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Needs Analysis of Interactive Multimedia Teaching Material on Alternative Energy Content to Facilitate Student's Concept Mastery and Technology Literacy

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ABSTRACT

Technological literacy is one of the crucial competencies for students in the 21st century. This study aims to analyze the level of student's mastery of concepts and technological literacy, especially in the topic of alternative energy. This research is motivated by observational findings at SMA N 4 Solok which showed low learning outcomes and limited technological literacy of students in physics learning. The approach used is Research and Development (R&D) by adopting the Hannafin and Peck development model at the needs assessment stage. Data were collected through questionnaires involving 35 grade 10 students and a physics teacher, discourse tests to identify misconceptions on the topic of alternative energy, and analysis of Mid-Semester Exam scores to measure initial concept mastery. The analysis shows that available learning resources do not optimally integrate Information and Communication Technology (ICT), thus under-supporting student learning independence. Furthermore, the average student learning achievement remains below the Minimum Completion Criteria. This finding underscores the urgency of developing innovative and contextual interactive multimedia learning tools. This development is expected to create more meaningful learning experiences while simultaneously facilitating improved student conceptual mastery and technological literacy.

INTRODUCTION

Twenty first century education brings significant changes to the competency requirements students must master. This shift is a response to the increasingly complex conditions of the globalization era, dominated by advances in digital technology (Trilling & Fadel, 2009; Dede, 2010). In this paradigm, learning no longer focuses solely on mastering static content, but rather on developing the 4C skills: critical thinking and problem-solving, creativity, communication, and collaboration (Partnership for 21st Century Learning, 2015).

The 21st century is marked by rapid social, technological, and economic change, requiring educational institutions to adapt through innovative approaches. Educational innovation is not merely a trend, but rather an urgent need to produce individuals who are resilient in facing challenges and adapting to opportunities in an ever-evolving world

(Yusuf, 2018). One crucial aspect of this innovation is the integration of technological literacy. Students are required not only to be able to operate digital devices but also to have the ability to access, manage, integrate, evaluate, and create information safely and accurately through technology (UNESCO, 2018).

Technological literacy acts as a crucial instrument that helps students bridge their understanding of abstract material, particularly in physics. The implementation of digital platforms and interactive multimedia in the classroom allows for the visualization of complex phenomena, stimulating students' analytical acumen and curiosity (Mayer, 2014). Therefore, the integration of 21st-century skills with digital literacy is a fundamental foundation for realizing education that is contextual, meaningful, and adaptive to industry demands and global dynamics.

In education, literacy is an essential pillar that equips students with the ability to adapt to the dynamics of the times. Comprehensively, this skill encompasses the processes of identifying, interpreting, and utilizing written materials to optimize personal potential and social contribution. Amidst the massive flow of digital information, this skill serves as a crucial filter for sifting through data from the internet. Furthermore, a strong mastery of literacy also positively impacts personal development, shaping individuals who are more confident and active in society. In this field, reading and writing skills are essential for the future and need to be improved and given attention by everyone. The better a person's reading and writing abilities, the greater their likelihood of success in the future. The importance of new literacies for an individual is in addressing rapidly developing technological issues and applying technology in learning.

The concept of new literacy is understood as a set of crucial competencies in addressing the challenges of the 21st century. Referring to the thinking of Ibda (2018) and Wardana (2018), there are three main pillars in this literacy: data, technology, and human. Data literacy emphasizes the ability to process and interpret digital information, while technological literacy focuses on operational technological skills in specific fields. Human literacy is directed at developing communication capacity and design expertise (Yahya, 2018), which are fundamentally closely related to soft skills such as critical thinking, creativity, collaboration, and innovation.

The implementation of new literacies in the education curriculum is crucial for producing globally competitive graduates. As a fundamental competency for the future, technological literacy is the primary focus of this study. This literacy extends beyond internet usage to encompass computer proficiency and supporting software. Research by Nasution (2018) confirms that digital instruments such as interactive multimedia and Android-based applications are effective in deepening understanding of material. As an evolution of digital literacy, technological literacy requires individuals to be selective in their use of cyber media while simultaneously understanding the working principles of machines and applications, from coding to artificial intelligence.

Technological literacy is defined as the ability to utilize technology, particularly to support science learning and investigative skills (Rose, 2007). According to Wandasari (2019), the scope of literacy has now gone beyond traditional reading and writing skills, extending to communication competencies in broader social interactions. To produce a competitive generation on the global stage, mastery of "new literacies" is an absolute requirement. As stated by Ibda (2019), this new literacy integrates three main pillars: data, technology, and people, as a complement to basic skills (reading, writing, and arithmetic). In this case, technical competency emphasizes a systemic understanding of how applications work and the optimization of technological products to achieve maximum results.

The first issue relates to student learning outcomes. To support good learning outcomes, learning activities are necessary, as learning experiences will not occur without them. Concept mastery is highly needed in learning, especially in physics learning. "Concept mastery" comes from the word "mastery" and "concept." Mastery is the process, method, act of controlling or taking charge, the understanding or ability to use knowledge, and skill. The word mastery can also be interpreted as a person's capability in a certain thing. Concept mastery refers to a deep and comprehensive understanding of a specific concept or topic. Concept mastery involves a deeper understanding than just facts or definitions; rather, it includes the ability to connect, apply, and explain the concept in various contexts (Fitrianingrum, 2023). Student concept mastery is expected to be able to manage cognitive competence so that improvements can be made in subsequent learning (Lestari et al, 2019). Concept mastery can be concluded as the process or method by which a person masters and understands an idea or notion related to knowledge for implementation in daily life. The utilization of multimedia during the learning process has led to the emergence of a new alternative learning pattern, where the learning process can proceed well collectively—in large, medium, or small groups—or individually and independently.

Multimedia packages are commonly used in the learning process, either individually or independently, but are sometimes also utilized in a classroom setting under the guidance of a teacher, lecturer, or instructor. It is not surprising that the concept of multimedia is closely associated with distance education systems or open education that requires students to learn independently without assistance from others. The multimedia concept is more closely aligned with a student-centered approach rather than a teacher-centered approach. Regardless of the context, the use of a multimedia package inevitably involves a high degree of interaction between the student and the learning material. Interactive multimedia is a learning medium that can substitute for the function of the teacher, especially as a learning resource. However, multimedia is not the sole primary determinant of success in learning. The success of physics learning can be assessed from student learning outcomes. This success can be seen from the level of understanding, mastery of the material, and learning achievement. The higher the student's understanding, mastery of the material, and learning achievement, the higher the level of learning success.

The use of appropriate and quality teaching materials is a key factor that highly determines the quality and effectiveness of the learning process. Data indicates a significant challenge in academic achievement, where many students, as reported by Fitria (2017) in the context of Natural Science, still obtain scores that are below the Minimum Competency Criteria. Therefore, a fundamental solution to address this learning gap is to design and provide teaching materials that are relevant and aligned with the needs of students and the curriculum. Well-designed teaching materials are proven to have strong potential to improve student learning outcomes and experiences. Teaching materials do not only function as a complement to the main textbook, but play a multifunctional role, both for teachers and students, in the effort to enhance the quality of education: For Students:Promoting Independent Learning: Teaching materials enable students to learn anytime and anywhere (self-learning), reduce dependency on the teacher, and allow them to progress through learning at their own pace.

Enhancing Understanding and Motivation: Varied teaching materials (including multimedia) can increase interest and motivation for learning, as well as help students understand concepts from multiple perspectives. Providing Alternative Learning Resources: Teaching materials complement or replace textbooks that are sometimes difficult to obtain or lack context. For Teachers: Increasing Effectiveness: Teaching materials help teachers direct all learning activities and ensure the material delivered aligns with the Basic Competence making the teaching process more focused, effective, and interactive. Changing Roles: Teachers can shift their role from merely being a deliverer of material to a facilitator who guides students in understanding and applying concepts. Saving Time: Neatly structured teaching materials save the teacher preparation time and allow them to focus on more creative and interactive teaching strategies. Overall, the development of systematic and structured teaching materials is a crucial effort to ensure that learning is efficient, effective, and inclusive, and is capable of supporting students in achieving the established competencies.

Based on the existing data at SMAN 4 Solok, it was found that the learning outcomes of students in Phase E are generally still low and have not reached the established Minimum Competency Criteria. Learning outcomes were obtained from the average semester exam scores of students in classes E 1, E 2, E 3, E 4, E 5, and E 6 at SMA N 4 Solok. The average mid-semester exam scores are E 1 with an average of 62, E 2 with an average of 51, E 3 with an average of 48, E 4 with an average of 51, E 5 with an average of 59, E 6 with an average of 49. All of these average mid-semester exam scores have not met the Minimum Competency Criteria for the physics subject. This indicates that student learning outcomes in physics are still low.

The second aspect reviewed was technological literacy, which was evaluated through a performance assessment sheet based on four main indicators: understanding the benefits of technology, utilizing multimedia features, using technology to search for learning resources, and access to digital media such as virtual laboratories (Greenstein, 2018). Based on the analysis, it was found that an average of 48% of students still rarely use learning media. This data indicates that although access to virtual laboratories and electronic media is available, the level of efficiency of their use by students is still relatively low.

The media used by the teacher, such as PowerPoint, is still limited to only images and text, so its usage still has many shortcomings. In the field, even though educational media is already ICT-based, its utilization is still not efficient, which leads to inefficient student learning processes in the classroom and poor learning progress. The lack of effective interaction will hinder students' ability to contextualize learning materials with phenomena that occur in real life. An alternative to overcome this problem is to use interactive multimedia content for learning. Interactive multimedia is a type of information technology used to optimize teaching and learning activities. Interactive multimedia provides students with opportunities to develop problem identification, information organization, analysis, evaluation, and communication skills. The presentation of material with audio, images, animations, and videos helps students in understanding the material delivered (Tazkia, 2019).

Interactive multimedia makes it easier for teachers to deliver learning material and facilitates the achievement of all learning skills. Furthermore, interactive multimedia content facilitates active learning for students, both independently and with guidance. The use of interactive multimedia can help teachers provide learning that is more engaging, effective, and efficient, thereby increasing students' interest and motivation in learning. Therefore, it is important to help adjust and balance the model and effectively teach the material used by students to enhance students' concept mastery and technology literacy. This research aims to facilitate students' concept mastery and technology literacy on the alternative energy topic. This analysis provides strategic information that can be used to optimize educational quality and formulate relevant solutions. The research findings are projected to serve as a reference in helping students master technological concepts and literacy, particularly in the area of alternative energy.

METHODS

This study utilizes a Research and Development (R&D) methodology, specifically employing the Hannafin and Peck instructional design model. Known for its productoriented approach, this model is frequently used to develop educational tools, such as learning media (Kustandi et al., 2020; Karim et al., 2021). The development process encompasses three systematic phases: Needs Analysis, Design and Development, and Implementation. During the initial needs analysis at SMAN 4 Solok, data regarding the teaching and learning of alternative energy were gathered from both educators and students. This preliminary phase involved the administration of questionnaires and performance assessment instruments to both groups to establish a baseline for the research.

Research instruments are tools used to collect data in research, consisting of performance assessment instruments, learning outcome documents, teacher questionnaires, validity test instruments, and practicality test instruments. A performance assessment instrument was used to measure student performance skills. The performance assessment instrument in this study was designed as an observation sheet with a rating scale. This instrument was used in the initial observation phase at SMAN 4 Solok. This instrument can be used to obtain information about student performance skills in the use of technology and interactive multimedia. The documentation method in this study was used to determine student learning outcomes, namely from the final semester Physics exam scores of class X Phase E students of SMAN 4 Solok. Furthermore, this questionnaire contains statements about students' motivation in learning Physics. In the questionnaire, answers are provided: often, always, sometimes, and rarely.

The research instruments used included a questionnaire for teachers and a performance assessment sheet for students. The teacher questionnaire covered three main aspects related to the topic of alternative energy: the implementation of learning models, the use of learning media, and the availability of supporting facilities and equipment. Meanwhile, the student performance assessment instrument was designed to identify indicators of technological literacy using a five-category rating scale, as shown in Table 1.

Table 1. Answer Categories for Teacher and Student Questionnaires

Evaluation	Answer Categories
1	Never performed as stated (0%-20%)
2	Rarely performed as mentioned (21%-40%)
3	Sometimes as mentioned (41%-60%)
4	Often performed as stated (61%-80%)
5	Always made the statement (81%-100%)

Statistical analysis techniques relate to calculations to answer the proposed problem formulation. The data analysis technique used in this study is descriptive statistical analysis. Descriptive statistics is an analysis technique that aims to provide a systematic overview of collected data without generalizing it to a wider population (Sugiyono, 2012). In this study, the application of descriptive statistics is realized through frequency distribution, which includes data presentation techniques in the form of tables and graphs, as well as calculations of central tendency measures.

The first analysis technique is tabular analysis. Tabular analysis describes the frequency distribution of data based on intervals or distances, presented in singular form, percentages, summed from top to bottom, bottom to top, and greater than or less than. Presenting research data using tables is widely used because it is more efficient and communicative. There are two types of tables: a regular table and a frequency distribution table. Each table contains a table title, column headings, data values in each column, and the data source from which the data was obtained. The second analysis technique is graphical analysis. Graphical analysis involves viewing histograms and normal probability plots. The type of graph used in data analysis is a bar graph (histogram). A bar graph (histogram) is used to visualize the physical appearance of the data obtained. From the graph, the percentage level of each factor influencing students' mastery of concepts and technological literacy can be determined.

RESULTS AND DISCUSSION

Results

The first analysis result in this study examined the needs of students related to the challenges they face in the alternative energy topic. The instrument used was a questionnaire sheet consisting of five questions, which was administered to 35 students in class E 1 at SMA N 4 Solok. The analysis results are presented in Figure 1.

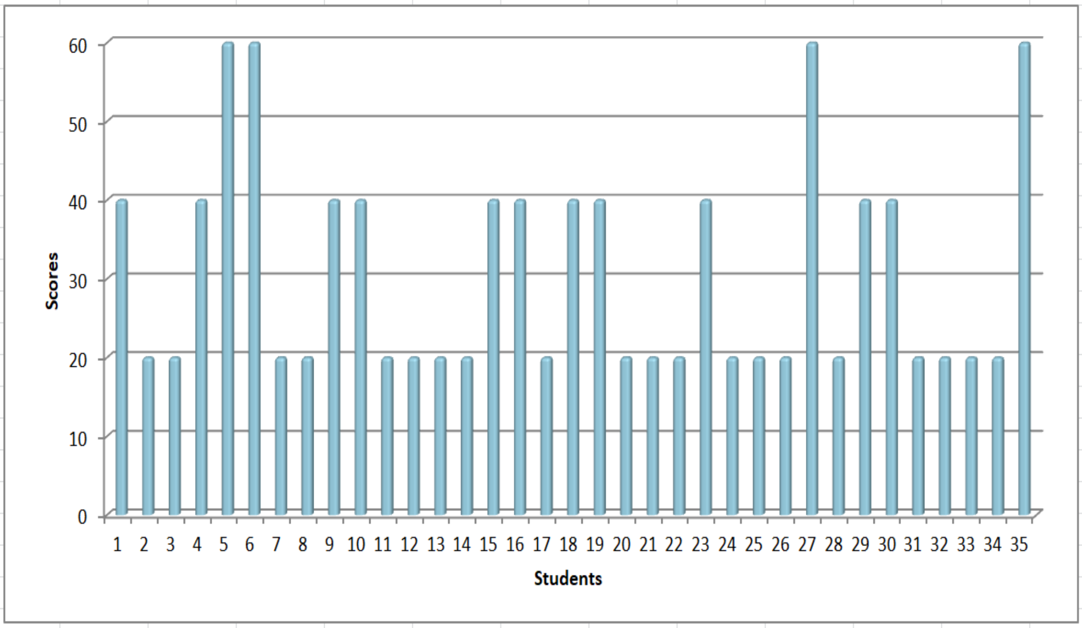

Figure 1. Analysis Results of Problems in Alternative Energy Material

The figure presents the results of an analysis investigating student needs related to the challenges they face in understanding the alternative energy topic. The data were obtained through a diagnostic instrument in the form of a questionnaire sheet consisting of five open-ended questions. This instrument was administered to 35 students of class X E 1 at SMA N 4 Solok. The bar chart in the figure illustrates the individual scores of each student, revealing a wide range of performance levels. Most students scored between 20 and 40, indicating significant difficulties in mastering alternative energy concepts. Only a few students achieved higher scores, with the highest score being 60, suggesting that only a small portion of the class has a strong understanding of the material. These findings highlight the need for targeted instructional support and the development of teaching materials that address specific learning gaps in the alternative energy topic.

The second analysis in this study focused on identifying student needs related to concept mastery or learning outcomes. Data were obtained through mid-semester test (MST) scores of students from grades E1 to E6 at SMA N 4 Solok. Initial achievement in concept mastery is then presented in depth in Table 2.

Table 2. Student Learning Outcomes

Grade	Average
E 1	62
E 2	51
E 3	48
E 4	51
E 5	59
E 6	49

Based on the data presented in Table 2, variations in the average Mid-Semester Exam scores across all classes in phase E are visible. Class E 1 recorded the highest average score of 62, followed by class E 5 with a score of 59. Meanwhile, classes E 2 and E 4 showed identical gains with an average score of 51. On the other hand, classes E 6 and E 3 were in the lowest score group, with averages of 49 and 48, respectively. Overall, these data show that most classes still have average scores in the 50s, which indicates the need for further evaluation of the learning process in each of these classes.

Evaluation of the performance assessment instrument was conducted to comprehensively map students' initial competencies. The instrument was developed to measure students' capacity to integrate technological devices into their cognitive activities. Based on the analysis of students at SMA N 4 Solok, a summary of students' perceptions and achievements of technological literacy indicators is presented in detail in Table 3.

Table 3. Performance Assessment Instrument Responses

Technology Literacy Indicators	Percentage of Student Responses
Knowing the Various Advantages of Different Technologies	44%
Knowing Multimedia Features in Learning	42%
Using Technology During Learning	43%
Selecting and Utilizing Technology During Learning	43%

Referring to the data in Table 3, the average student technological literacy ability in the alternative energy material reached 43%, which is qualitatively classified in the "low" category. When viewed per indicator, the highest achievement was in the ability to identify the advantages of various technologies with a percentage of 44%. Meanwhile, other indicators showed almost similar results, namely understanding multimedia features (42%), utilization of technology in learning (43%), and the ability to select and use technological instruments (43%). All of these aspects consistently at a level of achievement that still needs improvement (low category).

The data analysis results from the teacher questionnaire used to assess the learning media utilized during the learning process were obtained from the responses provided by the teacher in the questionnaire, as follows:

Table 4. Implementation of Learning by the Teacher (Alternative Energy)

No.	Aspect of the Question	Evaluation	Answer Categories
1.	Utilization of innovative learning models	26%	Rarely
2.	Use of digital teaching materials and learning media	47%	Sometimes

3.	Use of supporting facilities and equipment	38%	Rarely

Based on the data presented in Table 4, it can be concluded that the application of innovative learning models in alternative energy materials is still very limited, with teachers implementing them only occasionally, or even rarely. This limitation is directly proportional to the availability of supporting facilities; the teaching materials and learning media used are still conventional, limited to textbooks and Student Worksheets. Although there are updates to the materials in the form of modules or guidebooks, their use is still not optimal and is only done occasionally. This still-traditional learning situation has a direct impact on students' low technological literacy, as they are not facilitated to interact with digital instruments that are relevant to current developments.

Discussion

The second analysis relates to the difficulty in understanding the alternative energy material. The factors causing learning difficulties are categorized into internal and external factors. Internal factors include physiological factors (due to illness, poor health, or physical disability) and psychological factors (intelligence, aptitude, and others). Meanwhile, external factors include family factors, school factors, and media and social environment factors. Both internal and external factors contribute to learning difficulties (Husein, 2020). The difficulty in understanding the alternative energy material is because most students understand the material only in terms of the existing mathematical equations, without deeply understanding the basic concepts. If this issue continues, students will fail to understand a concept, which will eventually impact their understanding of subsequent materials. The test results also indicate that students' achievements remain well below the Minimum Competency Criteria, highlighting the need for more engaging and interactive teaching materials to enhance their grasp of alternative energy concepts and improve learning outcomes.

The second analysis highlights the low level of student technological literacy, driven by various factors, one of which is the minimal intensity of technology use in instructional activities. This phenomenon indicates that the guidance and facilities provided by educators in utilizing technology are suboptimal, resulting in students being less accustomed to operating interactive multimedia features that support their digital literacy (Irwan et al., 2019). Furthermore, students' limitations in selecting and utilizing technological devices during learning also exacerbate this condition (Nurlaili et al., 2023). Obstacles in observing contextual phenomena have implications for students' low literacy skills in solving real-life problems (Rifki, 2021).

Educators play a central role in mitigating students' low technological literacy through the transfer of relevant knowledge. Dragos and Mih (2015) and Sikas (2017) emphasize that teachers have the capacity to provide appropriate methods and stimulation through the selection of media and teaching materials. However, in practice, many teachers tend to prioritize achieving cognitive learning outcomes alone without delving into the depth of student understanding. Consistent with Rubini et al.'s (2017) opinion, the integration of technology relevant to students' life contexts is often neglected. The lack of reinforcement through problem-solving strategies and real-world applications makes the material difficult to retain, and students' understanding of the concepts remains superficial (Fuadi et al., 2020).

To optimize students' conceptual understanding and technological literacy, a transformation in teachers' pedagogical approaches is necessary. The focus of teaching should not be solely on achieving cognitive learning outcomes, but should also include intensive guidance in solving physics problems. Furthermore, students need to be encouraged to make critical observations of environmental phenomena relevant to physics principles, supported by the availability of competent technology-based learning media. Therefore, developing learning media designs that integrate conceptual mastery exercises and technological skills is crucial to facilitate student needs, particularly in alternative energy materials.

CONCLUSION

Based on data observations at SMA N 4 Solok, it was found that student achievement in alternative energy material was still far below the Minimum Completion Criteria. The results of the analysis of concept mastery through Mid-Semester Test scores showed an overall average of 53, which confirmed that student academic achievement had not met the minimum passing standard of 75. In addition, students' technological literacy profiles were also classified as very minimal; in the competency aspect, 26% of students were recorded as being in the "very low" category in terms of selecting and utilizing learning technology. Considering that the factors causing this failure include the effectiveness of models and teaching materials, strategic steps are needed to optimize students' mastery of alternative energy material.

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