

DEVELOPING STEAM-BASED INTERACTIVE E-MODULES WITH RELIGIOUS INTEGRATION TO ENHANCE STUDENTS' MATHEMATICAL LITERACY

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ABSTRACT

In the digital era, the challenge of learning lies not only in the delivery of material, but also in how the material is packaged to be meaningful and relevant to students. The use of technology in education, combined with STEAM (Science, Technology, Engineering, Arts, Mathematics) learning with the integration of religious values to improve mathematical literacy, is a potential strategy to improve the quality of student understanding, especially in mathematics learning. Therefore, this study aims to develop and assess the feasibility of a STEAM-based interactive e-module with the integration of religious values to improve students' mathematical literacy in statistics material. The research method used was Research and Development (R&D) with the ADDIE development model. The validation results showed that the developed interactive e-module was highly valid, with a score of 92.94% from media experts and 92.86% from material experts. In terms of practicality, student responses resulted in a score of 88.66% in the small-scale trial and 81.04% in the large-scale trial, both categorized as highly practical. Regarding effectiveness, the module achieved an effectiveness score of 76% in the small-scale trial and 88% in the large-scale trial. Furthermore, the effect size analysis showed a value of 0.7 in the small-scale trial and 1.2 in the large-scale trial, indicating a substantial increase in students' mathematical literacy. Thus, the findings suggest that the developed e-module is valid, practical, and effective for use as an interactive, innovative, and contextual mathematics learning medium that integrates religious values.

Keywords: *Interactive E-module, STEAM, Integration of Religious Values, Mathematical Literacy*

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Submission Jun 4, 2025	Revised July 12, 2025	Accepted July 20, 2025	Published August 2, 2025
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How to cite (in APA style):

Putri, D. P., Syaf, A. H., & Widiastuti A, T. T. (2025). Developing STEAM-based interactive e-modules with religious integration to enhance students' mathematical literacy. *Jurnal Pendidikan Matematika (JPM)*, 11(2), 129–140. <https://doi.org/10.33474/jpm.v11i2.23932>

INTRODUCTION

In the world of education, advancements in learning media have become a major concern amidst the development of information and communication technology (Nurhayati et al., 2024). Integrating the learning process with digital technology is a crucial transformation, particularly in increasing the effectiveness and efficiency of the learning process. This creates new opportunities for creating innovative and effective learning. According to Larson & Miller (2011) The use of technology in the learning process is essential because of its potential and ability to encourage student engagement in the learning process, making it more active and interactive.

Learning media itself has several roles, including concretizing/visualizing abstract concepts and assisting students in explaining material that is difficult to understand verbally (Susanti, 2020). One learning medium that can be developed in mathematics learning is electronic modules, better known as e-modules. The use of e-modules as a learning medium has the potential to clarify concepts more effectively because it presents information in various formats, including textual, visual, audio, and audiovisual content. Mathematics itself is the foundation of all science, playing a vital and useful role in various areas of life. As stated by Sholihah (2024), every student needs to have mathematical knowledge. Therefore, it is crucial for each student to understand different mathematical concepts, especially in real-world contexts. The ability to apply, explain, and understand mathematical concepts to solve everyday problems is part of the competency developed in the school environment through a mathematics learning approach.

According to the Organisation for Economic Cooperation and Development (OECD), mathematical literacy is a student's ability to formulate, use, and interpret mathematics in various contexts. This includes the ability to reason mathematically and the ability to use mathematical concepts, facts, procedures, and functions to describe, explain, and predict phenomena (OECD, 2023). Mathematical literacy skills encourage students to understand the function and contribution of mathematics in solving real-world problems encountered in everyday life. Therefore, mathematical literacy skills are crucial for every student to understand the true function of mathematics as a foundation for thinking and decision-making in problem-solving (Novalia & Rochmad, 2018).

According to Faiz Hamzah, the integration of religious values can be achieved using an interdisciplinary approach. One example is linking the Kauniyah verses in the Quran and religious values to learning materials so that the resulting understanding can be deepened and strengthened in Nisa', A. Z., Abdussakir. A., 2023). The integration of religious values in question relates to linking and integrating concepts from various scientific fields contained in the STEAM concept with religious values without losing the essence or purpose of these disciplines. One way to demonstrate the integration of religious values in e-learning modules is by using materials, practice questions, and evaluation tests that address issues from an Islamic perspective while maintaining the competency standards implemented in the curriculum. This is an effort to create better and more adaptive mathematics teaching materials, so that the learning process will be more realistic because it is explicitly linked to various problems that exist in the students' environment. Interactive STEAM-based e-modules with the integration of religious values can be used as an effective alternative solution in the development of interactive e-modules in mathematics learning. This is because it can combine an interdisciplinary approach in the learning process so that students can connect various educational fields in a more varied way. Furthermore, the integration of religious values can be concretely linked to mathematics in everyday life, so that students' thought processes can be more clearly visualized.

STEAM-based learning, which integrates science, technology, engineering, arts, and mathematics into real-life contexts, is known to foster critical and creative thinking as well as problem-solving skills among students. When integrated with religious values, this approach not only promotes cognitive development but also reinforces moral and character education. Several studies have previously developed STEAM- or STEM-based e-modules and reported them to be feasible and effective in various educational contexts. However, these studies often lacked the integration of Islamic values in mathematics instruction, particularly on statistical content such as measures of central tendency. In addition, most of the existing modules were designed for junior or senior high school students and did not consider the unique needs and characteristics of students in Islamic schools (madrasah). Many of these modules were also not fully interactive or contextualized to students' real-life environments.

To address these gaps, this study aims to develop a STEAM-based interactive e-module that integrates Islamic values to improve students' mathematical literacy, specifically tailored for statistics learning at the MA level.

METHOD

This study employed the Research and Development (R&D) method using the ADDIE model, which consists of five stages: Analyse, Design, Development, Implementation, and Evaluation. This model was chosen due to its systematic and structured approach in developing learning products, as explained by Branch (2009). In addition Hidayat, F. and Nizar (2021) emphasized that the ADDIE model supports the development of learning media in a logical and organized manner.

In the Analyse stage, observations and interviews were conducted with mathematics teachers in classes X-I and X-II to gather information regarding curriculum, student characteristics, and the need for digital learning media. In the Design stage, the researcher formulated research instruments, including expert validation sheets, practicality questionnaires for students, and pre/post-tests on mathematical literacy. These instruments were developed based on relevant literature and indicators, and were reviewed by experts before implementation. The researcher also created the initial design of the interactive e-module based on a predefined storyboard and user interface considerations.

During the Development stage, the interactive e-module was created using Canva and exported into HTML format via iSpring Suite 11. The HTML version was then converted into an Android-compatible application using Website 2 APK Builder Pro. The module underwent validation by two expert reviewers: (1) Wildan Budiawan Z., S.T., M.Kom., a lecturer in Informatics Engineering at UIN Sunan Gunung Djati Bandung, who served as the media expert, and (2) Yuyu Nurhayati Rahayu, S.Si., M.Stat., a lecturer in Mathematics Education at the same university, who acted as the material expert. Both validators possess relevant academic backgrounds and professional experience in digital learning media and mathematics education. Suggestions from both experts were incorporated into the revision of the e-module.

In the Implementation stage, the validated e-module was tested in classroom settings through small-scale and large-scale trials. Students used the module during mathematics lessons and were then asked to complete practicality questionnaires and mathematical literacy tests (pre- and post-tests).

Finally, in the Evaluation stage, the researcher analysed data from the previous stages to assess the feasibility, practicality, and effectiveness of the STEAM-based interactive e-module with the integration of religious values.

RESULT

The first stage is Analyse. At this stage, the researcher conducts an analysis of three main aspects, namely: (1) curriculum analysis, (2) analysis of student characteristics, and (3) analysis of students' learning media needs. In the curriculum aspect, the focus is on Grade X at MA Ar-Rosyidiyah. The school implements the Independent Curriculum, and the selected topic for this research is statistics. This topic was chosen because it is closely related to everyday life and relatively easy for students to observe and apply in real contexts.

Moreover, statistical content such as data collection and measures of central tendency provides opportunities for contextual learning that reflects students' real-world experiences. It also facilitates the integration of STEAM elements and religious values, making it highly relevant to the objectives of this study. The following learning outcomes based on curriculum domains are presented in Table 1.

Table 1. Learning Outcomes of Phase E

Element	Learning Outcomes
Data analysis	Students can understand and determine measures of central tendency, such as the mean, median, and mode, and use them to analyze and solve problems.

Based on these learning outcomes, the researcher outlined more specific learning objectives for STEAM-based interactive e-modules with integration of religious values as can be seen in Table 2.

Table 2. Learning Objectives

Domain Learning Objectives	Learning Outcomes
D.3 Determine the centrality measure of the data set (mean, median, and mode) on a single data	Determine and calculate measures of central tendency (mean, median, mode) in a data set. Apply the concepts of mean, median, and mode to analyze and solve problems related to the integration of religious values. Apply the concepts of mean, median, and mode to analyze and solve problems in various contexts, such as economics, social sciences, and science.

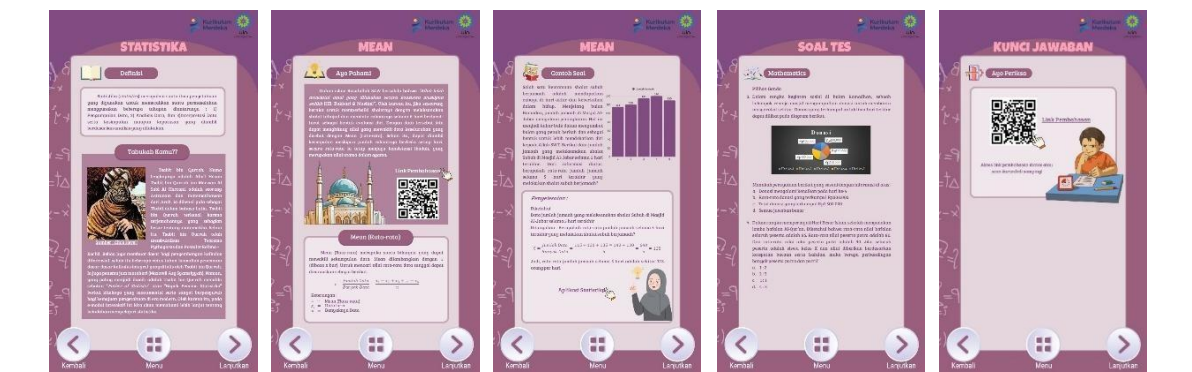
Next, an analysis of student characteristics was conducted. In this analysis, the researchers obtained the following data: (1) 62% of grade 10 students at MA Ar-Rosyidiyah still experience difficulty understanding abstract mathematical concepts; (2) 48.3% of students stated that the current teaching materials do not fully support their understanding of mathematics; (3) 72.4% of students prefer a visual learning style, 55.2% prefer a kinesthetic learning style, and 31% prefer an auditory learning style. (4) 89.6% of students indicated a connection to the use of technology in mathematics learning. MA Ar-Rosyidiyah has a relevance that supports the development of interactive e-modules based on religious values, which are included in the materials, practice questions, and other discussions. Furthermore, the results of the student needs analysis using Google Forms showed strong support for the integration of religious values in mathematics learning. Specifically, 85.7% of students agreed that it was necessary to develop interactive STEAM-based e-modules with Islamic integration. Furthermore, 71.4% of students believed that such integration helped them understand mathematical concepts in everyday life. Furthermore, 66.7% of students stated that religious content made learning more relevant. These findings reinforce the importance of integrating moral and religious values as part of e-module content design.

The second stage, design, involved several steps, starting with the formulation of research instruments: (1) compiling validation sheets for media and materials experts, as well as questionnaires assessing student practicality; (2) media selection, which involved determining the media to be developed, taking into account the achievement of learning objectives, suitability to student characteristics, and support for STEAM learning integrated with religious values. The main software chosen by the researcher is to use Canva to design interactive e-modules which are then made into HTML using Ispring 11 and converted into application form with the help of Website 2 APK Builder Pro, (3) format selection, namely determining the elements that are arranged and used in the development of the interactive e-module that will be developed, (4) initial design, namely designing by adjusting to the elements and needs that have been determined.

Table 3. Results of Interactive E-Module Design
Cover and introduction



Contents Section



Closing Section



The third stage is the Development stage. In this stage, the researcher refined each component that was designed during the previous phase. This included the full development of a STEAM-based interactive e-module integrated with Islamic values, focusing on statistical material. One example of this integration is reflected in a contextual problem provided in the e-module, as shown below:

1. In the “Jumat Berkah” (Blessed Friday) social program, tenth-grade students at a Madrasah Aliyah in Bandung collect donations each week. Initially, the average donation per student was Rp6,000. Then, one student donated Rp9,000, causing the overall average donation to increase to Rp6,500. A few days later, eight other students donated additional amounts (in thousand rupiahs): 3, 4, 5, 4, 8, 5, 2, 4.
 - a. What mathematical information can you extract from this story? How would you model it mathematically? (*Indicator: Formulate*)
 - b. What is the new average donation after all the additional data is included? (*Indicator: Employ*)
 - c. If the minimum target average donation is Rp6,500, how would you evaluate the outcome? Connect your answer with the Islamic values of sincerity and blessing. (*Indicator: Interpret*)

Figure 1. Example Questions on the Integration of Religious Values

This item was designed not only to enhance students' critical thinking and contextual problem-solving but also to incorporate spiritual reflection through the integration of religious values within the mathematics learning process. This approach helps make the learning more meaningful and relevant to students' real-life experiences.

After the module was fully developed, it was validated by a media expert and a content expert. The validation results are presented as follows:

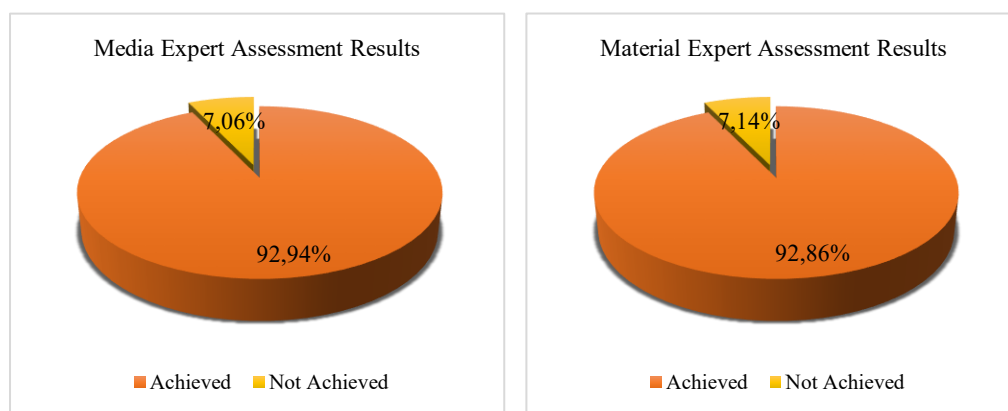


Figure 2. Interactive E-Module Validation Results

Based on the figure above, the interactive e-module achieved a media validation score of 92.94% and a material validation score of 92.86%, both of which fall into the “very valid” category. These results indicate that the module is highly appropriate in terms of visual design, usability, content accuracy, and alignment with learning objectives. The integration of STEAM elements and religious values was also deemed suitable and contextually relevant. This high level of validity reflects the effectiveness of the module's design process and its alignment with the needs of students in madrasah settings.

Despite the high scores, both experts provided constructive feedback for improvement. Suggestions included adjusting the font type and size for better readability, refining the layout of the main menu, and converting pie chart visuals into more detailed tables. Additionally, the material expert recommended enhancing religious integration in the content by modifying some questions to better reflect Islamic values. The feedback also emphasized the importance of contextual examples to improve student engagement. All input was incorporated into the revised version of the module, ensuring both pedagogical quality and contextual relevance before classroom implementation.

Table 4. Results of the Interactive Mathematics E-Module Revision (Part 1)

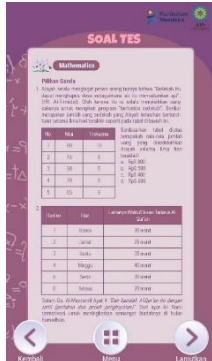
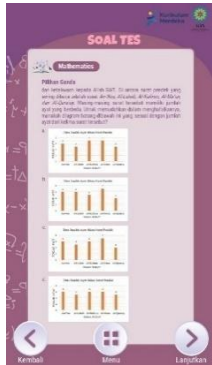
No.	Validator Suggestion	After Revision
1	Change the entire content of the material from the “Bree Serif” font type to the “Roboto Condensed” font type and the font size from size 12 to 14.	
2	On the “All Menu” page, only the main menu features are displayed.	
3	The addition of an "Other Menu" that allows access to more comprehensive additional menu features.	
4	Changes in each pie chart display are converted into a table form in more detail.	

Table 5. (Continued) Results of the Interactive Mathematics E-Module Revision (Part 2)

No.	Validator Suggestion	After Revision
5	Changes to the content of test questions related to prayer into short letters	
6	Additional information regarding Supervisors	

The fourth stage, implementation, is carried out after passing the validity test stage by media and material experts, having been revised and declared suitable for use. Then, a trial will be conducted on class X students at MA Ar-Rosyidiyah. The trials will include small-scale trials and large-scale trials. The following is a description of the trial process, which can be seen in Figure 3.

**Figure 3.** Interactive E-Module Trial Process

During the small and large-scale trials, students used the interactive e-module throughout the mathematics learning sessions. At the end of each trial, they were asked to complete a practicality questionnaire designed to assess the ease of use, engagement, and overall functionality of the developed e-module. This instrument aimed to capture students' perceptions regarding the module's clarity, accessibility, and relevance to the learning material. The collected responses provided valuable insights into how effectively the e-module supported student learning. The results of this practicality assessment are presented in Figure 4.

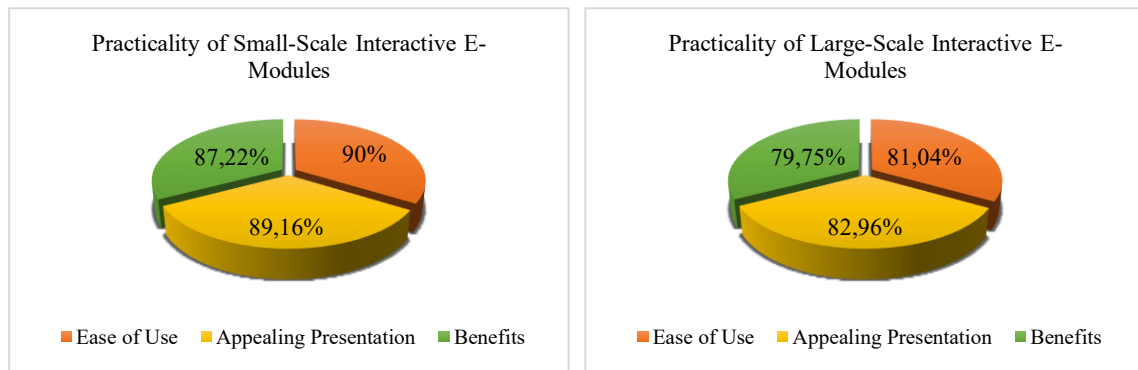


Figure 4. Results of the Practicality Analysis of the Interactive E-Module

Based on Figure 4, the overall score percentage was 88.66%, with the criteria being very practical, in the small-scale trial. Then, the overall score percentage was 81.04%, with the criteria being very practical, in the large-scale trial. In addition, students' mathematical literacy skills were measured through pre-tests and post-tests on statistics. The results showed an increase in mathematical literacy skills after using the interactive e-module. Students demonstrated progress in formulating contextual problems, selecting solution strategies, applying mathematical procedures, and interpreting results in real-life contexts. This reflects the achievement of mathematical literacy indicators as described by the OECD (OECD, 2019), namely the ability to formulate, apply, and interpret mathematics in a variety of relevant and meaningful contexts.

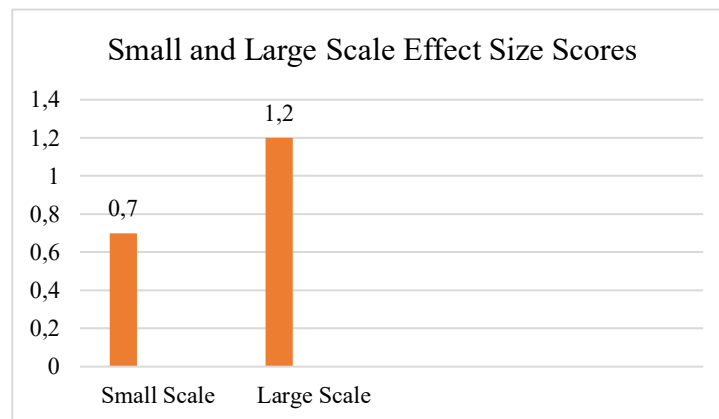


Figure 5. Effect Size Score for Effectiveness of Mathematical Literacy Improvement

The effect size value obtained from the effectiveness test results on students' mathematical literacy improvement, both on a small and large scale, is presented in Figure 5. The effectiveness analysis in this study was conducted using the effect size calculation Cohen's (K. H. Becker & Park, 2011) without applying a statistical significance test such as a t-test.

The Evaluation stage is the final step in the ADDIE development model. In this phase, all data from the previous stages were analysed to assess the feasibility, practicality, and effectiveness of the developed interactive e-module. Overall, the findings demonstrate that the STEAM-based interactive e-module is an effective learning tool for mathematics education that supports contextual learning and character development through the integration of religious values.

DISCUSSION

Based on the research findings, the development of this interactive e-module aims to improve students' mathematical literacy through STEAM (Science, Technology, Engineering, Arts, and Mathematics)-based learning integrated with religious values. The development was conducted at MA Ar-Rosyidiyah with 10th-grade students through small-scale and large-scale trials. The material developed focused on statistics, specifically measures of central tendency. The development process followed the ADDIE model, which consists of the stages of Analysis, Design, Development, Implementation, and Evaluation. The selection of the ADDIE model aligns with Mulyaningsih's opinion in Izza, H., Wardhono, W. S., Suharsono (2023) which states that this model is logical and comprehensive, and suitable for use in developing various quality educational products.

During the analysis phase, the curriculum, student characteristics, and learning media needs were identified. The results indicated that students' mathematics learning mastery was still relatively low, and learning tended to be conventional. Although students had used digital devices, technology-based learning media had not been optimized. STEAM learning had never been implemented before, and the integration of religious values into mathematics had not been explicitly applied. Therefore, this prompted researchers to develop an e-module that was not only interactive but also grounded in religious and scientific values. The inclusion of religious elements such as Islamic values embedded in examples, activities, and reflection questions was perceived positively by students. According to questionnaire responses, over 70% of students agreed that religious integration helped them better understand mathematical content and made the material more relevant to daily life.

The design phase included developing validation instruments, selecting media and e-module formats, and creating an initial storyboard-based design. Planning was carried out systematically, considering visual design, interactivity, and ease of navigation. This design was then implemented on the Canva platform and converted to PowerPoint to add mathematical features such as equations, before finally being developed into HTML and an application.

Product development was carried out by compiling the complete module based on the design. Validation was conducted by media experts and content experts. Both provided constructive input that was used in the revision process to refine the e-module's appearance and content. The validation results indicated that the e-module was of excellent quality and suitable for use in learning. The implementation phase then involved two pilot trials directly supervised by a mathematics teacher. Before use, students were provided with a guidebook and an application link. During the learning process, students accessed materials through the app or via a PDF version for incompatible devices. Issues with certain devices, such as iPhones, were addressed by using projectors and providing alternative formats that retained interactive features.

The evaluation stage was conducted through an analysis of validation results, practicality, and effectiveness. Media and content validation scores exceeded 92%, indicating strong validity. Student practicality assessments also showed the module was easy to use, engaging, and useful. Effectiveness was analysed by comparing learning outcomes before and after using the e-module. Results showed a notable improvement in students' mathematical literacy skills, with an effect size of 0.7 in the small-scale trial and 1.2 in the large-scale trial, reflecting medium to high effectiveness. These findings support the conclusion that the module successfully combines interactive learning with moral and contextual relevance.

In line with this, Aspriyani and Suzana in Rohmatulloh et al., (2023) emphasized that practical e-modules can enhance students' understanding of the content. Additionally, as

noted by Tambusai and Rakhmawati (as cited in Iriani et al., 2025) the STEAM approach can increase student engagement and support the achievement of higher learning outcomes. The increase in students' mathematical literacy through this module further confirms these benefits. Thus, the STEAM-based interactive e-module with the integration of religious values is declared valid, practical, and effective for use in mathematics learning.

Despite its promising outcomes, this study has several limitations that should be acknowledged. First, the implementation was limited to a single institution (MA Ar-Rosyidiyah) and only involved 10th-grade students, which may affect the generalizability of the findings. Second, the study did not include a long-term evaluation to assess the retention of learning or changes in behavior over time. Third, although the effect size was reported, no statistical significance testing such as a t-test was conducted, which could have provided more robust evidence of the learning gains. These limitations open opportunities for future studies to expand the scope and apply more comprehensive data analysis techniques to strengthen the findings.

CONCLUSION AND SUGGESTIONS

Based on the research findings, it can be concluded that the STEAM-based interactive e-module, which integrates religious values, developed for the topic of measures of central tendency, is valid, practical, and effective for mathematics learning. The module's validity is supported by high scores from media and material experts, and its practicality is evidenced by positive responses from students in both small- and large-scale trials. The module also proved effective in improving students' mathematical literacy, particularly in formulating contextual problems, applying statistical concepts, and interpreting results in real-life situations.

A notable contribution of this study lies in the integration of Islamic values within mathematics content. Students engaged with contextual problems that incorporated ethical and spiritual reflections, such as sincerity and blessings, which enriched the learning experience. Survey data from the needs analysis further revealed that a majority of students found religious integration helpful in understanding mathematical concepts and making learning more relevant.

Given these outcomes, it is recommended that teachers consider using this module as an alternative medium that is not only interactive and contextual but also supports value based learning. For future research, a more rigorous experimental design could be employed to compare the module's effectiveness against conventional learning approaches. Additionally, studies could focus on refining specific aspects such as the interactivity of the module, the design of embedded assessments, and the degree of integration of religious or character values across different mathematical topics.

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