Student Worksheet (LKPD) | Instructions | 3.90 | Very Good | 98 |
| | | Content Feasibility | 3.30 | Good | 95 |
| | | Procedures | 3.40 | Good | 96 |
| | | Questions | 3.50 | Very Good | 99 |
| 4 | Science Literacy Test | Instructions Aspect | 3.84 | Very Good | 98 |
| | | Question Construction | 3.60 | Good | 95 |
| | | Language and Question Writing | 3.23 | Good | 94 |

Based on the validation results of the learning tools, which include the Lesson Plan (RPP), STEM-Q-based e-modules, Student Worksheets (LKPD), and scientific literacy tests, the following is an analysis and discussion of these results:

a) Lesson Plan (RPP)

In the learning objectives aspect, the RPP received an average score of 3.97 with the category "Very Good" and a reliability of 99%. This indicates that the learning objectives in the RPP align with the expected competencies and are well-structured. However, in aspects such as learning activities, time management, learning tools, and language, the scores fall within the "Good" category, with averages ranging from 3.25 to 3.47 and reliability between 92% to 96%. This suggests that although these components are good,

there is still room for improvement, particularly in time management and the details of the learning tools.

In the presentation method aspect, a score of 3.58 ("Very Good" category) indicates that the strategies and learning approaches used are relevant and effective in the context of STEM-Q-based learning. Meanwhile, the language aspect, with a score of 3.44, highlights the need for refinement in the use of terms to ensure better comprehension by students.

b) STEM-Q-Based E-Module

The STEM-Q-based e-module received an average score categorized as "Good" across all aspects, with content feasibility at 3.30 (92% reliability), linguistic components at 3.00 (100% reliability), and presentation components at 3.10 (99% reliability). These results indicate that the e-module is generally feasible and effective in supporting STEM-Q-based learning. However, the linguistic component, which received the lowest score (3.00), suggests the need for further review, particularly in using appropriate and contextual language in the pesantren environment. The presentation component can also be improved by enhancing the structure and creating a more engaging and interactive interface.

c) Student Worksheets (LKPD)

In the instructions and procedures aspect, the LKPD received high average scores of 3.90 and 3.40, categorized as "Very Good" and "Good," respectively, with reliability of 98% and 96%. This indicates that the instructions in the LKPD are clear and easy for students to follow. The content feasibility aspect, with a score of 3.30 ("Good" category), suggests that the material presented is sufficiently relevant but may require further refinement to be more contextual and integrated with the STEM-Q approach. The question aspect of the LKPD, with a score of 3.50 ("Very Good" category), demonstrates that the questions are well-designed to stimulate students' critical and analytical thinking. This is a positive aspect of implementing the STEM-Q approach, which emphasizes problem-solving.

d) Scientific Literacy Test

The scientific literacy test shows satisfactory validation results, especially in the instructions aspect (score 3.84, "Very Good" category) and test construction (score 3.60, "Good" category). This indicates that the test is well-structured and aligns with the expected goals of scientific literacy. The language and question-writing aspect, with a score of 3.23, remains in the "Good" category but indicates that some improvements are needed in using simpler and more consistent language.

Overall, the validation results indicate that the developed learning tools meet the eligibility criteria for implementation in STEM-Q-based learning in the pesantren environment. The average scores, categorized as "Good" to "Very Good," show that these tools are effective, although some aspects still need improvement, particularly in language use and content presentation. With improvements in these components, it is hoped that these learning tools can provide more optimal results and support holistic and contextual learning in line with Islamic values. The integration of STEM into these learning tools makes them more meaningful (Lutfi et al., 2018; Afriana et al., 2016), highlighting the importance of implementing learning with teaching materials that effectively achieve learning objectives. Therefore, selecting the STEM approach in this research is highly appropriate.

2) Implementation in Learning

After the learning tools were validated by experts, the next step was to implement them in three pesantren-based schools in Jombang. A total of 90 students were involved, with each school—MA X, MA Y, and MA Z—having 30 students. The results of the STEM-Q-based e-module implementation were then tested using a scientific literacy test, showing improvement as illustrated in Figure 1.

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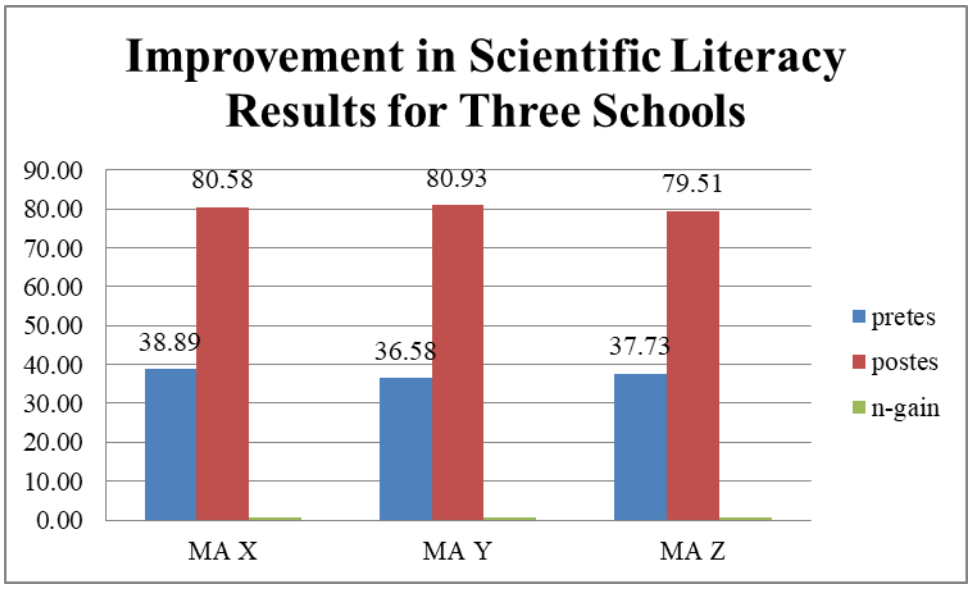


**Figure 1.** Improvement in Scientific Literacy Results for Three Schools

The implementation of the STEM-Q-based e-module in three Madrasah Aliyah (MA) in Jombang showed significant improvement in students' scientific literacy scores. This improvement was measured by comparing pretest and posttest scores and calculating the n-gain value. At MA X, the average pretest score was 38.89, indicating a relatively low initial understanding of scientific literacy. After learning with the STEM-Q-based e-module, the posttest score significantly increased to 80.58. The N-Gain score of 0.64 indicates that the improvement in students' understanding is in the moderate category. This suggests that the STEM-Q-based learning method had a positive and effective impact on enhancing students' scientific literacy. Students at MA Y also experienced significant improvement. The average pretest score of 36.58 increased to 80.93 in the posttest. The N-Gain score of 0.67 indicates that the increase in scientific literacy is in the moderate category and is slightly higher than at MA X. This demonstrates that the e-module used was able to bridge the initial gap in students' understanding of science and effectively improve their competence. At MA Z, the average pretest score was 37.73 and increased to 79.51 in the posttest. The N-Gain score obtained was 0.64, also in the moderate category. Although the results are not significantly different from the other two schools, this improvement shows that the use of the STEM-Q-based e-module consistently enhanced students' scientific literacy.

Overall, the results from the three schools indicate that the STEM-Q-based e-module is effective in improving students' scientific literacy in pesantren environments. With N-Gain scores ranging from 0.64 to 0.67, the improvement achieved falls within the moderate category. This suggests that the e-module helps students better understand scientific concepts (Arnila, 2021), integrating Quranic values with the STEM approach, which is relevant to the learning needs of pesantren-based madrasahs.

This success may indicate that the learning method integrating science, technology, engineering, and mathematics with the Quran can enhance students' understanding and interest in scientific literacy (Kiswanda et al., 2022).

3) Practicality Test

After the implementation activities were carried out, the practicality of the STEM-Q-based e-module was tested by having students fill out a practicality questionnaire to assess how practical the developed media is. Figure 2shows the results of the practicality test from the three schools.

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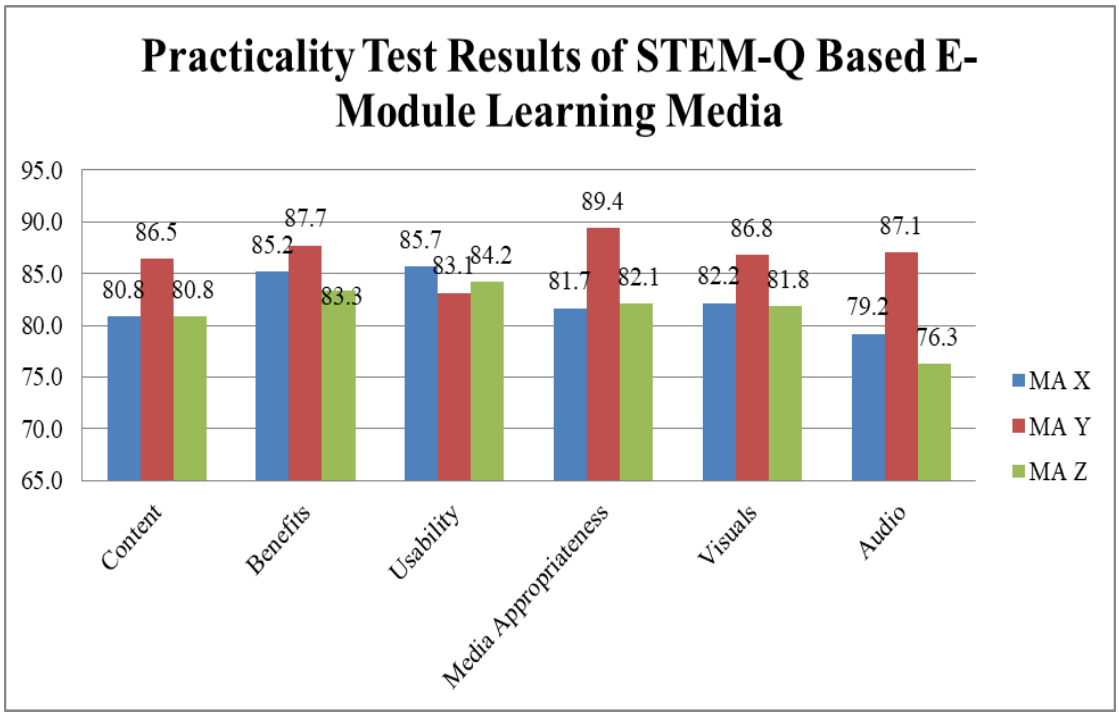


**Figure 2.** Practicality Test Results of STEM-Q Based E-Module Learning Media

The results of the practicality test for the STEM-Q-based e-module from three Madrasah Aliyah (MA) in Jombang indicate that this learning media is generally considered practical by users across various aspects, such as content, benefits, ease of use, media relevance, visuals, and audio. The following is a more detailed discussion of the results:

The average content aspect rating shows that the material in the e-module was rated quite well by all three schools. MA Y gave the highest score (86.5), indicating that students and teachers at this school felt the material presented was highly relevant to their learning needs. Although MA X and MA Z had lower scores (80.8), this aspect is still considered good and relevant, with room for improvement in content delivery. The benefit aspect received high ratings from all three schools, with the highest score at MA Y (87.7). This indicates that the e-module provided significant benefits in supporting students' learning, especially in the pesantren context. The slight differences in scores between MA X and MA Z show that the benefits of this e-module are felt almost evenly across different school environments. The ease of use aspect was rated quite well in all schools, with the highest score at MA X (85.7). This suggests that the interface and structure of the e-module are easy for users to understand and operate. The differences in scores between schools are not very significant, indicating that this e-module is user-friendly across various contexts. The relevance of the media to learning needs was rated highest at MA Y (89.4). This shows that the e-module is highly relevant to the curriculum and learning situation at that school. The slightly lower scores at MA X and MA Z (81.7 and 82.1) still indicate good relevance, though some adjustments may be needed to optimize it further. The visual aspect was rated well by all schools, with the highest score at MA Y (86.8). This shows that the graphical design and layout of the e-module are attractive and support the learning process. The other schools also gave positive ratings, although there is room for improvement in visual elements to make them more engaging and interactive. The audio aspect received more varied ratings, with MA Y giving the highest score (87.1), while MA Z had the lowest score (76.3). This indicates that audio quality and clarity could be improved, especially at MA Z. It is important to ensure that the audio in the e-module is clear and easy for all students to understand.

The practicality test results show that the STEM-Q-based e-module is generally practical for use in pesantren-based madrasahs. Overall, the feedback from teachers and students regarding the STEM-Q-based e-module is very positive. This is due to the ease of access (Herlina et al., 2022), which can be used via smartphone or personal computer, either in the form of a link, PDF, or image (JPG/PNG). The e-module is designed with appealing colors and

designs, so students do not get bored while studying physics. Additionally, the learning videos included in the module help students improve their understanding through audio-visual media.

d. Dissemination

At the dissemination stage, the main focus is to introduce and apply the STEM-Q-based e-module more widely after it has undergone validation and limited implementation in three Madrasah Aliyah (MA). The dissemination is carried out to ensure that the benefits of this e-module can be felt by more students, especially in pesantren-based schools.

## CONCLUSION

The research on the development and implementation of a STEM-Q-based e-module for Islamic boarding school-based madrasahs in Jombang shows positive and significant results in improving students' science literacy. The e-module successfully integrates the STEM approach with Qur'anic values, creating a learning medium that is not only academically relevant but also contextually aligned with the boarding school environment.

Validation results indicate that the e-module has a good level of practicality, with positive assessments in terms of content, benefits, ease of use, media suitability, visuals, and audio. Implementation in three schools resulted in a significant increase in science literacy scores, with N-Gain values falling in the medium category, demonstrating the effectiveness of this media in the learning process.

The dissemination of the e-module to other schools also showed good acceptance, with positive feedback from new users, both teachers and students. This indicates that the STEM-Q-based e-module has the potential for wider application in Islamic boarding school-based educational environments.

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