ANALYSIS OF MULTI-REPRESENTATION-BASED E-BOOK NEEDS ON BASIC PHYSICS MATERIALS, DEPARTMENT OF PHYSICS EDUCATION, MUSAMUS UNIVERSITY

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Abstract

This study aims to describe the analysis of development needs and produce multi-representation-based e-books for basic physics courses. The study utilizes a mixed-method, explanatory sequential design model. Currently, the research is limited to the needs analysis phase before developing multi-representation-based e-books. The development of a multi-representation-based basic physics e-book is based on several aspects of student needs, including the student's basic physics lecture process, difficulties in understanding basic physics material, and the learning resources used by students to study basic physics material. Students require integrated multi-representation in solving physics problems. The study involves 76 students from the Department of Physics Education, Musamus University, Merauke. The analysis results indicate that 91.1% of students in the physics education department at Musamus University express a need for multi-representation-based e-books in the basic physics learning process. This is supported by student response data. Firstly, the majority of students still rely on conventional teaching methods during lectures, hence they require interactive media to enhance the quality of learning. Secondly, most students have limited access to learning resources, mainly relying on textbooks. Thirdly, students encounter difficulties in understanding physics concepts. Lastly, students express a need for multi-representation-based e-books in their physics lectures.

Keywords: Needs analysis, E-book, Multi-representation, Basic Physics

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1. Introduction

Basic physics is one part of the field of natural science that describes natural phenomena, theories, and concepts, both abstract and real. The process of studying basic physics is very challenging for students, both in terms of their ability to analyze and understand the concept of physics itself [1]. Findings from research on students indicate that students consider physics content difficult due to several factors. One of these factors is the form of problem-solving, specifically conceptual problem-solving [2]. Solving conceptual problems is considered challenging because it is related to individuals' ability to analyze the construction of phenomenal physics problem-solving [3]. Another factor is that basic physics material encompasses a multidisciplinary scope of knowledge, including conceptual, factual, procedural, and metacognitive knowledge [4]. Factual and conceptual knowledge are fundamental abilities that support higher-order thinking skills (HOTS) [5]. These two abilities form the fundamental knowledge for students in planning and finding solutions to physics problems. On the other hand, procedural and metacognitive knowledge are higher-order thinking skills used to solve abstract physics problems. Students' learning difficulties in basic physics lectures are quite complex, requiring a needs analysis to determine appropriate innovative approaches, strategies, and learning media to support the achievement of optimized lecture objectives. One of the basic needs is teaching materials. The physics teaching materials needed should be innovative and capable of attracting students' interest [6] and promoting independent learning [7]. Innovative teaching materials must be able to adapt to the development of science, including technological advancements. The development of science and technology acts as a facilitator, providing convenience for learners and instructors in creating and innovating. One form of this facilitation is the use of interactive media. Interactive learning media is a form of packaging the learning process in electronic media, including e-books, learning videos, virtual laboratories, and simple animations. In the learning process, interactive media plays a crucial role in providing easy access to information by utilizing media to help implement and achieve effective learning. In terms of impact, interactive learning media can provide numerous benefits.

Based on the results of interviews and preliminary observations on several students from the Physics Education Department at Musamus University, several conditions were found in basic physics lectures. Firstly, the average student is only familiar with textbooks in paper format and electronic books in PDF format. The discovered textbooks have not been developed into interactive e-books with simulations, videos, animations, audio, and images. Secondly, there is a lack of electronic teaching materials that can be accessed by students or lecturers through an integrated learning management system (LMS). This has an impact on the quality of learning, including the low level of higher-order thinking skills among students and their technological literacy. Teaching materials play a crucial role in directing all activities during the learning process and can contribute to the achievement of learning quality. In basic physics lectures, teaching materials serve as a source of independent learning for students, helping them expand their knowledge, understand concepts, and develop higher-order thinking skills. With the rapid advancements in technology, instructors now have the opportunity to develop technology-based teaching materials. One such development is the creation of interactive electronic books (e-books). Interactive e-books are innovative and adaptive teaching materials that align with the current demands of learning. They integrate interactive learning media into a unified teaching resource. E-books, as digital books, serve as learning media that present information in the form of text, images, or both, and can be accessed through computers or mobile devices [6]. They can also be viewed as interactive learning resources, presenting messages or information in an engaging and diverse manner through a combination of text, images, animations, sounds, and videos [8]. With the progress in science and technology, software development has become increasingly rapid and accessible, both in free and paid forms. This allows educators to combine various online and

offline media into comprehensive e-book packages that are more attractive and interactive. The packaging of basic physics e-books is enhanced with engaging content such as videos, animations, audio, and images. The inclusion of such content provides students with multiple approaches to solving physics problems [9]. E-book content typically includes text, equations, graphics, animations, and videos, and can be accessed using mobile phones or computers.

Ayu and Fauzi revealed several advantages of e-books as innovative learning media [10]. E-books can be easily accessed through electronic devices anytime and anywhere. They serve as a source for student self-study [11]. Independence in individual learning can be fostered through active learning activities driven by intentions and motives to master competencies and solve problems. Students can study in various locations and conditions, with independent learning being influenced by the availability of suitable learning resources. The packaging of the basic physics e-book requires additional assistance in the form of a multi-representation approach, incorporated within the textbook. The multi-representation approach involves delivering concepts through various means, such as text, tables, diagrams, visual images, mathematical equations, computer simulations, and others [12]. Presenting physics concepts in different formats allows individuals to comprehend them more effectively. People often have a better understanding when information is presented through words and pictures rather than just words. This aligns with research findings that indicate better and longer-lasting memory recall for visual images compared to written information [8], [13]. Integrating the multi-representation approach into the basic physics e-book is an innovative step in developing physics learning materials. The integration of multiple representations in e-books is believed to provide opportunities for students to enhance their higher-order thinking skills. Some representation features guide students in solving physics problems within the e-book content and evaluations. For instance, visual representations can effectively portray problems that cannot be directly observed.

Based on the results of research by Wilda & Yusnaidar, the development of multi-representation-based physics teaching materials is following the characteristics of the learning process at the university level [14], [15]. One of the achievement targets is to produce competent students who know Physics content, can solve Physics problems, and have other higher-order thinking skills [16]. In addition, research that develops e-books can increase students' motivation, interest, and quality of learning. Following several descriptions of the advantages of e-books in learning physics, the authors are motivated to carry out similar developments, namely the development of multi-representation-based basic physics e-books. The results of the research become an initial study related to the needs of students in supporting product development. The purpose of the initial study is to find out the basic problems needed in the development of e-books. The multi-representation-based e-book development stage uses a 4D development model. There are several stages, the next for the e-book is a need assessment (needs analysis), which is an analysis that finds out what the initial needs are, the required literature, and the theoretical limitations that will be used. For this reason, to develop a Multi-Representation-Based Interactive Basic Physics e-Book, a preliminary analysis is required. One of the preliminary analyzes that need to be done in the development of this e-book is an analysis of E-book needs. The product to be developed is an E-book for the mitigation of the volcanic eruption disaster. The variable of this research is the need for a valid and reliable multi-representation-based interactive basic physics E-book used in learning.

2. Methdology

This research uses a mixed research approach (quantitative and qualitative) type of explanatory sequential design (Cresswell, 2014). Approach of this study aims to analyze the need for an interactive, multi-representation-based e-book of basic physics. Mix Method Research is a research model that specifically examines the description of

research results through several testing or observation techniques that need to be tested in terms of outputs and processes, in the form of quantitative and qualitative data descriptions that are interpreted simultaneously. This research is limited to quantitative and qualitative analysis related to the need for multi-representation-based e-books derived from initial observations in the field (Needs assessment) based on several indications. Several indicators serve as benchmarks for obtaining this needs analysis data, namely: (1) The basic physics learning process for students. The learning process is more about the method or platform used by lecturers in basic physics lectures. (2) students' difficulties in understanding the basic physics material. Several indicators are used as benchmarks, namely understanding concepts, ability to solve mathematical problems, ability to analyze graphs, ability to interpret physical phenomena in the form of sketches or drawings, and ability to understand and analyze tables (3) Learning resources used by basic physics students. It aims to determine the learning media used by students during learning. (4) Student needs to be related to the integration of some basic physics e-book features that need to be integrated with solving Physics problems. Figure 1 is the flow of the research method.

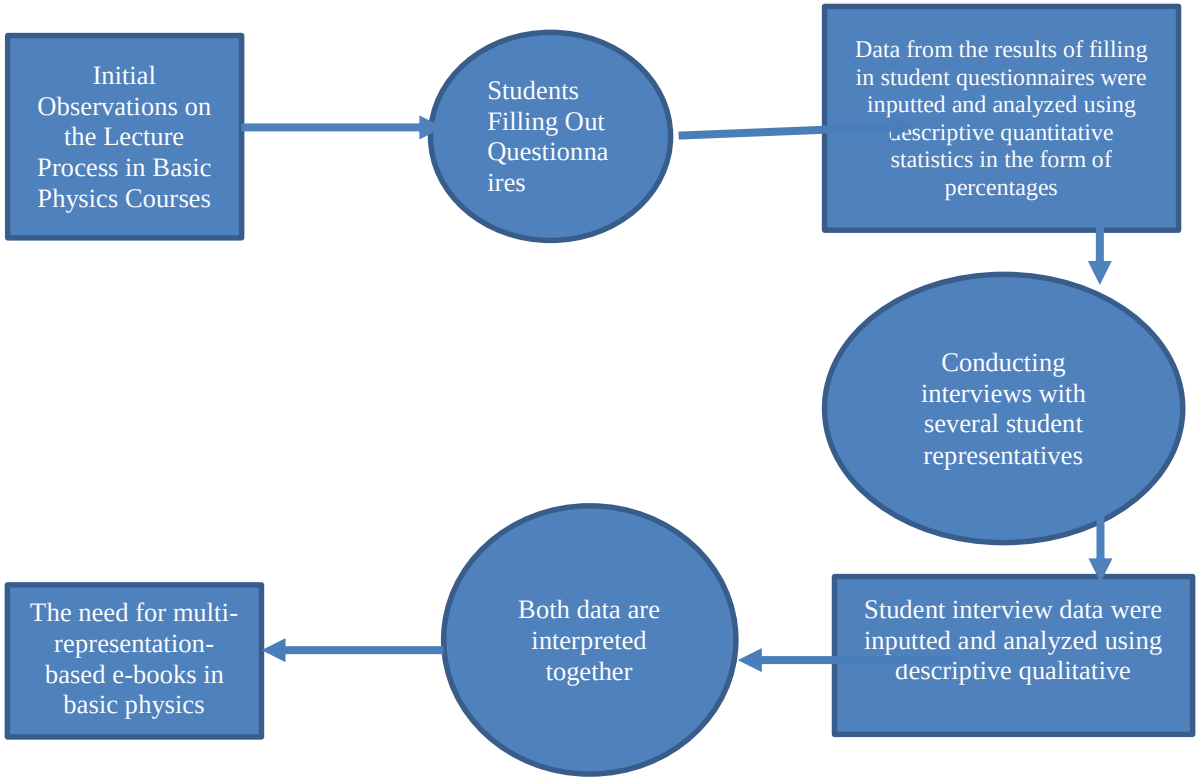

Figure 1: Research Flow

Research data in the form of initial needs for this development is an interactive, multi-representation-based e-book. The subjects of this study involved 76 students from the Department of Physics Education at Musamus University, Merauke. Data collection was carried out by involving students in responding to the four aspects needed by researchers to analyze the needs of e-books. These four indicators were summarized into several points comprising 12 questions and statements. Data collection techniques in this study utilized survey techniques in the field, employing questionnaires as instruments to gather student opinions on the need for developing a multi-representation-based Basic Physics e-book. Additionally, structured interviews were conducted to gain detailed

insights into the students' needs in improving the quality of physics lectures. The data analysis technique employed several methods, including data reduction, data presentation, and conclusion drawing/verification. To ensure data validity, a validity test was conducted using the source triangulation method.

3. Results and Discussion

Based on the results of the needs analysis test to create an interactive multi-representation-based Basic Physics E-book, the lecturer of the Physics education department at the University of Musamus Merauke stated that they needed digital teaching materials as one of the learning media in the lecture process. These results are supported by the results of the analysis on four aspects of supporting analysis, namely aspects of the recovery process, aspects of access to learning resources, difficulties in learning physics, and the need for multi-representation-based e-books. The researcher presents several planned questions and is followed by structured interviews to obtain student responses regarding these needs. The number of respondents was 76 students of the Department of Physics Education, Musamus University. The results of the analysis of the needs of students are contained in several aspects as follows:

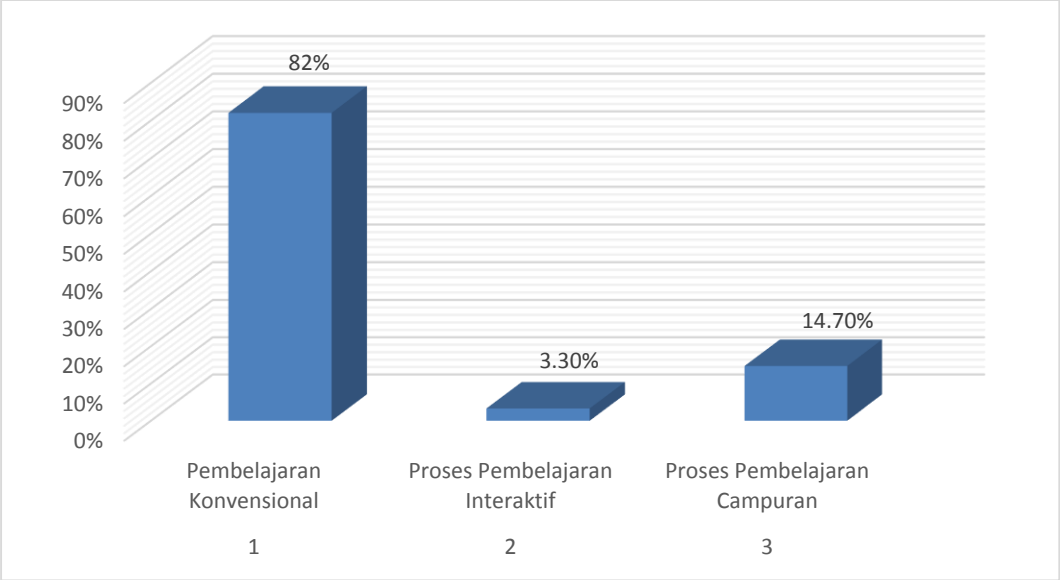

Figure 2: Student responses regarding the Basic Physics Learning Process

Based on Figure 2 obtained data related to the learning process that has been carried out in basic physics lectures. There are three groupings of the basic physics learning process based on student responses, namely as follows: 1) The first number graph illustrates that the basic physics lecture process uses conventional learning techniques. Conventional learning means that Physics learning is carried out without using interactive media or interactive learning models. Student responses show more than 82% of the conventional-based learning process. They said that conventional learning is difficult to develop their creativity, thinking quality, and thinking ability. 2) The second graph illustrates that some basic physics lectures use interactive learning techniques. Interactive learning means that the Physics learning process is carried out using some media assistance or innovative learning models. Student responses showed only 3.3% of the learning process was based on innovative learning. The interactive learning used is an assessment based on the Quiziz game application. 3) The third graph illustrates that some basic physics lectures have used mixed learning techniques. Interactive learning means that the Physics learning process is carried out using some innovative assistance. Student responses show less than 14.7% of the learning process is based on innovative learning. A quality learning process will be supported by quality

learning facilities. Based on the student responses above, it is necessary to improve the quality of learning by maximizing interactive learning media in lectures. Therefore, in the basic Physics lecture process, there must be an innovative learning process that supports the competence of students in the era of Society 5.0

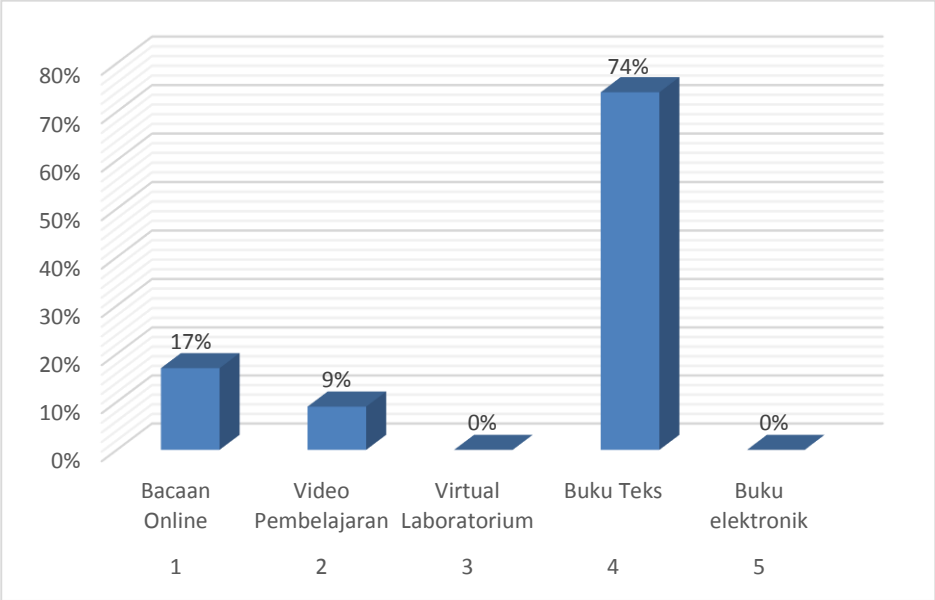

Figure 3**:** Student responses regarding access to learning resources

Based on Figure 3 obtained data related to student responses to access to learning resources in basic physics lectures. There are five learning resources found based on student responses, namely as follows: 1) The first number graph describes student responses related to utilizing online reading resources in supporting Physics learning. The results show that 17% of students have used online reading such as opinions, articles, blogs, articles, journals, and other reading sources. This indicates that students' interest in using online reading sources is still low. Several factors caused this to happen because they did not understand the contents of the reading source. The language displayed is difficult to understand in terms of meaning. In addition, it is difficult to access paid reading resources. 2) The second graph depicts student responses related to utilizing learning video sources through the YouTube platform. The results show that only less than 9% of students use the YouTube platform as a learning resource. This indicates that students' interest in using YouTube as a learning resource is still low. several factors identified that the majority of students access YouTube in the form of learning videos and mathematical problem-solving. Another factor is the financial considerations of students to buy internet packages to access YouTube. 3) The third graph describes the process of basic physics lectures using a virtual laboratory as a tool. The results showed that students had never used a virtual laboratory in basic physics lectures. Students tend to carry out practical in real laboratories. This is considered by the inability of students to access and use virtual laboratories. 4) The fourth graph illustrates that in the basic physics lecture process, students are more dominant in using textbooks as learning resources. This is supported by student response data showing more than 74% use textbooks as a source of learning basic physics. They said that Indonesian textbooks were easier to understand than English textbooks. However, another thing was found the average student did not understand the concept even though he had read various kinds of textbooks. This is because the content of the textbook does not comprehensively contain the aids used to describe the concepts of physics. Therefore we need the right tools to describe the concept

of physics clearly. 5) The fifth graph illustrates that in the process of basic physics lectures, students have never used electronic books. This is supported by student response data showing that more than 75% use textbooks as a source of learning basic physics. They said that Indonesian textbooks were easier to understand than English textbooks. However, another thing was found the average student did not understand the concept after reading the textbook. This is because the content of the textbook does not comprehensively contain the aids used to describe the concepts of physics.

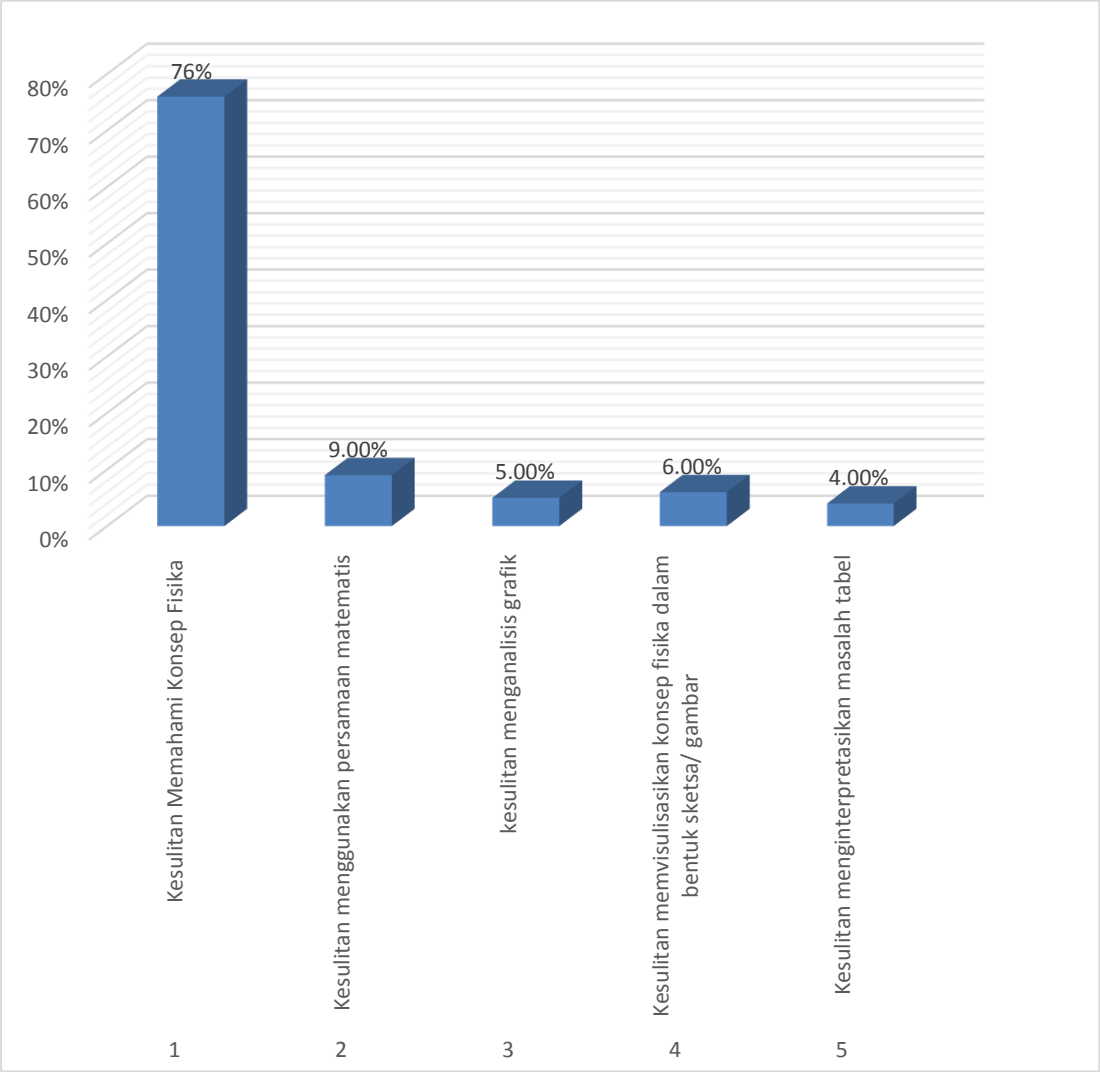

Figure 4: Student responses regarding students' learning difficulties in Basic Physics

Based on Figure 4 obtained data related to student responses to their difficulties in understanding basic physics in the lecture process. There are 5 categories of student difficulties in understanding basic physics, which are as follows: 1) The first number graph describes student responses related to student difficulties in understanding physics concepts. The results show that more than 76% of students have misconceptions and do not understand the concept. Difficulty understanding physics concepts mean the individual's ability to translate physical phenomena into physics problem-solving. In addition, misconceptions are errors in translating physics concepts. This is caused by several factors, one of which is the textbook used in lectures. Some students said that reading sources were not interesting and the language had multiple interpretations, making it difficult for them to understand physics concepts. They expect innovative

textbooks that can accommodate all tools or aids that can visualize physics concepts so as not to cause misconceptions. 2) The second graph describes student responses related to student learning difficulties in using mathematical equations in solving physics problems. The results show that only less than 5% of students have difficulty using mathematical equations in solving physics problems. This indicates that mathematical equations are no longer the main problem in solving physics problems. One of the supporting factors is that students are used to practicing formulas and equations in mathematics course I. On average, they do not have problems with solving physics problems with the help of mathematical equations. 3) The third graph illustrates student responses to their understanding of graphs. The results show that students have difficulty analyzing physics concept problems through graphs. Students have never solved physics problems in graphic form. In addition, students do not understand how to analyze the relationship between variables on the graph. This shows that the ability of students to analyze and evaluate the truth of physics concepts correctly is still low. 4) Graph number four illustrates student learning difficulties in terms of applying drawing diagrams or sketches in solving physics problems. This is supported by data that 78% of student responses have not been able to describe physical phenomena through picture diagrams. One of the main reasons the teaching materials used do not contain examples of solving physics using diagrams. The ability to visualize physical phenomena through diagrams is one of the main steps in solving physics problems. Therefore, drawing diagrams or sketches need to be added to the content and evaluation tools of textbooks. 5) The fifth graph describes student responses to student learning difficulties in interpreting and analyzing physics problems in tabular form. The results obtained indicate that students have difficulty making tables to analyze the experimental results. This is caused by the textbooks that are used as reference materials have not accommodated the practicum content and analytical techniques into teaching materials. Table 1 below is a student response regarding several features that will be integrated into the basic physics e-book.

Table 1. Student responses to the need for multi-representation-based e-books in learning basic physics

No	**Statement**	**Percentage of Student Agree Response**
1	The need for digital teaching materials in the form of e-books in basic physics lectures	100%
2	Online or offline-based learning videos need to be integrated with basic physics lectures	86%
3	Several multi-representation features such as images, animations, and video tutorials need to be added to the e-book	94%
4	The quiz link needs to be added to the e-book	100%
5	Virtual laboratories need to be integrated into e-books	76%
6	E-books need to be equipped with problem-solving-based content	82%
7	E-book for basic physics lectures using easy-to-understand language	100%
Average		91,1 %

Based on the average student response to the need for e-books, it shows that 91.1% agree to develop multi-representation-based e-books for learning basic physics. This finding is supported by data analysis on deficiencies observed in the learning process, accessibility to learning resources, student learning difficulties, and current student needs. The analysis of the learning process indicates that conventional teaching methods are still being used, which do not align with the demands of the Society 5.0 era. In the Society 5.0 era, distance learning systems through Learning Management Systems (LMS) are essential. Saprudin et al. (reference 17) suggest that e-books can serve as a medium for distance learning and LMS-based education. Students in this era are expected to be technologically literate to adapt to information technology-based learning processes. Regarding access to learning resources, the analysis reveals that students predominantly rely on printed books as their primary reference material during lectures. However, printed books have limitations, as they only offer textual content and static images without videos or interactive animations, leading to student boredom. By packaging teaching materials in the form of engaging and innovative e-books, students can be motivated to actively participate in the learning process. Anggreini and Permadi's research (reference 18) also supports the use of interesting teaching materials to enhance student motivation. Motivation plays a crucial role in students' interest in learning, influenced by factors such as learning media, learning environment, teaching materials, and instructor actions. Developing e-books as part of teaching materials in the physics learning process can enhance problem-solving skills, critical thinking, and creative thinking (reference 19). Additionally, addressing students' needs is crucial to avoid misconceptions and promote better concept understanding among physics education students at Musamus University. To address these needs, integrating a multi-representation approach into digital teaching materials is essential. This approach makes the learning process more interactive and creative, allowing students to access textbooks using mobile devices anytime, anywhere. Multi-representation-based e-books serve as innovative and adaptive self-study resources for students (reference 21). The inclusion of varied representations such as videos, images, and animations, particularly with a multi-representation approach, generates student interest. Students find multi-representation-based e-books useful and helpful in understanding physics concepts, as they visualize the content with different models. A study by Ayu and Fauzi (reference 22) supports the feasibility of using multi-representation-based teaching materials, considering aspects such as quality, attractiveness, readability, and usefulness in improving student learning outcomes. Therefore, the development of e-books should adhere to several criteria to ensure the resulting product is of high quality. The development of a multi-representation-based basic physics e-book must have good quality from several criteria. First, the criteria in terms of content, basic physics e-books in terms of presentation content. Things to consider in the presentation, namely, first, the e-book includes the learning outcomes of the subject, the material concept map diagram, the content of the material, and the instructions for using the e-book. Second, the criteria for presenting multi-representation-based basic physics material must be accompanied by picture illustrations or explanations with various forms of representation. Third, evaluation criteria must be available such as strategic problem-solving exercises, facts, interesting information in the e-book, and the existence of evaluation questions in the e-book. Next in terms of learning media criteria. The quality of the presentation of images, videos, and animations in the E-book must be full-colour HD quality, and the topics displayed are related to the sub-topics on basic physics. Fourth, the criteria in terms of language use. The use of language in e-books must be following the characteristics of students' abilities which can make it easier for them to understand the material and provide attractiveness for students in learning. The language used does not cause ambiguous meanings, misconceptions, and errors in physics concepts. The use of language that is following the development of students will

certainly make it easier for students to understand the material. Fifth, the criteria in terms of graphic design, e-books have graphics like the appearance of a real book with A4 size paper with full-colour display mode. The letters used in the e-book are adjusted to the standard rules in writing teaching materials. In addition, several other components of teaching material components such as objectives, instructions, facts, interesting information, quizzes, and summaries need to be added. This has the aim that evaluation feature has the aim of evaluating their learning abilities through several evaluation features that are following their abilities (Yanti, 2018). In addition, evaluation is used in learning to obtain accurate information about the level of achievement of learning objectives so that it can be used as evaluation material and can be followed up (Moh Soheh, 2019).

4. Conclusion

Based on the results of the research conducted, it can be concluded that students of the physics education department at Musamus University need an interactive basic physics e-book. They stated that 91.1% agreed that they needed the development of an interactive basic physics E-book as one of the innovative learning media to support the lecture process. In addition, they said that e-books have benefits in improving critical thinking skills. Based on the needs analysis, there are several considerations related to the development objectives, namely 1) an interactive basic physics e-book can be developed so that it can be used as reference material for students in taking online lectures through LMS. 2) In the aspect of e-book content, it is necessary to add some additional content such as videos, quiz links, virtual laboratories, and simple animations. 3) In the language aspect, it is necessary to use language that is easy to understand and does not cause misconceptions and does not understand concepts in physics material. 4) In the aspect of graphic design, e-books can be developed with full-color display with various images and additional content through E-book designs such as magazines with A4 size.

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