e-ISSN: 2355-620X
DOI: 10.12928/jrkpf.v12i2.1272

Analysis of the needs for STEM-R-based e-module on renewable energy topic for madrasah tsanawiyah students

Mega Kurnia, Hamdi Akhsan, Ismet

Master of Physics Education Program, Universitas Sriwijaya, Palembang, Indonesia

Email: hamdiakhsan@fkip.unsri.ac.id

Abstract
This study analyses the needs of STEM-R-based e-modules through a quantitative descriptive method. The survey of 325 students from four MTs in South Sumatra used stratified random sampling. The 27-item instrument, comprising 10 indicators, was validated using the Rasch model with a reliability of 0.74. Integrating religious values into STEM is essential to align with moral and ethical principles. As a result, 49.1% of students liked the multimedia e-modules with interactive quizzes, and 38.5% emphasised integrating Islamic values in science learning. Additionally, 36.8% showed strong interest in solar energy topics. These insights provide empirical support for designing an e-module that enhances science literacy, environmental awareness, and Islamic character development. Findings highlight the feasibility and relevance of context-specific, interactive, and value-integrated STEM-R. This study confirms the demand for digital learning resources that combine scientific knowledge with moral principles, underscoring the potential of STEM-R to support holistic education in Islamic schools.

Keywords: e-Module, Needs Analysis, STEM-R

Article submitted 2025-02-03. Revision uploaded 2025-05-31.
Accepted for publication 2025-07-11.
Available online on 2025-10-31.
https://doi.org/10.12928/jrkpf.v12i2.1272

I. Introduction

STEM (Science, Technology, Engineering, and Mathematics) has become a global focus in improving education quality by enhancing students' cognitive development, scientific attitudes, and problem-solving skills [1], communication skills [2], creative thinking [3], reflective and critical thinking [4], analytical and collaborative skills [5], which can be considered as 21st-century student skills. This approach is recognised as capable of preparing the younger generation to face global challenges and rapid technological advancements [6].

However, with the advancement of technology pursued in STEM education, religious studies are increasingly distancing themselves from science. The conflict between science and religion creates the perception that religion and science are two separate fields that cannot be unified [7]. In fact, one of the factors for success in teaching in the 21st century is the application of moral values within it [8]. Religion and STEM are two aspects that appear to be distant from each other [9]. The issue has led to a solution for improving the quality of education by integrating religion into the natural sciences studied by students [10].

The integration of religious values into STEM, known as STEM-R, has emerged as an innovative approach to aligning scientific learning with moral and ethical principles. The transformation of STEM into STEM-R reflects a global awareness of the importance of religious studies in shaping the morals and ethics

that reinforce scientific knowledge in forming the identity of STEM [11]. In the modern era marked by rapid technological development and innovation, the need to shape a generation that is not only skilled in technical aspects but also has a strong moral foundation is becoming increasingly urgent. Research indicates that integrating the STEM approach with a religious dimension is an innovative way to enhance students' understanding of scientific concepts within a religious context [12]. Studies also show that incorporating religious perspectives into STEM education can enhance students' science literacy and improve their understanding of the relationship between science and spirituality [7]. Despite its growing recognition, most existing studies on STEM-R are theoretical or limited to higher education levels, with minimal empirical evidence from secondary Islamic schools such as Madrasah Tsanawiyah (MTs).

In an increasingly complex global context, the STEM-R approach offers a learning framework that enables students to develop a holistic perspective on their roles as future scientists and technologists. Recent research suggests that integrating religious values into STEM education enhances students' abilities to think reflectively and critically [4]. For example, renewable energy can be studied from both technical and moral, as well as environmental ethical perspectives. This is highly relevant for education at Madrasah Tsanawiyah, where character building and environmental awareness are essential components of learning [13].

However, the low scientific literacy of renewable energy among Madrasah Tsanawiyah (MTs) students remains a challenge. According to PISA 2018 results, Indonesia ranked 72nd out of 77 countries in science literacy [14]. Renewable energy literacy among Indonesian students is still low [15]. Additionally, there is a lack of contextualised and interactive teaching materials that integrate scientific concepts with Islamic values, which is crucial in an Islamic education environment. Most of the available modules rely heavily on general textbooks and teacher-centred teaching, failing to effectively engage students or connect science with environmental issues and real-life religious aspects. Despite the growing interest in STEM education, few studies have explored its integration with religious values at the secondary school level, especially in Islamic educational institutions. Existing research often focuses on theoretical frameworks or higher education contexts, leaving critical gaps in practical applications for MTs students.

In response to current educational challenges, STEM-R-based e-modules are needed for the topic of renewable energy. The digitisation of teaching materials not only enhances accessibility but also enables the design of more interactive content that is relevant to students' real-life experiences [16]. Previous research has found that the use of digital media STEM-Smart Physics E-Module can enhance students' conceptual understanding and their Communication, Collaboration, Critical Thinking, and Creativity (4C) skills [17]. Creating e-modules that explicitly incorporate religious aspects into discussions about science and technology concepts is still incomplete.

With its different demographics and climate, South Sumatra needs educational methods tailored to its local context. This area has considerable potential for renewable energy sources, including solar energy, biomass, and hydropower; however, students' awareness of these renewable energies remains low [18]. The STEM-R e-module can help students understand both the moral and ethical responsibilities in natural resource management and the technical aspects of renewable energy. In several Madrasah Tsanawiyah (MTs) in South Sumatra, educators face the challenge of integrating STEM concepts with religious principles. The primary obstacles are limited resources, a lack of comprehensive teaching materials, and inadequate training in interdisciplinary approaches. Therefore, the development of well-designed and research-based e-modules has become a necessity.

This study addresses a critical need for empirical data on the development of STEM-R-based e-modules tailored specifically for MTs students in South Sumatra. While previous studies have explored digital modules in general STEM education, few have focused on how integrating religious values can enhance science literacy and environmental awareness among Muslim students at the MTs level [19]—[24]. Moreover, many existing STEM modules are either too generic or not adapted to the cognitive and cultural context of madrasah students. This research fills this gap by analysing student needs and preferences through direct survey responses, ensuring that the resulting e-module is both educationally effective and culturally relevant.

Despite growing interest in STEM-based learning in Islamic educational settings, there remains a lack of research focusing specifically on the integration of religious values (R) within STEM modules for MTs students. Most existing studies generalise findings across different educational levels and contexts, without addressing the unique characteristics and learning preferences of MTs students. By collecting needs analysis data, this study provides specific insights into the contextual and pedagogical requirements for developing STEM-R-based e-modules, particularly in the context of renewable energy topics.

The potential of this research lies in creating an educational model that differs from existing science teaching methods. This research aims to create relevant and contextual learning experiences by integrating digital technology, STEM methodologies, and religious perspectives [25]. This will not only enhance students' academic abilities but also improve their problem-solving skills, higher-order thinking skills, conceptual understanding, science literacy, creativity, and overall learning outcomes.

Theoretically, integration of STEM and religion can coexist peacefully without sacrificing scientific integrity; this study adds to the growing conversation about interdisciplinary education. In practice, it offers a framework for creating e-modules that take into account MTs students' spiritual beliefs, preferred methods of learning, and level of technological readiness. This twofold contribution ensures that the final module promotes environmental stewardship and character development in line with Islamic values, while also enhancing academic performance.

This study addresses the gap by providing empirical data on student preferences and contextual needs, which informs the design of a religion-integrated STEM-R e-module focusing on renewable energy for MTs students. The primary objective of this study is to analyse the demand for and design features of a STEM-R-based e-module focused on renewable energy for MTs students. Specifically, it seeks to: (1) Identify key characteristics of effective STEM-R-based learning for MTs students; (2) Determine preferred formats and content elements of e-modules that integrate science and Islamic values; and (3) Provide empirical support for developing localised, interactive, and ethically grounded educational tools. The STEM-R e-module on renewable energy is expected to enhance students' critical thinking skills, as well as increase their moral and spiritual awareness in addressing global issues [26].

II. Methods

This research method employs a quantitative descriptive approach, utilising survey data to analyse the needs of MTs students for STEM-R-based e-modules on renewable energy. The quantitative descriptive method was chosen to describe, summarise, and interpret numerical data collected from a population or sample [27]. The population in this study consists of Madrasah Tsanawiyah students in several districts in South Sumatra. The sample in this study consisted of 325 respondents from 4 MTs in South Sumatra, who were selected through random sampling.

The population of this study consisted of students from MTs in several districts across South Sumatra Province. A stratified random sampling technique was used to ensure representation from different regions within the province. Four MTs were selected from three districts: South OKU, Musi Banyuasin, and Palembang. Within each school, students were randomly chosen to participate in the survey. A total of 325 respondents participated in the study. This sample size is sufficient to generalise findings at the provincial level, especially given the relatively homogeneous educational context among MTs in South Sumatra. The respondents' characteristics were as follows: 37.5% were in Grade VII, 15.7% were in Grade VIII, and 46.8% were in Grade IX. The sample is divided by gender, with 60% female and 40% male.

The questionnaire used in this study consisted of 10 main indicators derived from the core components of STEM-R learning. Each indicator was further described by three descriptors, forming a total of 30 items in the final questionnaire. The indicators consist of the following aspects: (1) Characteristics of science learning; (2) Use of technology in learning; (3) Learning resources and media; (4) Project-based learning; (5) STEM-R integration; (6) Renewable energy materials; (7) E-module content needs; (8) Aspects of self-directed learning; (9) Religious aspects (Islam); and (10) Evaluation and assessment. Each indicator was described with three descriptors, resulting in a total of 30 items in the final questionnaire. These indicators and descriptors were developed based on a thorough review of relevant literature and existing frameworks related to STEM-R education and e-module development.

The questionnaire uses a Likert scale with scores ranging from 1 to 4. Next, the scores of each indicator in each aspect are summed and then converted into a value within the range of 0 to 100. The presentation of descriptive statistical data in this study is illustrated through graphs, facilitating easy understanding. The value for each indicator can be determined using equation 1.

$$Value = \frac{\text{Obtained score}}{\text{Maximum score}} \times 100\% \quad (1)$$

Before data collection, the instrument underwent construct validation using the Rasch measurement model to assess validity and reliability. The analysis revealed that three items showed misfit to the model, indicated by infit and outfit mean square (MNSQ) values outside the acceptable range of 0.6–1.4 [28]. These items were removed, leaving 27 valid items with an internal consistency reliability index of 0.74. Although expert validation was not conducted, the Rasch analysis provided empirical evidence regarding the quality of the items and their suitability for the research context. Descriptive statistical analysis was performed to summarise the responses, and results were visualised using graphs for better interpretation. These methods support the quantitative nature of the research and provide clear insights into students' preferences and needs regarding STEM-R-based e-module.

III. Results and discussion

The research population consists of students from Madrasah Tsanawiyah in South Sumatra Province. The sample was randomly selected from 4 MTs originating from 3 districts/cities, comprising a total of 325 students. The distribution of students by their school of origin is shown in Table 1.

Table 1. Distribution of MTs Student Respondents Sample

Origin District/City	Name of the Madrasah	Number of Students
South OKU	MTsN 1 South OKU	136
	MTs al Ittifaqiah Kuripan	3
Musi Banyuasin	MTsN 1 Musi Banyuasin	173
Palembang	MTsN 1 Palembang	13

To ensure the validity and reliability of the survey instrument, it was analysed using the Rasch model. The initial instrument consisted of 30 items derived from 10 indicators related to the needs of STEM-R-based e-modules. The results of the Rasch analysis revealed that three items, namely numbers 2, 3, and 4, showed misfit. Thus, the final data analysis was based on 27 valid items.

Regarding the reliability of the instrument, person and item reliability indices were calculated. The item reliability value was 0.74, which indicates acceptable internal consistency for the instrument. This finding confirms that the revised 27-item questionnaire is suitable for collecting valid and reliable data regarding students' needs for STEM-R-based electronic modules. Although the removal of three items may slightly limit coverage for certain aspects, the resulting instrument retains its core functions and improves measurement accuracy by eliminating misfit items.

Characteristics of Science Learning

The first indicator was asked of students regarding the characteristics of science learning, described by three descriptor items: students' interest in science learning in class, the preferred learning methods for understanding science, and the main difficulties students face in studying science. Students' responses to the given questionnaire are shown in Figure 1.

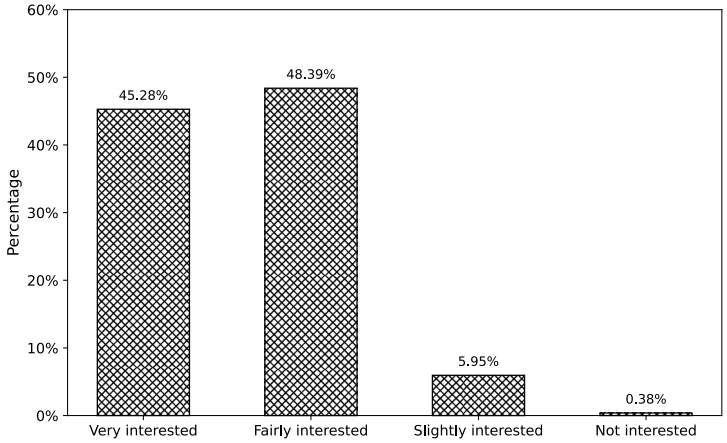

Figure 1. Characteristics of Science Learning

Figure 1 shows that 45.3% of students are very interested in studying science because they enjoy understanding natural phenomena. 48.4% of students are moderately interested in learning science on specific topics only. Only 6% of students are not interested in learning science because the material is considered difficult, and 0.4% of students are not interested in learning science at all. This shows that most students are interested in learning science.

The Use of Technology in Science Learning

The second indicator asked of the students is the aspect of technology use in learning. This indicator assesses the readiness of existing technology for use in learning, which includes ownership of digital devices used for studying, students' ability to operate these devices for learning purposes, and students' internet access for educational purposes. A summary of the survey results for this indicator is shown in Figure 2.

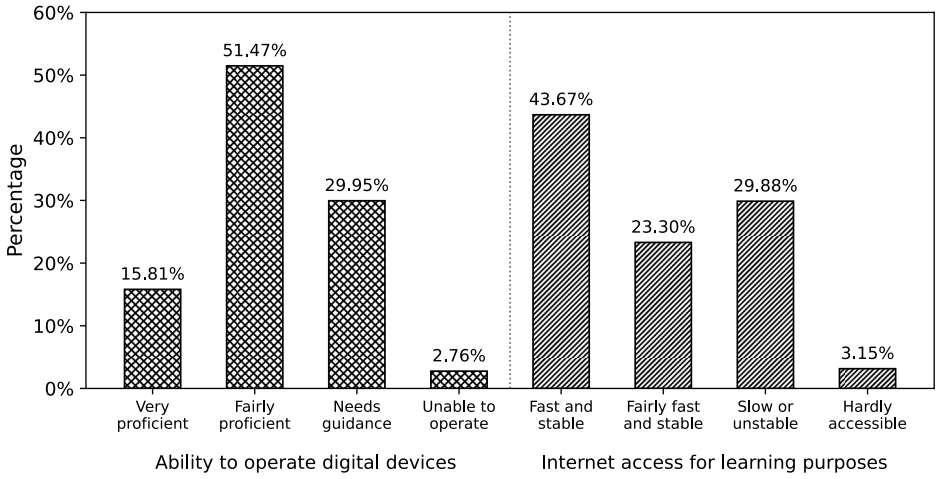

Figure 2. The use of technology in science learning

Regarding proficiency in operating digital devices, almost all students (97.2%) can operate them, while 2.8% of students experience difficulty. Meanwhile, for internet access to support learning, it is almost without obstacles, as 96.9% of students can access the internet, even though some use data quotas. Only 3.1% of students have difficulty obtaining stable internet access. According to the second indicator, almost all students can operate a smartphone and have internet access for their studies. This supports learning using digital technology, where digital learning tools are very effective in the 21st century [29].

Learning Media Source

The third indicator asked of the students is the aspect of learning resources and media. This indicator surveys the sources/media used for learning, which include: frequently used learning resources, preferred forms of learning media, and the availability of learning resources at school. Figure 3 shows a summary of the survey results for this indicator.

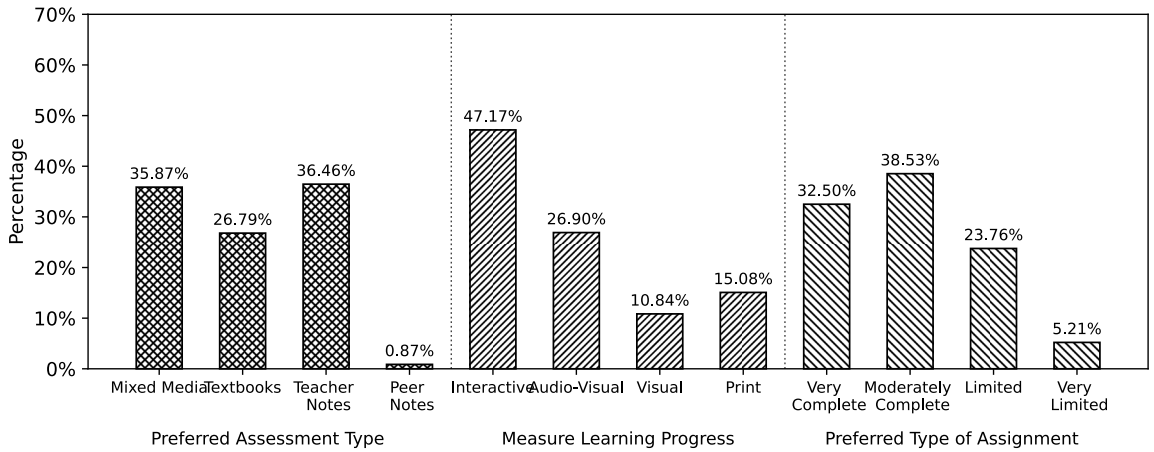

Figure 3. Aspects of student learning resources and media

Figure 3 shows that the learning resources used by students are as follows: 35.9% use books, 35.9% use the internet, and 29.2% use educational videos. 26.8% of students use textbooks and worksheets provided by their school, while 36.5% rely solely on notes explained by the teacher, and 0.9% use summaries provided by their friends. For the most preferred form of media, it is interactive media that can be practised directly (47.2%). Audio-visual media, in the form of educational videos, accounted for 26.9%, while visual media, in the form of images, diagrams, or posters, accounted for 10.8%. Meanwhile, students who prefer print media such as books and modules make up 15.1%.

As for the availability of learning resources in schools, the majority (71%) fall into the very complete and fairly complete categories, 23.8% are limited to textbooks and worksheets, and 5.2% have very limited learning resources that rely solely on teacher notes. According to this indicator, the most commonly used learning resources by students are notes from the teacher, followed by a combination of books, the internet, and learning videos. The type of media most in demand is interactive media that can be practised directly.

Project-Based Learning

The fourth indicator asked of students is the aspect of project-based learning. This indicator captures the experience and interest in project-based learning, including experience with project-based learning, the availability of project-based learning, and the types of learning projects that are of interest. An overview of the respondents' perceptions related to this indicator is illustrated in Figure 4.

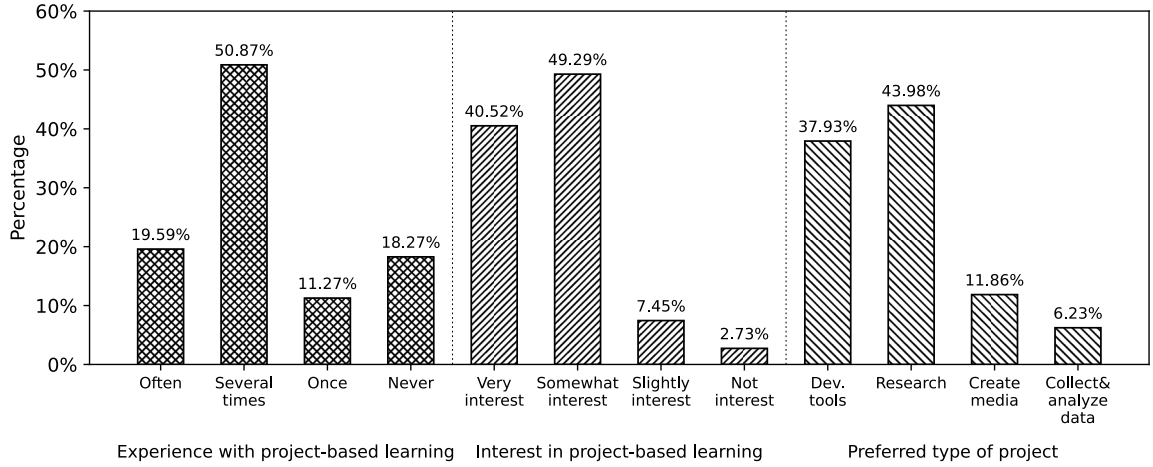

Figure 4. Aspects of project-based learning

Regarding the aspect of project-based learning, the majority (81.7%) of students have engaged in project-based learning at some point, although some have only done so once. There are 18.3% of students who have never done project-based learning at all. Regarding the aspect of interest in project-based learning, 40.5% of students are very interested because they can conduct experiments directly. There are 49.3% of students who are quite interested in project-based learning because they can collaborate with friends. In contrast, 7.5% are not interested because it requires a lot of time and effort, and only 2.7% are not interested in project-based learning. After all, they prefer conventional learning.

For the most popular type of science project, 44% are simple observation and research projects, 37.9% are simple tool/technology creation projects, 11.9% are poster/presentation media creation projects, and only 6.2% prefer data collection and analysis projects. From these indicators, it is evident that most students have experience with and are interested in project-based learning, with simple observation and research projects being the most favoured. Previous research shows that project-based learning can improve academic achievement [30]. Other studies also demonstrate that project-based learning in STEM can enhance students' interest and understanding of technology and science concepts [31].

STEM-R Integration

The fifth indicator asked of the students is the aspect of STEM-R integration. This indicator includes: the relationship between science and technology, mathematical skills in science learning, and experiences in integrating STEM. Figure 5 provides a concise representation of the survey findings associated with this indicator.

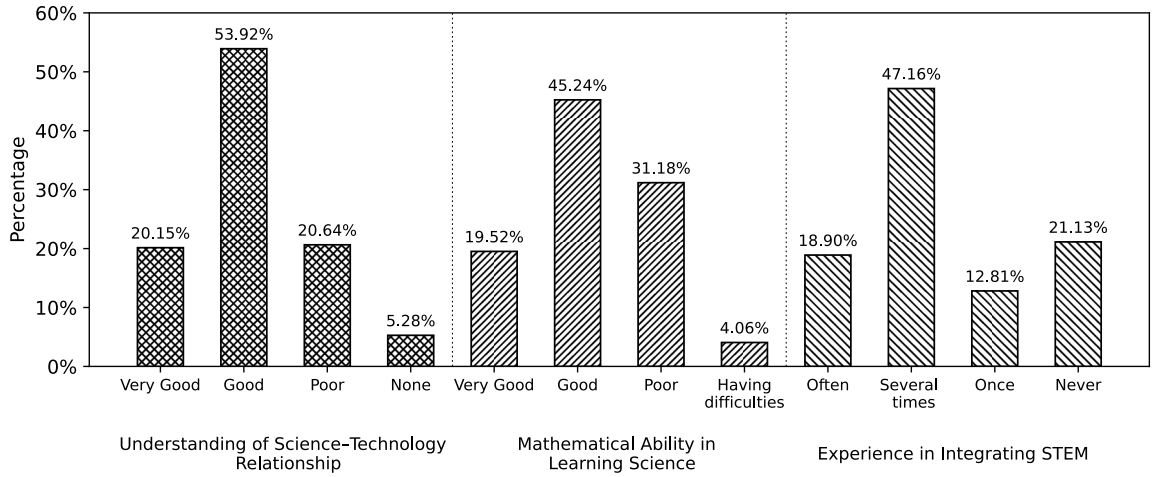

Figure 5. Aspects of STEM-R Integration

For the integration of STEM-R in the aspect of the relationship between science and technology, 20.2% of students very well understand that science is the foundation for the development of technology. As many as 53.9% of students have a fair understanding of several examples of the application of science in technology, 20.6% of students have a limited understanding of the relationship between the two, and 5.3% do not understand the connection between science and technology. Regarding the aspect of mathematical ability in science learning, more than half (64.8%) of the students are very good or quite good at using formulas and performing simple calculations. However, 31.2% of students still struggle with calculations in science, and 4.1% of students find it very difficult to apply mathematics in science learning.

In the experience of integrating STEM, more students have frequently and occasionally learned with the STEM approach. However, some have only done so once, and only a quarter of the students have never learned with the STEM approach at all. From this indicator, three-quarters of the students already understand the relationship between science and technology. However, only three-fifths of the students are sufficiently and well-versed in using mathematical calculations in science, and a quarter of the students have never been introduced to the STEM approach. Through STEM learning, students can enhance their motivation, deepen their conceptual understanding, and recognise the relevance of the connection between physics and mathematics [21]. The STEM approach is recognised as capable of preparing the younger generation to face global challenges and technological developments [6].

Renewable Energy Materials

The sixth indicator asked of the students is the aspect of renewable energy materials. This indicator encompasses initial knowledge about renewable energy, the specific type of renewable energy in focus, and the relevance of renewable energy in everyday life. The results of the survey for this indicator are visualised in Figure 6. Figure 6 shows that in terms of students' initial knowledge about renewable energy, 18.9% of students have a strong understanding of various types and benefits of renewable energy, 48.6% of students understand some common types of renewable energy, 24.2% of students know only a little about renewable energy, and 8.3% of students are not yet aware of renewable energy. In the aspect of types of renewable energy that are of interest, 36.8% of students like solar energy and its applications, 24.2% of students choose wind energy and its potential uses, 35.4% of students are interested in water energy and power plants, and only 3.6% of students are interested in biomass energy from organic waste.

For the indicator of the relevance of renewable energy in daily life, 79.5% of students have a very good and sufficient understanding of several examples of renewable energy applications. In comparison, 20.5% have a limited and insufficient understanding of the usefulness of renewable energy in daily life. From this indicator, it can be concluded that more than half of the students already possess initial knowledge about renewable energy, and 4 out of 5 students understand examples of the connection between renewable energy and daily life. The most popular types of renewable energy are solar energy (utilising sunlight) and its applications, followed by hydropower and hydroelectric power plants. Learning about solar energy not only provides practical solutions to energy problems but also teaches students about the importance of renewable energy in reducing dependence on fossil energy sources that may be replaced by 2050 [32]. The importance of learning

about renewable energy extends beyond providing knowledge about science and technology, as it also trains students to think creatively in finding solutions to global problems [33].

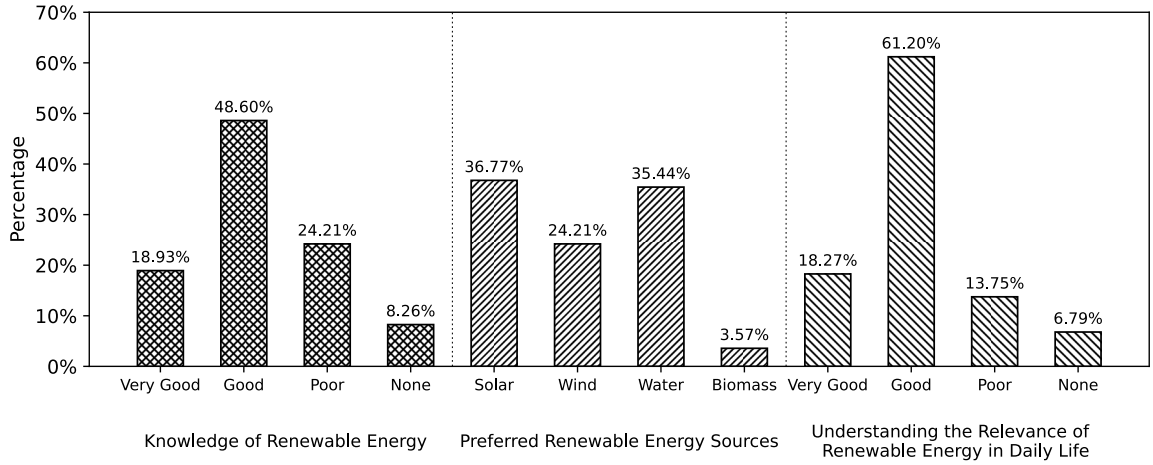

Figure 6. The aspect of renewable energy

Content Needs for e-Module

The seventh indicator asked students about the aspect of e-module content that is needed. This indicator includes: the desired e-module format, the preferred evaluation form, and the expected interactive features in the e-module. A summarised depiction of the survey responses corresponding to this indicator is shown in Figure 7.

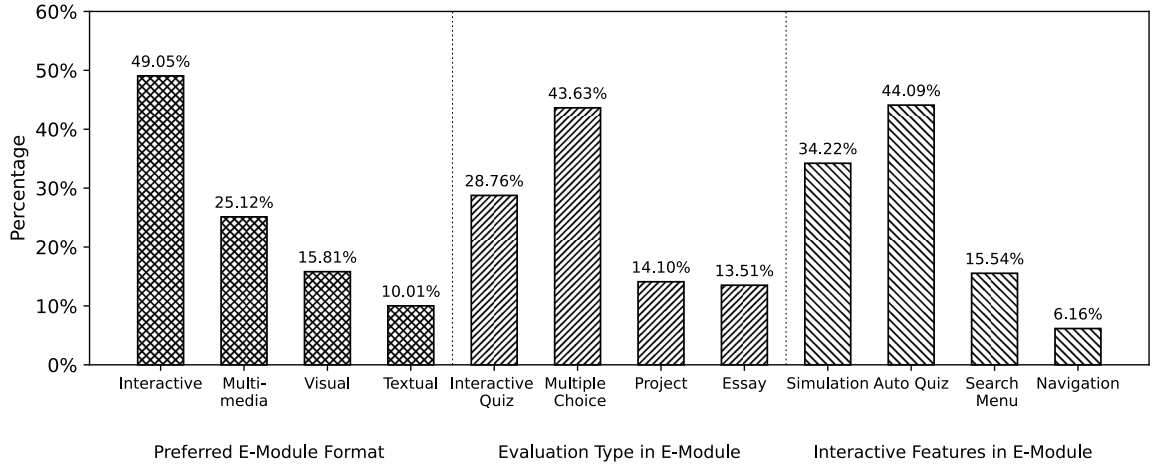

Figure 7. Aspects of the e-module need

Regarding the e-module format, a portion (49.1%) of students prefer the e-module to contain a combination of concise text, images, videos, and interactive quizzes. As many as 25.1% of students want the text accompanied by images and educational videos, 15.8% of students prefer the text supplemented with images only, and the remaining 10% of students prefer the text complete with detailed explanations. Meanwhile, in terms of the preferred evaluation format in the e-module, 28.8% of students prefer interactive quizzes with immediate feedback, while 43.6% prefer multiple-choice questions with explanations. As many as 14.1% of students want evaluations in the form of project assignments with complete guidelines, and 13.5% of students prefer essay questions with answer keys.

In terms of the interactive features expected in the e-module, 34.2% of students hope for virtual experiment simulations, 44.1% of students want quizzes with automatic scoring and explanations, 15.5% of students prefer a search menu and a list of essential terms, and 6.2% of students expect easy-to-use navigation buttons and menus. From these indicators, the most desired e-module format is a combination of concise text, images, videos, and interactive quizzes. Meanwhile, the most preferred form of evaluation is in the form of multiple-choice questions with explanations, and its interactive feature is a quiz with automatic scoring and explanations. The use of e-modules is considered effective in improving students' critical thinking skills, as

learning through e-modules creates interactive learning experiences and prevents students from feeling bored [34]. Previous research also found that the use of e-modules can improve 4C skills, which are essential 21st-century skills [17]. Other research results show significant potential for a project-based e-module to enhance student abilities [35].

The findings showed that the majority of students (49.1%) wanted e-modules that combine concise text, images, videos, and interactive quizzes. This is in accordance with research results that show the use of audio-visual learning media can improve learning outcomes [36] and students' conceptual understanding [37]. Additionally, learning with interactive media can enhance students' critical thinking skills and motivation to learn [38].

Learning Independence

The eighth indicator asked of the students is the aspect of learning independence. This indicator assesses students' ability to learn independently, their strategies for understanding the material, and their methods for self-evaluating their understanding. Figure 8 presents a summary of the survey results related to the aspects of student learning independence.

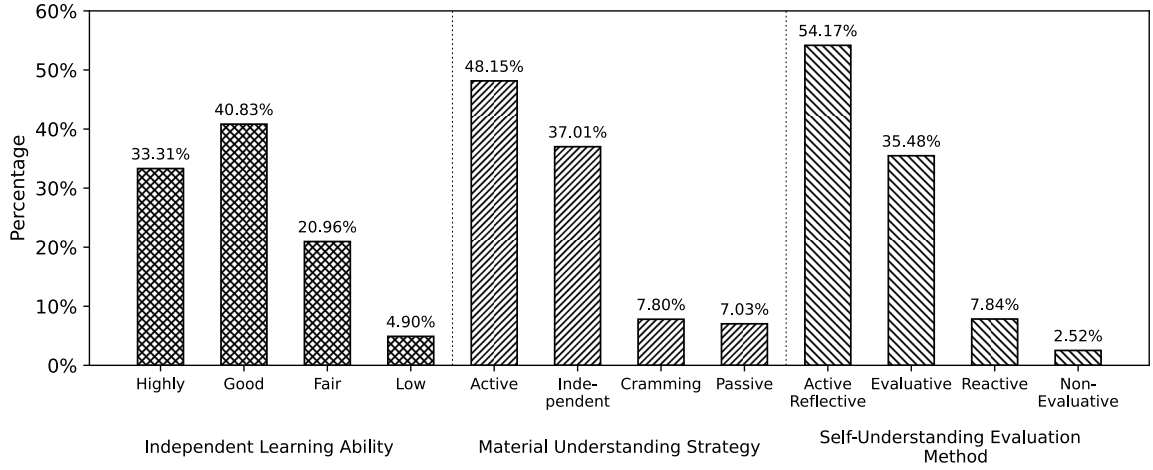

Figure 8. Aspects of student learning independence

In terms of independent learning ability, the majority of students (95.1%) can study independently with only occasional guidance needed, while 4.9% of students always require guidance when studying. In terms of strategies for understanding the material, 48.2% of students demonstrate independence in learning by reading the material, creating summaries, and attempting practice questions. As many as 37% of students read the material and do practice questions. However, 7.8% of students only read the material before the exam, and 7% wait for explanations from teachers/friends.

The way students evaluate their understanding is as follows: 54.2% of students practice exercises and note down the material they do not understand. In comparison, 35.5% of students practice exercises to measure their understanding. As many as 7.8% of students wait for the test results to gauge their understanding, and 2.5% of students are unsure how to evaluate their own understanding. According to this indicator, most students are already able to study independently, with the most common strategies being reading the material, creating summaries, and attempting practice questions. Meanwhile, students mostly evaluate their understanding by completing practice questions and taking notes on material they have not understood.

Religious Aspect (Islam)

The ninth indicator asked of the students is the religious aspect (Islam). This indicator encompasses understanding the relationship between science and religion, the necessity of incorporating religious content into science learning, and the application of religious values within the context of science. A synthesised overview of the survey findings related to the religious aspect (Islam) is illustrated in Figure 9.

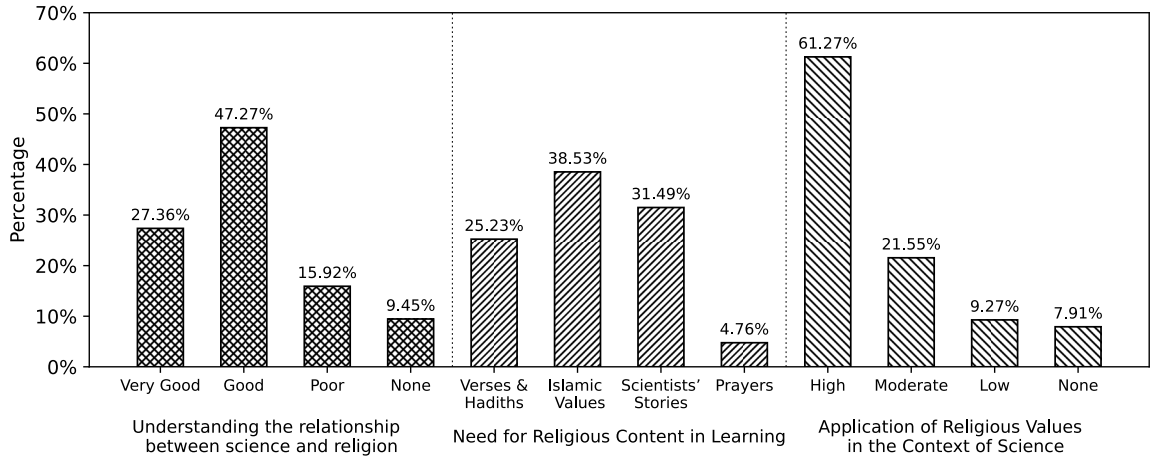

Figure 9. Religious aspects (Islam)

In the religious aspect, it can be seen that regarding the understanding of the relationship between science and religion, ¾ of the students already have a very good and sufficient understanding. In contrast, ¼ of the students have a limited understanding and have not yet seen the connection between natural sciences and Islamic teachings. For the aspect of religious content needed in science learning, 25.2% of students desire verses from the Qur'an, Hadith, and explanations about their relevance to science material. Then, 38.5% of students need Islamic values related to science subjects, 31.5% of students want stories of Muslim scientists related to the material, and only 4.8% need prayers relevant to science learning.

In the context of applying religious values in Islam, 61.3% of students consistently express gratitude and admire the greatness of Allah while studying science. Students sometimes relate science learning to Islamic values by 21.5%. Students rarely consider the connection between science and Islam, with 9.3% of them and 7.9% of students having never applied Islamic values in their science learning. From this indicator, it can be concluded that three-quarters of the students already understand the relationship between science and religion. The religious content in learning that is most needed is the Islamic values related to science and their application, such as always being grateful and admiring the greatness of Allah while studying science.

The survey results show that the majority of students (38.5%) believe that Islamic values should be integrated into science learning. Therefore, the STEM-R module should include Qur'anic verses, Hadith, and stories of Muslim scientists relevant to the material. In addition, gratitude and reverence for the greatness of Allah (61.3%) can be integrated through spiritual reflection at the end of each topic. This aligns with the findings of previous research, which suggests that integrating Islamic values into the science curriculum can create a comprehensive knowledge framework for students [39]. In addition, STEM-R integration can bridge the gap between religion and science, enabling students to acquire a more balanced understanding while strengthening their moral values [7].

The results of this study provide concrete guidelines for designing STEM-R-based e-modules adapted to the context of MTs students. In particular, the integration of religious aspects must be meaningful and contextualized. As in the discussion of solar energy, it can include Quranic verses about the sun as a gift from Allah, encouraging reflection on environmental management as a mandate that must be maintained. Similarly, project-based learning activities could involve designing simple solar-powered devices while incorporating ethical considerations such as sustainability and social benefits. This approach differs from typical STEM modules, which primarily emphasise scientific understanding, by also incorporating character and moral development based on Islamic teachings. This is a new contribution to STEM education and Islamic pedagogy.

Evaluation and Assessment

The tenth indicator asked of the students is the aspect of evaluation and assessment. This indicator encompasses the types of assessments preferred by students, methods for measuring students' learning progress, and the preferred forms of assignments. As depicted in Figure 10, the summarised results related to the evaluation and assessment aspects are provided for further analysis.

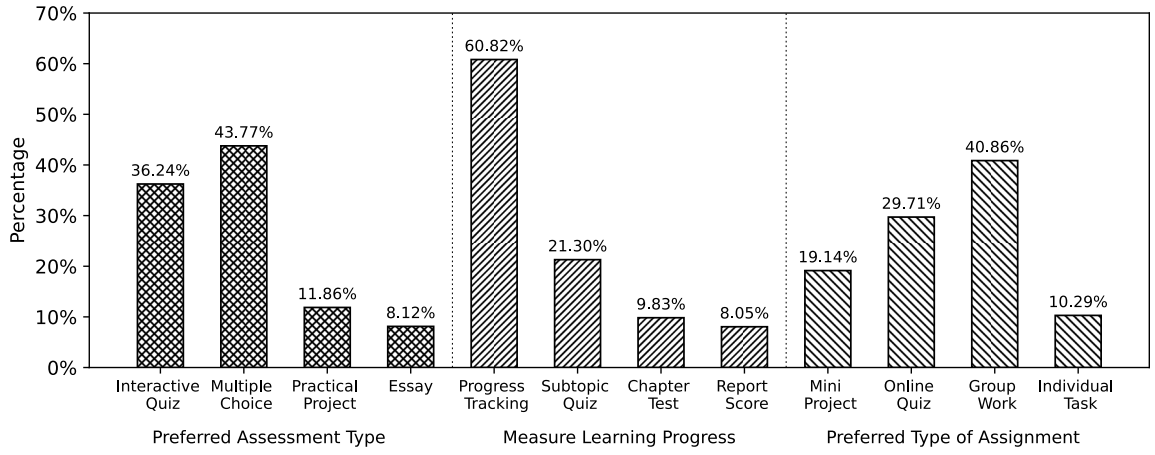

Figure 10. Aspects of evaluation and assessment

According to Figure 10 on evaluation and assessment, 36.2% of students prefer interactive quizzes with immediate feedback and discussion. In comparison, 43.8% prefer multiple-choice questions with explanations. Then, 11.9% of students prefer evaluation in the form of simple practical assignments, and 8.1% of students prefer essay questions with answer guidelines. In terms of measuring learning progress preferred by students, it was found that 60.8% preferred to see the learning process and grades for each part of the material. 21.3% of students prefer taking quizzes at the end of each sub-material, 9.8% of students choose to take exams at the end of each chapter, and the remaining 8% wait for report card grades to assess their learning progress.

Regarding the type of assignment preferred by students, it was found that 19.1% of students preferred mini projects that could be completed at home, while 29.7% of students preferred online quizzes that could be retaken. Meanwhile, group assignments with clear guidelines accounted for 40.9%, while individual assignments, in the form of summaries, accounted for 10.3%. Based on this last indicator, the form of assessment most preferred by students is multiple-choice questions with discussions, with a preference for group assignments that have clear guidelines and objectives.

These findings indicate that students value immediate feedback and structured assessment methods. To address this need, the e-module should integrate interactive quizzes with instant scoring and explanations. Additionally, including project-based assignments with clear guidelines can help reinforce practical understanding of renewable energy concepts, aligning with the STEM-R approach. The results of this study have direct implications for the design of STEM-R-based, contextualised learning in madrasah. Firstly, the strong interest in multimedia and interactive content suggests that digital platforms can be utilized to create an active, engaging, and independent learning atmosphere. Secondly, the demand for integrating Islamic values indicates the need for a curriculum that links science and religion in an intellectually and spiritually coherent way. For example, when studying hydropower, modules can include discussions on the Islamic principle of al-istiqra' (observation of nature), encouraging students to appreciate Allah's creation while exploring hydropower technologies. In addition, assessment tools such as quizzes with immediate feedback or mini-projects with clear guidelines support formative learning and help reinforce scientific and moral understanding.

In general, the results of this study suggest that educators in Islamic schools should use a more digitally integrated and interdisciplinary approach in science teaching. By developing e-modules that integrate STEM concepts with religious values, teachers can develop not only scientific competence, but also environmental awareness and moral responsibility. In addition, teacher training programmes should include modules on how to effectively implement STEM-R, including strategies for integrating religious content into science lessons without compromising scientific rigour. This will ensure that the developed e-modules are not only accessible but also usable effectively in classrooms.

One limitation of this study is the uneven distribution of respondents across the four madrasahs sampled. In MTsN 1 Musi Banyuasin, the number of respondents was 173 students, whereas MTs Al Ittifaqiah Kuripan had only three respondents. This imbalance could affect the representativeness of the sample and lead to selection bias. It could introduce potential sampling bias if the characteristics of students from each school differ significantly. However, given the relatively homogeneous education policy and curriculum across MTs in South Sumatra, the overall results of the study can still be generalized at the provincial level. Future studies should aim to draw a more balanced sample to strengthen external validity.

IV. Conclusions

This study found that 76.3% of MTs students expressed a strong need for a STEM-R-based e-module on renewable energy topics. The majority preferred interactive features, such as animated videos and real-life applications that align with Islamic teachings. These findings support the development of a contextual and engaging e-learning resource tailored to the cognitive and cultural level of MTs students.

This study has limitations in that the distribution of respondents was not evenly distributed among madrasahs from all districts in South Sumatra Province, which may affect the generalisability of the findings beyond the province. In addition, this study focused more on the cognitive and technological aspects, so the socio-emotional dimensions were not explored in depth. Future research should aim to develop and evaluate a comprehensive STEM-R module that incorporates components addressing students' social and emotional learning (SEL), including teamwork, resilience, empathy, and ethical decision-making in the context of global challenges. This could involve longitudinal studies that assess the impact of e-modules on academic performance and character development. In addition, incorporating teacher training programmes and interactive feedback between teachers and students will be crucial to ensure effective implementation and continued engagement with the e-modules.

Acknowledgements

The author would like to thank the Graduate Program of Physics Education, Faculty of Teacher Training and Education, Sriwijaya University, for facilitating the materials, as well as all the co-researchers who have contributed to this research. Without the support of all parties, this research on the analysis of STEM-R-based e-module needs would not have been completed correctly.

References

[1] N. H. Astuti, A. Rusilowati, and B. Subali, "STEM-Based Learning Analysis to Improve Students' Problem Solving Abilities in Science Subject: a Literature Review," *Journal of Innovative Science Education*, vol. 9, no. 3, pp. 79–86, Apr. 2021, doi: 10.15294/jise.v9i2.38505.

[2] K. Sury, K. Wiyono, and S. M. Siahaan, "Effectiveness of Using E-learning at STEM-based Physics Learning to Improve Communication Skills of High School Students," *Jurnal Ilmiah Pendidikan Fisika*, vol. 6, no. 3, p. 539, Dec. 2022, doi: 10.20527/jipf.v6i3.5781.

[3] N. Nazhifah, K. Wiyono, and I. Ismet, "Development of STEM-Based E-Learning on Renewable Energy Topic to Improve the Students Creative Thinking Skills," *Jurnal Penelitian Pendidikan IPA*, vol. 9, no. 11, pp. 9575–9585, Nov. 2023, doi: 10.29303/jppipa.v9i11.5206.

[4] S. Sarwi, P. Marwoto, E. Susilaningsih, Y. F. Lathif, and W. Winarto, "Science learning STEM-R approach: A study of students' reflective and critical thinking," *Journal of Education and Learning (EduLearn)*, vol. 18, no. 2, pp. 462–470, May 2024, doi: 10.11591/edulearn.v18i2.21080.

[5] R. N. Hidayah, K. Wiyono, and Ismet, "STEM-based sound wave e-learning for high school students collaboration skills," 2024, p. 020049. doi: 10.1063/5.0201015.

[6] S. Halawa, T.-C. Lin, and Y.-S. Hsu, "Exploring instructional design in K-12 STEM education: a systematic literature review," *Int J STEM Educ*, vol. 11, no. 1, p. 43, Sep. 2024, doi: 10.1186/s40594-024-00503-5.

[7] W. Sumarni, Z. Faizah, B. Subali, W. Wiyanto, and E. Ellianawati, "The urgency of religious and cultural science in STEM education: A meta data analysis," *International Journal of Evaluation and Research in Education (IJERE)*, vol. 9, no. 4, p. 1045, Dec. 2020, doi: 10.11591/ijere.v9i4.20462.

[8] Y. M. Yusof, A. Tajuddin, S. S. Abd Azis, and M. A. Othoman, "Determinant Factor of the 21st Century Teaching and Learning Skill among the College Community Entrepreneurship Lecturer in College Community Perak, Malaysia," *International Journal of Business and Social Science*, vol. 9, no. 6, 2018, doi: 10.30845/ijbss.v9n6a11.

[9] S. H. Jones, R. Catto, T. Kaden, and F. Elsdon-Baker, "'That's how Muslims are required to view the world': Race, culture and belief in non-Muslims' descriptions of Islam and science," *Sociol Rev*, vol. 67, no. 1, pp. 161–177, Jan. 2019, doi: 10.1177/0038026118778174.

[10] R. Kang and J. Peters, "Dunhuang as a Model for EthnoSTEM Education. In: Di, X. (eds) The Dunhuang Grottoes and Global Education. Spirituality, Religion, and Education," X. Di, Ed., Cham: Palgrave Macmillan, 2019, pp. 135–160. doi: 10.1007/978-3-030-13356-6_8.

[11] S. L. Rodriguez, R. Friedensen, T. Marron, and M. Bartlett, "Latina Undergraduate Students in STEM: The Role of Religious Beliefs and STEM Identity," *J Coll Character*, vol. 20, no. 1, pp. 25–46, Jan. 2019, doi: 10.1080/2194587X.2018.1559198.

[12] T. N. Wiyatno, M. Z. El Wahyu, A. Rahman, and S. Edy, "Integrating STEM into Religious Education: Exploring the Role of University Lecturers in Merging Science, Technology, Engineering, and Mathematics with Faith-Based

Pedagogy," *AL-ISHLAH: Jurnal Pendidikan*, vol. 16, no. 4, pp. 4450–4461, Nov. 2024, doi: 10.35445/alishlah.v16i4.5231.
[13] A. M. Wibowo, S. Utaya, W. Wahjoedi, S. Zubaidah, S. Amin, and R. R. Prasad, "Critical Thinking and Collaboration Skills on Environmental Awareness in Project-Based Science Learning," *Jurnal Pendidikan IPA Indonesia*, vol. 13, no. 1, pp. 103–115, Mar. 2024, doi: 10.15294/jpii.v13i1.48561.
[14] OECD, *PISA 2018 Results (Volume I): What Students Know and Can Do*. in PISA. Paris: OECD Publishing, 2019. doi: 10.1787/5f07c754-en.
[15] M. Sianturi, E. N. Giawa, Faradiba, N. Masta, T. Guswantoro, and E. Murniarti, "The Use of Solar Power Plant Media to Increase Literacy Ability Solar Energy of Students," *Journal of Education Research and Evaluation*, vol. 8, no. 3, pp. 508–519, Dec. 2024, doi: 10.23887/jere.v8i3.77438.
[16] E. H. Touli, M. Radid, and M. Talbi, "Digitization in teaching and learning physical sciences," *International Journal of Emerging Technologies and Innovative Research*, vol. 11, no. 12, pp. d548–d550, 2024, [Online]. Available: http://www.jetir.org/papers/JETIR2412365.pdf
[17] A. Asrizal, N. Nazifah, H. Effendi, and H. Helma, "STEM-Smart Physics E-Module to Promote Conceptual Understanding and 4C Skills of Students," *International Journal of Information and Education Technology*, vol. 14, no. 2, pp. 279–286, 2024, doi: 10.18178/ijiet.2024.14.2.2049.
[18] N. Agung Pambudi, I. Riva Nanda, F. Tahta Alfina, and A. Zulfia Syahrial, "Renewable energy education and awareness among Indonesian students: Exploring challenges and opportunities for a sustainable future," *Sustainable Energy Technologies and Assessments*, vol. 63, p. 103631, Mar. 2024, doi: 10.1016/j.seta.2024.103631.
[19] H. Y. Suhendi, D. Mulhayatiah, N. Komalasari, R. Ardiansyah, and R. Kariadinata, "Alquran Values-Integrated Physics Modul: The Effect on Students' Problem Solving Skill and Spiritual Attitude in Physics," *JIPF (Jurnal Ilmu Pendidikan Fisika)*, vol. 7, no. 1, p. 71, Jan. 2022, doi: 10.26737/jipf.v7i1.2258.
[20] N. Mansour, M. Çevik, A. Yağci, S. B. M. Alotaibi, and H. EL-Deghaidy, "Modeling the Factors Influencing Secondary Students' Performance in STEM Subjects," *Journal of Baltic Science Education*, vol. 23, no. 3, pp. 518–535, Jun. 2024, doi: 10.33225/jbse/24.23.518.
[21] L. Goovaerts, M. De Cock, K. Struyven, and W. Dehaene, "Developing a Module to Teach Thermodynamics in an Integrated Way to 16 Year Old Pupils," *European Journal of STEM Education*, vol. 4, no. 1, Apr. 2019, doi: 10.20897/ejsteme/3964.
[22] H. Akhsan, G. S. Putra, K. Wiyono, M. Romadoni, and M. Furqon, "Development of A STEM-Based Introduction to Quantum Physics Module on the Sub-Subject of Potential Variations in the Physics Education Study Program," *Jurnal Penelitian Pendidikan IPA*, vol. 9, no. 9, pp. 7408–7412, Sep. 2023, doi: 10.29303/jppipa.v9i9.3577.
[23] H. Akhsan, S. Rianti, M. Muslim, and M. Ariska, "Development of digital handout on particle wave dualism material," *J Phys Conf Ser*, vol. 1816, no. 1, p. 012006, Feb. 2021, doi: 10.1088/1742-6596/1816/1/012006.
[24] P. I. Anwar, A. Pasaribu, M. Ariska, and H. Akhsan, "Character Education Oriented Physics E-Module Development in the Static Fluid Section," *Berkala Ilmiah Pendidikan Fisika*, vol. 9, no. 2, p. 174, Jun. 2021, doi: 10.20527/bipf.v9i2.10518.
[25] Dwi Ayu Lestari, I. R. Suwarma, and E. Suhendi, "Development of STEM-Based Physics E-Module with Self-Regulated Learning to Train Students' Creative Thinking Skills," *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, vol. 9, no. 2, pp. 197–206, Dec. 2023, doi: 10.21009/1.09202.
[26] I. A. Rizki and N. Suprapto, "Project-Oriented Problem-Based Learning Through SR-STEM to Foster Students' Critical Thinking Skills in Renewable Energy Material," *J Sci Educ Technol*, vol. 33, no. 4, pp. 526–541, Aug. 2024, doi: 10.1007/s10956-024-10102-2.
[27] J. W. Creswell and J. D. Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. SAGE Publications, 2017.
[28] W. J. Boone, J. R. Staver, and M. S. Yale, *Rasch Analysis in the Human Sciences*. Dordrecht: Springer Netherlands, 2014. doi: 10.1007/978-94-007-6857-4.
[29] M. Tartuk, "Metaphorical Perceptions of Middle School Students Regarding the Concept of Artificial Intelligence," *International Journal of Education and Literacy Studies*, vol. 11, no. 2, pp. 108–116, Apr. 2023, doi: 10.7575/aiac.ijels.v.11n.2p.108.
[30] J. Han, T. Kelley, and J. G. Knowles, "Building a sustainable model of integrated stem education: investigating secondary school STEM classes after an integrated STEM project," *Int J Technol Des Educ*, vol. 33, no. 4, pp. 1499–1523, Sep. 2023, doi: 10.1007/s10798-022-09777-8.
[31] D. G. Bustamante *et al.*, "Tech Lunar Toilet: A STEM Project with High School Students," *European Journal of STEM Education*, vol. 6, no. 1, p. 08, Nov. 2021, doi: 10.20897/ejsteme/11322.
[32] J. L. Holechek, H. M. E. Geli, M. N. Sawalhah, and R. Valdez, "A Global Assessment: Can Renewable Energy Replace Fossil Fuels by 2050?," *Sustainability*, vol. 14, no. 8, p. 4792, Apr. 2022, doi: 10.3390/su14084792.
[33] A. Ulazia and G. Ibarra-Berastegi, "Problem-Based Learning in University Studies on Renewable Energies: Case of a Laboratory Windpump," *Sustainability*, vol. 12, no. 6, p. 2495, Mar. 2020, doi: 10.3390/su12062495.

[34] K. Adhelacahya, S. Sukarmin, and S. Sarwanto, "Impact of Problem-Based Learning Electronics Module Integrated with STEM on Students' Critical Thinking Skills," *Jurnal Penelitian Pendidikan IPA*, vol. 9, no. 7, pp. 4869–4878, Jul. 2023, doi: 10.29303/jppipa.v9i7.3931.

[35] Y. Yulkifli, Y. Yohandri, and H. Azis, "Development of physics e-module based on integrated project-based learning model with Ethno-STEM approach on smartphones for senior high school students," *Momentum: Physics Education Journal*, pp. 93–103, Jan. 2022, doi: 10.21067/mpej.v6i1.6316.

[36] W. Manulang, Haifaturrahmah, Linda Sekar Utami, Syaharuddin, and Siti Ala, "The Audio-Visual Media on Cognitive Learning Outcomes," *Jurnal Ilmiah Sekolah Dasar*, vol. 7, no. 4, pp. 641–648, Jan. 2024, doi: 10.23887/jisd.v7i4.61138.

[37] E. J. Filimditty, A. Pattiserlihun, and W. H. Kristiyanto, "The Effectiveness of Audio-Visual Based Learning Media Assisted by Adobe Software in Physics Learning," *Radiasi : Jurnal Berkala Pendidikan Fisika*, vol. 16, no. 2, pp. 90–96, Oct. 2023, doi: 10.37729/radiasi.v16i2.1709.

[38] F. Murtianingsih and J. Astono, "Pengembangan media pembelajaran fisika interaktif berbasis smart apps creator untuk meningkatkan kemampuan berpikir kritis dan motivasi belajar peserta didik SMA," *Jurnal Pendidikan Fisika*, vol. 10, no. 1, pp. 17–28, Aug. 2023, doi: 10.21831/jpf.v10i1.19341.

[39] Y. F. Lathif, P. Marwoto, E. Susilaningsih, W. Winarto, and S. Sarwi, "Student Perceptions of Science Learning at Tahfidz Boarding School," *Pegem journal of Education and Instruction*, vol. 14, no. 1, pp. 296–302, Aug. 2023, doi: 10.47750/pegegog.14.01.33.