



## Analysis of Multi-Representation-Based E-book Needs on Basic Physics Materials, Department of Physics Education, Musamus University

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| <i>Article History</i>   | <b>Abstract</b>  |
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| Received: 06 June 2023<br>Revised: 05 Sept 2023<br>Accepted: 06 Dec 2023 | <p><i>This study aims to describe the analysis of development needs and produce multi-representation-based e-books in basic physics courses. This study uses a mixed-method, explanatory sequential design model. This research is still limited in definition, namely needs analysis 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 aspects of the student basic physics lecture process, student difficulties in understanding basic physics material, learning resources used by students in studying basic physics material: student needs related to basic physics e-book needs integrated multi-representation in solving Physics problems. The subjects of this study were 76 students of the Department of Physics Education, Musamus University, Merauke. The results of the analysis show that a total of 91.1% of students of the physics education department at the University of Musamus need multi-representation-based e-books in the basic physics learning process. This is supported by student response data. First, the majority of student learning processes are still learning using conventional methods in lectures, so they need interactive media to improve the quality of learning. Second, the majority of students only have access to learning resources in the form of textbooks in lectures. Third, the majority of students have difficulties understanding physics concepts. Fourth, students need multi-representation-based e-books in Physics lectures.</i></p> |
| <b>CC License</b><br>CC-BY-NC-SA 4.0                                     | <b>Keywords:</b> Needs analysis, ebook, multi-representation, Basic Physics  |

### 1. Introduction

Basic Physics material 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 difficult for students to explore, both in the ability to analyze and in the context of understanding the concept of physics itself [1]. Some findings on the results of research on students. Students have the concept that physics content is considered difficult by several factors. One of the factors is the form of problem-solving in the form of conceptual problem-solving [2]. Solving conceptual problems is considered difficult because it is considered related to the individual's ability to analyze the construction of phenomenal physics problem-solving [3]. Another factor is that the basic physics material has a multidisciplinary scope of knowledge, namely conceptual, factual, procedural, and metacognitive knowledge [4]. Factual and conceptual knowledge are basic abilities that support higher-order thinking skills (HOTS) [5]. These two abilities become fundamental knowledge for students in planning and finding solutions to Physics problems. Procedural and metacognitive knowledge is higher-order thinking skills used to solve abstract physics problems. Students learning difficulties in basic Physics lectures are quite complex, so a needs analysis related to appropriate innovative approaches, strategies, and learning media is needed to support the achievement of optimizing lecture objectives. One of the basic needs is teaching materials. The physics teaching materials needed are innovative and can attract students' interest [6] and independent learning [7]. Innovative teaching materials have the meaning that they must be able to adapt to the development of science, including technological developments. The development of science and technology acts as a facilitator to provide convenience for learners and instructors in creating and innovating. One form is the use as an interactive medium. Interactive learning

media is one form of packaging the learning process in the form of electronic media. Some examples are e-books, learning videos, virtual laboratories, and simple animations. In the learning process, interactive media has the function of providing easy access to information in the form of utilizing the use of media to help the implementation and achievement of learning. In terms of impact, interactive learning media can provide

Based on the results of interviews and preliminary observations on several students of the physics education department at Musamus University, they found several conditions in basic physics lectures. First, the average student only knows textbooks in paper form and electronic books in PDF format. The textbooks found have not been developed in the form of e-books with interactive simulations equipped with videos, animations, audio, and pictures. Second, they do not yet have electronic teaching materials that can be accessed by students or lecturers with an integrated learning management system (LMS). This has an impact on the achievement of learning quality such as the low level of high-order thinking skills of students and students' technological literacy. The function and role of teaching materials in the lecture process can help the implementation of the learning process, namely in directing all activities taught to students during the learning process. The role of teaching materials for students as a source of independent learning in basic physics lectures, more specifically to help students broaden their horizons, and understand concepts and higher-order thinking skills. Rapid technological developments allow instructors to develop technology-based teaching materials. One of them is the development of an interactive electronic book (e-book). Interactive e-books are one of the innovative and adaptive teaching materials according to today's learning demands that integrate interactive learning media into one unified teaching material. Digital books or e-books are learning media to convey concepts in the form of information on learning in the form of e-books by presenting text, images, or both, and can be accessed via a computer or mobile [6]. E-books can also be viewed as an interactive learning resource, where messages or information can be presented in a more interesting and varied manner in the form of a combination of text, images, animation, sound, and video [8]. Along with the development of science and technology, the development of software is increasingly rapid and relatively easy to access both free and paid, so educators can be able to combine various online and offline media into one e-book package that is much more attractive and interactive. The basic physics ebook packaging is expanded with some interesting content such as videos, animations, audio, and images. The integration of some interesting content into e-books allows students to have many ways to solve Physics problems [9]. E-book content contains information that can be in the form of text, equations, graphics and animations, and videos and can be accessed using a mobile phone or computer.

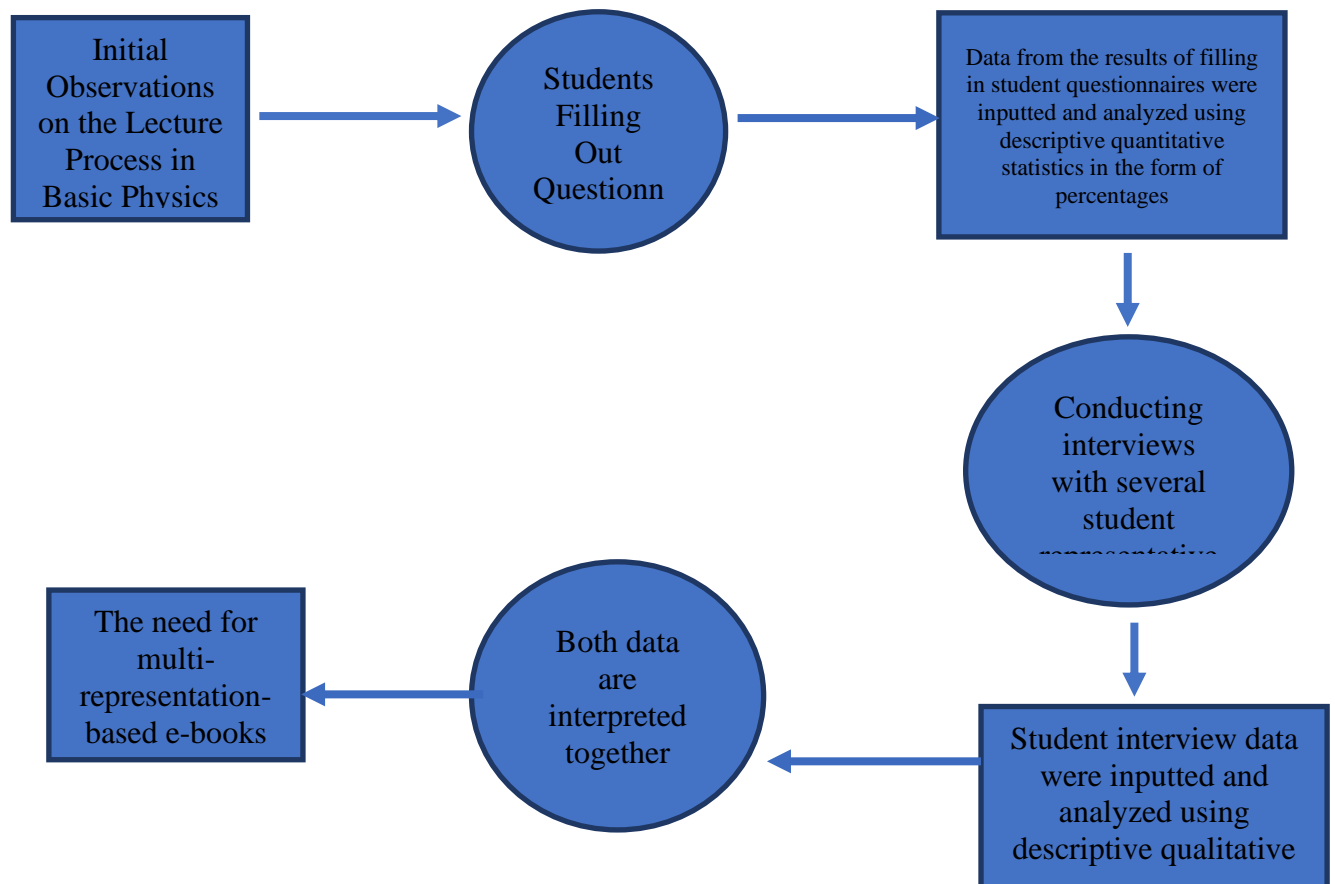
Ayu & Fauzi revealed several advantages of e-books as innovative learning media [10]. E-books are easily accessible using electronic devices anytime and anywhere. As a source of learning, e-books are a source of student self-study [11]. Independence in individual learning can be created through active learning activities that are driven by intentions and motives to master competency to solve a problem. Students can study in any place and condition so independent learning is more determined by the availability of appropriate learning facilities. The packaging of the basic physics e-book needs additional assistance in the form of some assistance packaged in the textbook, namely a multi-representation approach. The multi-representation approach is a method of delivering a concept through various means such as text, tables, diagrams, visual images, mathematical equations, computer simulations, and others [12]. The form of physics concepts with different formats allows individuals to have different abilities in understanding concepts. A person will understand something better through words and pictures than just words. This is also in line with the results of research which shows that a person's memory of images (visual) is better and lasts longer than writing [8], [13]. The integration of the multi-representation approach into the basic physics e-book is one of the innovations in developing physics learning media. Multi-representation integration into e-books is considered to provide opportunities for students to practice their higher-order thinking skills. Some representation features have their path in solving physics problems in e-book content and evaluation. One example is that image representation can represent a problem that cannot be observed directly.

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 analyses 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. Materials And Methods

**Methods** This research uses a mixed research approach (quantitative and qualitative) type of explanatory sequential design (Cresswell, 2014). **Approach** 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. There are several indicators that 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 related to the integration of some basic physics e-book features that need to be integrated in solving Physics problems. Figure 1 is the flow of the research method.



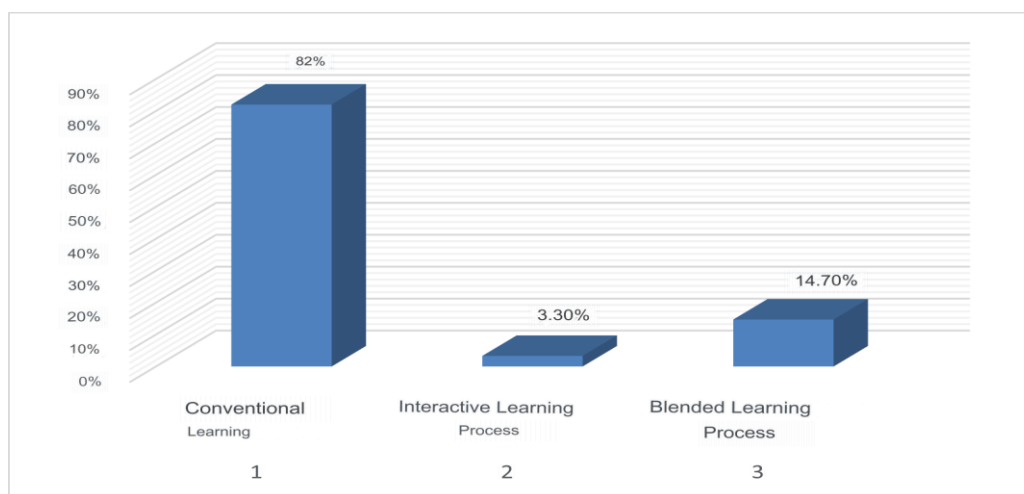
**Figure 1: Research Flow**

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 of the Department of Physics Education, Musamus University, Merauke. Data collection was carried out by involving students to respond to the

four aspects needed by researchers in analyzing the needs of e-books. The four indicators are summarized in several points of 12 questions and statements. Data collection techniques in this study used survey techniques in the field using instruments in the form of questionnaires and student response interviews. Questionnaires were used to find out student opinions regarding the need for developing a multi-representation-based Basic Physics e-book and structured interviews were conducted to find out in detail the needs of students in improving the quality of physics lectures. The data analysis technique uses several methods, namely data reduction (data reduction), data presentation (data display), and conclusions, drawing or verification (conclusion Drawing/Verification). The validity of the data used a validity test using the source triangulation method.

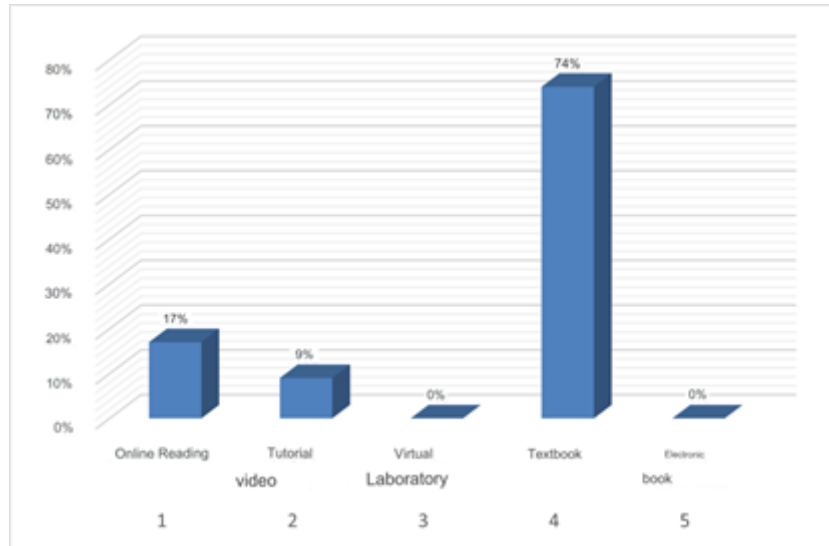
### 3. Results and Discussion

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

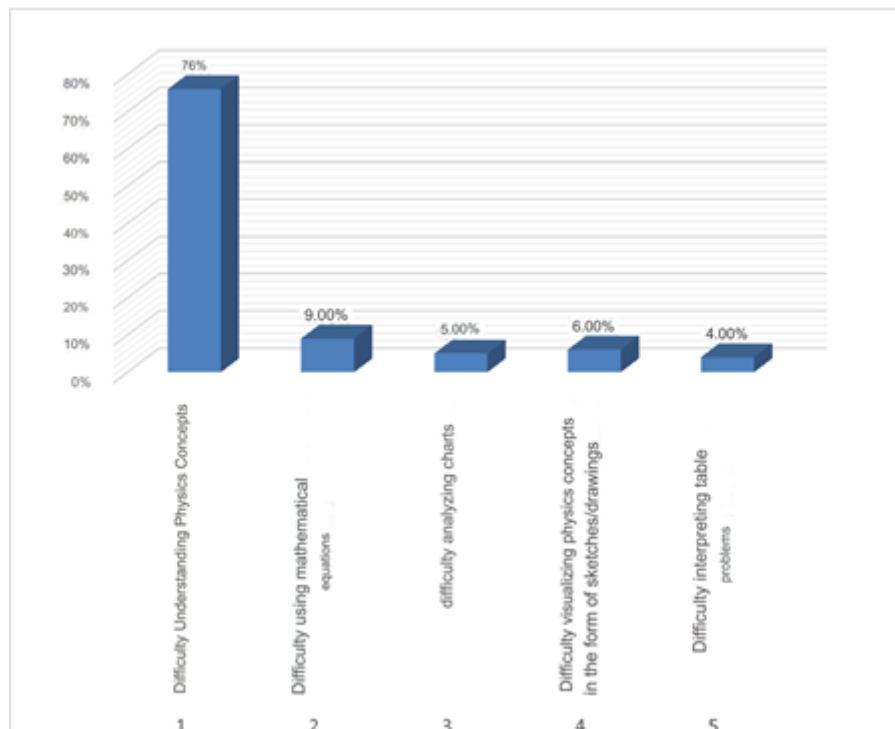
Based on Figure 2 obtained data related to the learning process that has been carried out in basic physics lectures. There are three groupings of the basic physics learning process based on student responses, namely as follows: 1) The first number graph illustrates that the basic physics lecture process 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's 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 in learning basic physics. This description is supported by data from the analysis of deficiencies obtained based on the learning process, availability of access to learning resources, student learning difficulties, and current student needs. The results of the analysis of the learning process found that the learning process still uses conventional methods. Conventional learning methods are not following the demands of the era of Society 5.0. Learning Society 5.0 era to be able to implement a distance learning system through LMS. Saprudin, et al, stated that e-books can be a medium in distance learning and LMS-based learning [17] In that era, students were required to be technology literate which was adapted to the information technology-based learning process. The results of the analysis on the availability of access to learning indicate that students still use printed books as the main reference in lectures. The weakness of printed books is that the material content is only in the form of reading and printed images without being equipped with videos or interactive animations so readers get bored easily. Packaging teaching materials in the form of interesting and innovative e-books can motivate students to take part in the lecture process. This is in line with the results of research by Anggreini & Permadi which states that teachers need to use interesting teaching materials to motivate students to learn [18]. The existence of motivation for students can be a driving factor for students in increasing interest in learning. Interest in learning a person is determined by several factors, namely: learning media, learning environment, teaching materials, and instructor actions. The development of e-books in the teaching and learning process of physics is one component of teaching materials that can improve some problem-solving skills, critical thinking, and creative thinking [19]. In addition, several other considerations in the development of electronic teaching materials are the needs of students so that there is no misunderstanding of concepts and misconceptions. The current need is to overcome the problem of not understanding concepts in students of the physics education department at the Musamus University. These efforts can be applied by integrating a multi-representation approach into digital teaching materials. Through the use of teaching materials using a multi-representation approach, someone will become more active and creative in the learning process [20]. This is because they are easier to understand physics material and can access textbooks using mobile phones, anytime and anywhere. They can construct their knowledge before attending lectures. Multi-representation-based e-books become an innovative and adaptive book as a source of student self-study without teacher guidance [21]. The presentation of e-books with varied representations such as videos, pictures, and animations in such a way, especially with a multi-representation approach, makes students interested in learning them. Students feel that multi-representation-based e-books are useful and make it easier for them to understand physics concepts visualized with other models. Following the results of Ayu & Fauzi's research which found that multi-representation-based teaching materials were declared feasible in terms of quality, attractiveness, readability, and usefulness for improving student learning outcomes [22]. Therefore, the development of this e-book needs to consider several criteria so that the resulting product is of high quality.

The development of a multi-representation-based basic physics e-book must have the 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-color 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-color 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 an 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 Musmaus 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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