



Needs analysis of interactive STEM-based multimedia to enhance literacy and 21st-century skills

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ABSTRACT

Learning media development should integrate interactive features with engaging, real-world content. This study aims to analyze the need for interactive multimedia based on STEM (Science, Technology, Engineering, and Mathematics) education to enhance literacy skills and 21st-century competencies. The study employs a qualitative approach using a needs analysis method, involving data collection through in-depth interviews with teachers and curriculum document analysis. The results indicate that students require learning media that are engaging, relevant to their daily lives, and capable of fostering literacy and 21st-century skills. On the other hand, teachers highlight the need for practical, accessible learning media that can enhance student engagement in the learning process. These findings emphasize the importance of developing interactive multimedia based on STEM education to support more effective learning. This study implies the need for innovations in developing interactive STEM-based learning media that align with modern educational demands.

Analisis kebutuhan multimedia interaktif berbasis STEM untuk meningkatkan literasi dan keterampilan abad ke-21

ABSTRAK

Kata Kunci:

keterampilan abad ke-21, media pembelajaran interaktif, pengembangan literasi, analisis kebutuhan, multimedia berbasis STEM

Pengembangan media pembelajaran seharusnya mengintegrasikan fitur interaktif yang menarik dengan konten berbasis fenomena nyata. Penelitian ini bertujuan untuk menganalisis kebutuhan multimedia interaktif berbasis STEM (Science, Technology, Engineering, and Mathematics) education dalam membangun kemampuan literasi dan keterampilan abad ke-21. Penelitian ini menggunakan pendekatan kualitatif dengan metode analisis kebutuhan, yang melibatkan pengumpulan data melalui wawancara mendalam dengan guru dan analisis dokumen kurikulum. Hasil analisis menunjukkan bahwa siswa membutuhkan media pembelajaran yang menarik, relevan dengan kehidupan sehari-hari, dan mendukung pengembangan literasi serta keterampilan abad ke-21. Sementara itu, guru mengungkapkan perlunya media pembelajaran yang praktis, mudah diakses, dan mampu meningkatkan keterlibatan siswa dalam pembelajaran. Temuan ini menegaskan pentingnya pengembangan multimedia interaktif berbasis STEM education untuk mendukung pembelajaran yang lebih efektif. Penelitian ini mengimplikasikan perlunya inovasi dalam pengembangan media pembelajaran

berbasis STEM yang interaktif dan sesuai dengan kebutuhan pembelajaran modern.

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Contribution to the literature

This research contributes to:

- Highlighting the specific needs of students and teachers for interactive STEM-based multimedia to enhance engagement and relevance in learning.
- Emphasizing the role of STEM-based multimedia in fostering literacy and 21st-century skills in educational contexts.
- Providing a qualitative perspective on the essential features of effective STEM-based multimedia for future educational innovations.

1. INTRODUCTION

The Merdeka curriculum focuses on recovering students' low ability to understand simple reading and apply basic mathematical concepts [1]. Thus, one of the focuses of emphasis in the Merdeka curriculum is strengthening students' literacy skills. One international program that measures literacy skills is the Program for International Student Assessment (PISA). The average Indonesia PISA result in 2022 for literacy skills was 359 points. This result was 117 points away from the global average score of 476.

Furthermore, these results decreased by 12 points from the previous edition of PISA [2]. The PISA results show that the literacy skills of Indonesian students are generally relatively low. The presentation of the PISA results requires teachers as facilitators of the learning process to find appropriate solutions to optimize students' learning outcomes, one of which is literacy abilities. Conventional learning media in Indonesia have shortcomings in facilitating phenomenon-based learning because they are less interactive, have minimal visualization, and are limited in connecting concepts with real phenomena. Media, such as textbooks and lectures, tend to make students passive, prioritizing memorization over exploration. Therefore, innovative learning media is needed in the learning process to create good interaction between teachers and students and achieve learning objectives [3]. Furthermore, the use of appropriate media significantly influences the information literacy skills of fourth-grade elementary school students [4].

Ideal learning media can be used anywhere and anytime. Moreover, it can be integrated with an application that is easy to use and attracts students' interest in learning [5]. E-modules are a learning medium that can provide a systematic presentation of material to make it easier for students to learn independently. Because e-modules can be connected with links that link animation, audio, or video, which provide an interactive learning experience and attract students' interest in learning, suppose the learning media can attract students' interest in learning [6]. In that case, it is hoped that students' literacy skills will begin to develop, especially for subjects considered difficult for most participants, such as physics. Furthermore, interactive multimedia influenced students' literacy skills in energy material at Madrasah Ibtidaiyah Negeri 3 Pekanbaru, Indonesia [7]. In line with this research, developing website-based interactive multimedia effectively increases the scientific literacy skills of class XI students at SMAS Catholic 1 Kabanjahe on respiratory material [8].

The 21st Century Skills are also one of the focuses in implementing the Merdeka Curriculum. This skill includes four important aspects that students must master: critical thinking, communication, collaboration, and creativity. The research results state that the 21st-century skills of Indonesian students are, on average, below and close to standard [9].

Students' low mastery of 21st-century skills can impact the inability of the nation's next generation to compete globally in the future. In developing interactive multimedia, it is hoped that it will be able to build students' 21st- century skills. Therefore, an appropriate development base is needed. One of them is that the scope of its content presents contextually based learning. Because the learning media will show the real experiences of students in the learning process. Thus, multimedia-based contextual learning has a positive impact because it makes the material more relevant and interesting to students, helping them relate concepts to real situations. With visual, audio, and interactive elements, multimedia facilitates deeper understanding, increases student engagement, and supports critical thinking and problem-solving skills. One of the basic approaches that corresponds to this is the STEM education approach. STEM learning integrates STEM learning, which is recommended to help achieve 21st-century skills [10]. This follows the research results, which state that STEM positively affects students' creative, critical thinking, and problem-solving abilities. In line with these, Amin and Ibrahim [11] & Sari *et al.* [12] state that STEM education can improve students' problem-solving abilities, help them become innovators, be independent, and connect what they learn with daily activities. Fitriani [13] also revealed that learning media using interactive multimedia can improve the mathematical communication skills of prospective teacher students. Furthermore, Winarti *et al.* [14] revealed research results that stated that multimedia-assisted problem-based learning models can improve students' critical mathematical thinking abilities.

Based on the above explanation, STEM education is essential to prepare students for future challenges by developing critical thinking, creativity, collaboration, and communication skills 21st-century skills. Through a practical, project-based approach, STEM encourages students to think scientifically, solve problems, and innovate while introducing them to modern technology. This education is relevant in opening up future career opportunities and creating a generation that can adapt to dynamic global developments.

In carrying out development, it is also necessary to adjust the material to be suitable for inclusion in the media that will be created. Wulandari *et al.* [15] state that teachers must be able to choose learning media that suits the material to be delivered, and teachers must also adapt to the character of their students when choosing learning media. Learning media can provide concrete experiences and act as intermediaries that help students learn [16]. Based on the problems above, research will be carried out to analyze the need for developing interactive multimedia based on STEM Education to build students' literacy abilities and mastery of 21st-century skills. The novelty of this research compared to previous reference studies lies in the type of ability that will be measured. The types of abilities that will be looked at in this research are literacy and 21st-century skills. Furthermore, further differences in this research lie in the discussion of the material that will be included in the media that will be developed.

The Merdeka Curriculum focuses on improving students' literacy skills, particularly given the low performance of Indonesian students in the 2022 PISA assessment [17]. Current studies show innovative learning media, like e-modules and interactive multimedia, can enhance students' literacy and engagement. These tools are also important for building 21st-century skills, such as critical thinking, communication, collaboration, and creativity, which are crucial for future competitiveness. However, most research addresses literacy and 21st-century skills separately, and there is limited focus on integrating these areas into a single educational tool, especially within the Indonesian context. This gap highlights the need for comprehensive solutions that address both literacy and 21st-century skills in an integrated manner.

Research on multimedia development has been widely conducted, including the development of web-based interactive multimedia [8], interactive multimedia for geometry learning [13], and autoplay learning media to support the Merdeka Curriculum [18]. However, no studies have analyzed the need for interactive multimedia based on STEM education to enhance literacy skills and 21st-century competencies. This study aims to analyze the need for developing STEM-based interactive multimedia to build literacy skills and mastery of 21st-century competencies. While previous studies have focused on developing educational multimedia with other approaches to improve specific skills, this study seeks to analyze the need for multimedia to enhance literacy and 21st-century skills.

2. METHOD

This study analyzes the need for interactive multimedia based on STEM education to enhance literacy skills and 21st-century competencies. It employs a qualitative approach using a needs analysis method, which includes data collection through in-depth interviews with teachers and curriculum document analysis. The analysis consists of a literature review on interactive multimedia based on STEM education, as well as an exploration of the needs of teachers and students for the development of such multimedia. Following the approval of ethical clearance, the research was conducted.

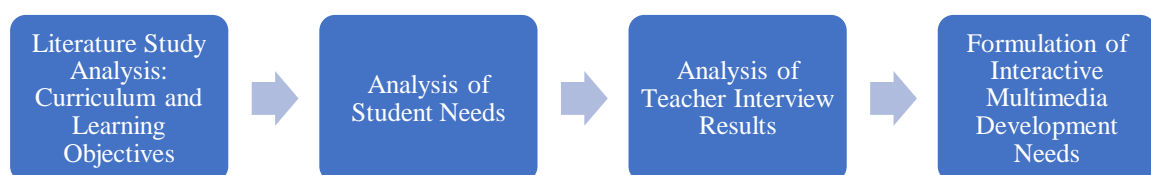


Figure 1. Stages of The Research

The stage is carried out through several activity steps, including, first, distributing questionnaires to students to see students' learning difficulties and collecting opinions from students regarding the ideal learning that students want; second, interviews with a physics teacher, aimed at seeing the problems encountered by teachers in carrying out learning and seeing the ideal conditions for physics courses from the teacher's point of view; last, review several documents related to multimedia based on STEM education. The subjects involved in this research were teachers and students of the eleventh grade of SMA Negeri 1 Lhokseumawe Aceh. After receiving consent from parents and students the research was conducted. These steps ensured the data collected was comprehensive and reflected the needs of both teachers and students. Furthermore, the ethical considerations in obtaining consent added credibility to the research process.

Data was collected through literature studies, field studies, and interviews. Literature studies were carried out to examine concepts that would be used as a basis for developing media. Meanwhile, field studies take the form of observations and distributing media needs questionnaires to students. Further interviews were conducted with teachers regarding the suitability of development materials and products according to needs. The research instrument used was a questionnaire sheet on students' media needs. The measurement scale on this instrument uses a Likert scale with a value range of 1 to 5. The data obtained was then analyzed descriptively, quantitatively, and qualitatively. Quantitative analysis was conducted to investigate the questionnaire results using a percentage formula. In contrast, a qualitative study was carried out by describing the research results and linking them with the results of previous research. These combined methods ensured a comprehensive understanding of the needs and context for media development.

3. RESULTS AND DISCUSSION

3.1 Literature Study Analysis

Initial analysis was carried out through a literature study of relevant research to strengthen the study in this research. Anam and Septiliana explained that the Merdeka Curriculum was presented as a response to overcome global human resource competition in the era of society 5.0, where humans and technology develop together [18]. Meanwhile, states that one of the factors causing students' low scientific literacy is the choice of textbooks and learning that need to be more contextual [19], [20]. Based on this explanation, it was concluded that, as an implementation of the Merdeka curriculum, teachers, as facilitators, must utilize technological developments in the learning process. One of them is the development of digital media for the learning process. This approach not only aligns with the demands of society 5.0 but also ensures that learning materials become more relevant and accessible for students. Consequently, the integration of technology into learning design is an essential step in fostering scientific literacy.

The results of data analysis of PISA literacy scores for Indonesian students from 2014 to 2022 are still relatively low and have never reached the standard scores set by PISA [21]. The results of this presentation must, of course, be followed up to find a solution. Herdiana *et al.* [6] research explains that it is necessary to develop inquiry-based science e-modules by utilizing local potential learning resources to increase students' scientific literacy. Meanwhile, research conducted by Zulkadri and Nurgiyantoro [22] revealed that web-based interactive multimedia products are suitable for use based on validation from experts and potential users and are effectively used to increase cultural literacy. Furthermore, Maziyah and Pangestuti [23] also state that e-modules based on outdoor education on ecosystem material can build students' scientific literacy skills. These results also align with research conducted by Cholifah and Novita [24]. The research results stated that developing e-modules based on outdoor education empowered the scientific literacy skills of class X students at NU Pujon Islamic High School on ecosystem material. This indicates that a variety of innovative learning resources can address gaps in literacy development. Further research and implementation are needed to ensure these strategies are widely adopted and optimized in educational contexts.

Aliftika *et al.* [9] stated that the 21st-century skills of Indonesian students are, on average, below and close to standard. Based on this explanation, teachers must look for alternative learning approaches to solve students' low 21st-century skills. Aisyah *et al.* [25] revealed that Gembil interactive learning media can be applied to physics learning to improve students' critical thinking skills in sound wave material and increase teacher creativity in expressing interesting ideas when delivering lesson material. Furthermore, Maulidiyah *et al.* [26] revealed that using articulate storyline-based interactive learning media could improve communication skills at SMPN 11 Jember.

3.2 Analysis of Student Needs

The advanced analysis stage is carried out by analyzing students' needs for learning media. This stage is carried out by distributing questionnaires to students via the Google form provided via the link. Analysis was conducted to see students' responses to learning using STEM education-based multimedia. The questionnaire contains statements that explore information related to needs and suggestions in the learning process. The results of the student analysis questionnaire distribution are in Figure 2. This analysis aims to ensure that the developed multimedia aligns with students' expectations and learning goals. The feedback collected serves as a critical foundation for refining the design and implementation of the learning media.

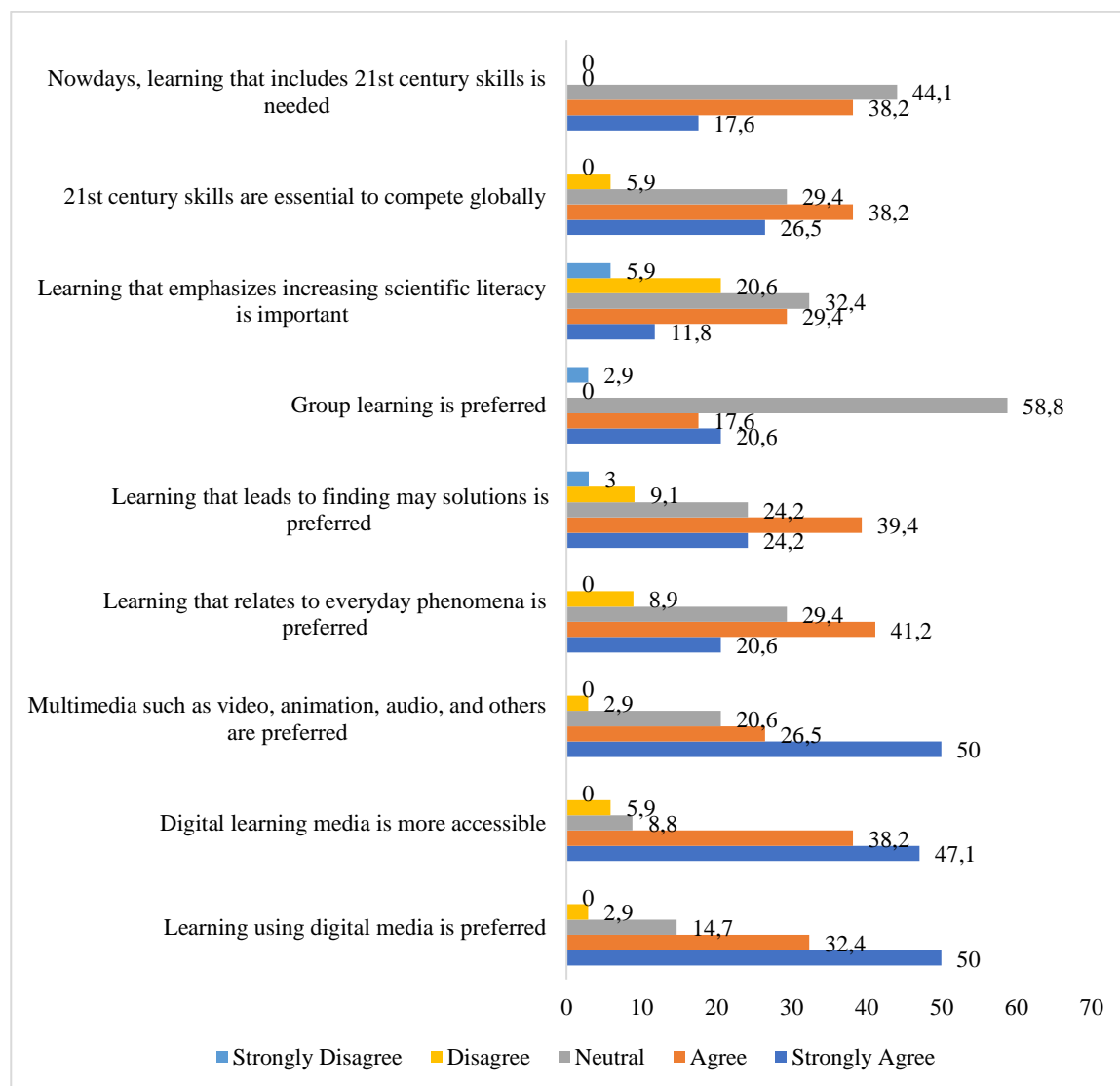


Figure 2. Student Responses to STEM-based Multimedia

Figure 2 illustrates some information: First, as many as 82.4% of students are interested and like learning using digital media; second, as many as 85.3% of students like learning media with easy access anywhere and anytime; third, as many as 76.5% of students like learning with media that can display animation, images, audio and video; fourth, as many as 61.8% of students liked learning that related to everyday life phenomena; fifth, as many as 63.6% of students liked learning that can guide students in finding many ways to find a solution to a problem; sixth, as many as 41.2% of students need learning that can improve scientific literacy skills; seventh, as many as 65% of students agreed that 21st-century skills are one of the essential skills to be able to compete globally in the future; eighth, as many as 55.8% of students need learning that strengthens 21st-century skills. Based on the presentation of the results of the needs analysis above, it is concluded that students need digital-based learning media that is capable of displaying animation, audio, and video, and the material coverage relates to the phenomena of everyday life problems. -days and be able to build literacy abilities and 21st-century skills. Students' interest in learning media like this will increase their learning motivation. This is in line with research conducted by Utami *et al.* [27] research, which stated that digital comic learning media based on a contextual approach increased students' motivation

regarding optical instruments. This is also in line with research results of Hidayat *et al.* [28] research that pictorial learning media, such as Android-based digital comics, effectively improve students' literacy skills in science material.

3.3 Analysis of Teacher Interview Results

Further research data was obtained through structured interviews with several physics teachers. The interviews obtained information that the learning media used during the learning process focused more on textbooks. More media development needs to be carried out due to many factors. Several factors that are the biggest obstacles in developing media are time and lack of ability to develop media, especially digital media.

The teacher concerned also said that students could have used the existing textbooks more optimally. Students prefer to use smartphones daily, and textbooks are considered less practical to carry in their daily activities. He also added that textbooks have not attracted students' attention for use in learning because their content could be more varied, making students quickly bored. Based on this presentation, it was concluded that there was a need to develop teaching materials whose presentation material was not just written or pictures but also presented moving animations, audio, and video. This presentation is in line with the results of research conducted by Fauziah's [29] research, which states that students need assessment media that are active and mobile and utilize technology to help them understand the material and complete assignments.

The interview results also concluded that students need media that has the practicality to make it easier for students to learn anywhere and anytime. The results of this presentation align with Annisa and Darussyamsu [30], which stated that the results of the interactive multimedia practicality test by students obtained an average score of 94.95%, so it was concluded that the interactive multimedia developed had practical criteria. At this interview stage, the scope of teaching suitable teaching materials to be included in the media created is also discussed. Based on the analysis of student needs, students need to discuss material that presents phenomena in everyday life. These results were then followed up by an analysis of class XI physics material distribution, especially learning material in semester 1. Based on the study of the distribution of existing materials, kinematics material was chosen because the concept of this material is often found in phenomena that exist in everyday life, such as straight motion and circular motion.

Furthermore, kinematics material is the basic foundation for advanced motion dynamics material. So, it is hoped that a good understanding of the concept in kinematics material will make it easier for students to learn motion dynamics material. It is hoped that a good understanding of the concept in kinematics material will make it easier for students to learn motion dynamics material. In addition, kinematics material can also be presented in the form of moving animations, which later, if presented in the developed media, are expected to increase students' interest in learning, especially in building their literacy skills.

Based on the results of the analysis of literature studies related to interactive multimedia based on STEM education, analysis of students' needs through questionnaires provided, and the results of interviews with several physics teachers at schools, it was concluded that it was necessary to develop learning media that contained animation, audio and video features and was integrated with the material presented [31]. The content relates to everyday phenomena that can build students' literacy abilities and 21st-century skills. Thus, it is concluded that developing interactive multimedia based on STEM education is necessary to build students' 21st-century literacy and skills. This development should focus on creating engaging, accessible, and pedagogically effective multimedia to maximize its impact on student learning.

4. CONCLUSION

Based on the questionnaire given to students, it was concluded that students need learning media with many features, such as moving animation, audio, video, and interactive features that make independent learning easier. Another result was that students need learning media that is practical to use. Meanwhile, interviews with teachers showed that limited time and ability were significant obstacles in developing digital media. Furthermore, teacher interviews also confirmed the results of the analysis of student needs, where students need practical and exciting media to attract their interest in learning. Thus, the development of interactive multimedia-based STEM education is expected to enrich learning in the Merdeka curriculum by making STEM concepts easier to understand, interesting, and applicable. This media supports 21st-century skills by honing students' critical thinking, creativity, and collaboration skills through simulations, videos, and interactive quizzes. This multimedia integration also supports independent and active learning following the Merdeka curriculum, bringing students closer to more adaptive and innovative national education achievements. This study has implications in informing that the development of interactive and practical STEM-based learning media is needed.

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AUTHOR CONTRIBUTION STATEMENT

WW contributed to the fieldwork, prepared the background, and supervised writing the entire article. ZM contributed to the fieldwork and data entry. AM contributed to the data analysis, interpretation, and literature review and provided critical contributions to the drafting and revision of the manuscript. ATH contributed to improving and providing input on the research manuscript.

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