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Needs Analysis in the Development of Basic Physics Practical E-Module Based on Interactive Flipbook with STEM Approach

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ABSTRACT

The low interest of students in reading the practicum guide is the focus of the problem in this study. This study is a survey study which is part of development research. This study aims to describe the define stage at the needs analysis stage (initial-final analysis and student analysis), identification of Basic Physics material, and identification of resources. The research data were analyzed descriptively. The study results indicate that the curriculum applied to the Physics Education Study Program at one of the Muhammadiyah Universities in Makassar is the MBKM-oriented KKNi curriculum. The initial-final analysis found that the Basic Physics practicum module was still conventional and in printed form, manually distributed to students. Student analysis found that students' learning styles were visual. The specification-identification of Basic Physics material found that the essential material for Basic Physics practicum consisted of five experimental units that would be developed. Information was obtained from the identification of resources that all students had smartphones that could access the practicum e-module. Therefore, the practicum e-module that will be developed will direct students to visual activities like user-friendly flipbooks and easily accessible via students' smartphones.

INTRODUCTION

Introductory Physics is a mandatory subject in the Physics Education Study Program [1], which has a credit weight of 3 credits and is integrated with practicum [2]. Practicum is integral to learning [3] [4]. In introductory physics lectures, practicums are activities that test the theory by providing direct experience in [5]. Providing direct experience in physics learning can improve students' memory skills by 70% more than using the lecture method [6]. Basic Physics Practicum usually consists of 4-8 practicum units each semester, adjusted to the number of students taking the Basic Physics course.

Introductory physics practicum is an essential component in the higher education curriculum [7] [8], especially for science and engineering students. The practicum is designed to give students direct experience learning physics principles through systematic experiments. Through practicum, students can understand the basic concepts of physics in more depth and develop critical and analytical thinking skills.

Implementing practicum activities requires a module to guide students [9] so that practicum activities run well according to the expected practicum procedures [10]. The practicum module usually consists of guidelines for preparation, implementation, and assessment of the practicum [11]. The practicum module also has a way to analyse data and a guide to making practicum reports [12]. The Basic Physics practicum module in the Physics Education study program is currently available in printed form. The Physics Education Study Program provides the Basic Physics practicum module through the course's lecturers. From interviews with lecturers in charge of Basic Physics courses and Basic Physics laboratory assistants, information was obtained that students' interest in reading the printed version of the practical module was shallow. This can be seen from only a few students who bring practicum modules when taking the Basic Physics practicum. Some students have taken photos of the Basic Physics practicum module so that students always have their smartphones open during the practicum. This causes students to need help understanding the procedures or steps of practical work correctly.

Several universities have developed basic physics practicum modules that use several approaches. Some of these are the development of problem-solving-based basic physics practicum modules [13]. This study has several limitations; namely, the scale of the study still needs to be expanded by only involving a small number of validators in testing the readability and validation of the product. This can affect the generalisation of the research results to a broader population. After using the developed module, the article must provide detailed empirical data on improving students' problem-solving abilities. In addition, the article only focuses on developing problem-solving-based modules; researchers have yet to find a visible study related to essential aspects of the learning process, such as teacher-student interaction, learning environment, and technology support, that can affect learning effectiveness.

Another development research is the development of basic physics practicum instructions 1 based on 5M to train science process skills [14]. Similar to previous research, this research also has weaknesses, namely the limited research scale, the sample used is small so that it can affect the generalisation of research results, empirical data on improving science process skills is less detailed, the research also does not present supporting aspects of module development such as teacher-student interaction and technology support for the developed module. One area that could be improved is testing other variables, such as students' educational background and learning styles, on module effectiveness.

The following research is the development of an introductory physics practicum module based on guided inquiry learning type [10]. The article "Development of a Basic Physics Practicum Module Based on Guided Inquiry Learning Type for Mathematics Education Students" by D. L. Saraswati has several limitations. This research was conducted on a small scale, only up to the development stage without wide distribution, and the evaluation only involved validator assessment and readability tests. Empirical data is limited, and there is no comparative analysis with other methods. Although it contributes significantly, this research requires a larger scale and more comprehensive evaluation for broader validity.

Development of a digital essential physics practical module on electricity and magnetism [11]. This study has limitations because it only involved a few students and lecturers, limiting the generalisation of the research results. This study only examines the development stage without long-term implementation and impact analysis. The context of adapting to the COVID-19 pandemic affects the teaching and learning process, which may not reflect long-term normal conditions. In addition, implementing digital modules requires good technological access and literacy, which can be an obstacle. This study also needs empirical data on the long-term impact of using the module on students' understanding of physics concepts and practical skills.

Researchers have also conducted a literature review, and it was found that there has been research using STEM in learning, including research related to descriptions of sequence-based Inquiry-Based Learning (IBL) worksheets with a STEM approach to stimulate students' communication skills [15]. The case study shows that the use of IBL-STEM based e-worksheets in physics classes significantly increases students' active participation and confidence in conveying their ideas. The technology in e-worksheets also helps to improve students' engagement and motivation in learning. The effect of STEM in solving Skills student problems [16]. STEM-based learning has a significant positive impact on students' problem-solving skills. This study shows that through the STEM approach, students can better develop critical and analytical thinking skills essential to solving complex problems. Implementing the STEM method in the learning process helps students understand scientific concepts in depth better and apply them in real situations, thereby increasing the effectiveness of their learning and their skills in solving problems. Validated and tested STEM project-based virtual learning modules can improve students' higher-order thinking skills. This study shows that using these modules effectively develops students' analytical, evaluative, and creative abilities. These modules are designed to facilitate independent and collaborative learning, allowing students to actively engage in the learning process and application of STEM concepts in authentic contexts, thereby strengthening higher-order critical thinking and problem-solving skills [16]. This study shows that the PjBL-STEM method allows students to be actively involved in real-life projects, which encourages them to think innovatively and creatively. Through these projects, students can develop the ability to identify problems, design solutions, and apply physics concepts in practical situations. The results showed a significant increase in aspects of creativity, such as originality, flexibility, and elaboration of ideas [17], and several other studies [18] [19]. Many researches using flipbooks has also been carried out [20] [21] [22].

However, so far, there has been no development of an introductory physics practicum module that uses a STEM approach, while based on a literature review, the proposing team found that the STEM approach is very close to scientific concepts and can increase students' understanding of concepts, especially regarding abstract essential physics content. This is something new in STEM-based F2D development research. STEM-based introductory physics practicum enriches student learning experiences by integrating physics concepts with technology, engineering, and mathematics. Through STEM-oriented practicums, students can learn how physics concepts can be applied in the context of technology and engineering and how mathematics plays a role in data analysis and modelling.

Therefore, the proposing team designed a digital Basic Physics Flipbook (F2D) digital Basic Physics practicum device (practicum module) with a user-friendly Science, Technology, Engineering and Mathematics (STEM) approach. Hopefully, this Basic Physics practicum tool can be used in the Physics Education Study Program at one of the PTMAs in Makassar. Apart from that, with a STEM approach, this F2D module is expected to shape students' scientific character through the introduction of concepts (science) and apply these concepts through skills (technology) to design in a certain way (engineering) and then analyse them based on mathematical calculations (mathematics) [23]. Furthermore, it is hoped that the F2D module with a STEM approach can make it easier for students to carry out practical activities. This study aims to describe the defined stages in the needs analysis stage (initial-final analysis and student analysis), identification of Basic Physics materials, and identification of resources.

METHOD

This study is a survey study that is part of development research. It aims to describe the definition stage at the needs analysis stage (initial-final analysis and student analysis), identify Basic Physics material, and identify resources. The e-module development refers to the 4D-Thiagarajan development model [24] [25] [26], as shown in Figure 1.

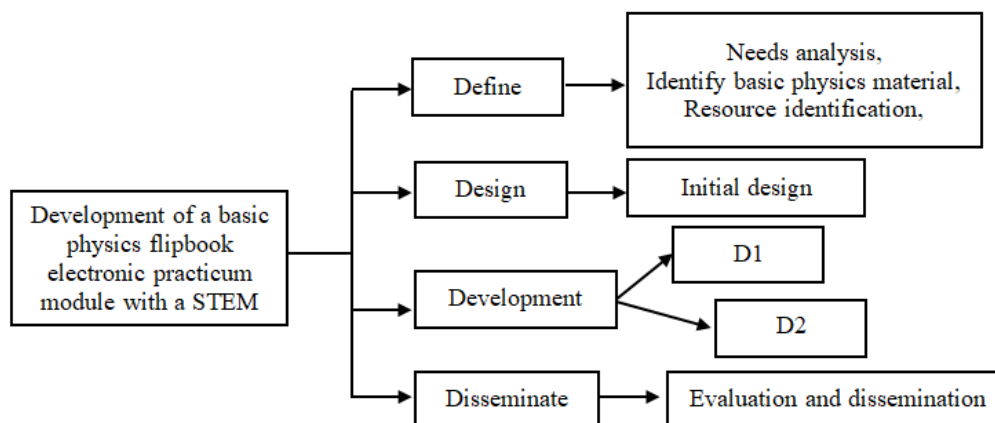


Fig 1. 4D-Thiagarajan Stages

Figure 1 shows the development model used in developing the basic physics flipbook electronic practicum module for the STEM approach, which is the Thiagarajan 4D model. However, in this article, we will specifically examine the definition stage of research into developing the basic physics flipbook electronic practicum module for the STEM approach. The define stage is the first stage in the 4D-Thiagarajan development model. A needs analysis will be conducted at the defined stage, and fundamental physics materials and resources will be identified. At the needs analysis stage, researchers carried out curriculum analysis, beginning-to-end analysis, and analysis of student characteristics as a basis for selecting the format and shape of books at the design stage. Researchers provided an online questionnaire to measure student learning styles by analysing student characteristics. The grid and distribution of learning style indicators can be seen in Table 1 below.

Table 1. Learning Style Indicators for UM Makassar Physics Education Students

Various Learning Styles	Indicator	Answer Choices	Question Number
Visual Learning	Learn by reading, Remembering what is seen, rather than what is heard, Usually not disturbed by noise, Enjoy demonstrations rather than giving speeches, Often answer questions briefly, Fast speaking patterns Prefer art to music	V	2, 3, 4, 5, 6, 11, 12, 17, 20, 24, 26, 27, 28
Auditory Learning	Learn by listening, It's easier to remember what you hear, Easily distracted by noise, Easy way to communicate via telephone, The preferred activity is discussion or talking, Moderate and rhythmic speech patterns, Prefer music to art.	A	1, 9, 18, 19, 21, 22, 23, 29, 31, 32, 36, 37, 39
Kinestetik Learning	Learn by practicing, Speak slowly, Memorize by walking and looking, Use a lot of body signals, Use your finger as a pointer when reading, Cannot sit still for a long time, Always be physically oriented and move a lot	K	7, 8, 10, 13, 14, 15, 16, 25, 30, 33, 34, 35, 38

Before being used in research, this learning style questionnaire was first tested for validity [27]. Validity test using Karl Person's product-moment correlation equation. Karl Pearson's product-moment correlation equation is one of the methods used to measure construct validity. Of the 39

statements in the learning style questionnaire, 30 show a correlation coefficient value above 0.30. Thus, the statements in the questionnaire were declared valid, and 30 statements were tested on the research sample.

The research sample is saturated. That is, the research sample includes the entire population studied. In a statistical context, saturated samples are used when researchers want to obtain representative information about a particular population. The advantage of selecting the entire population as a sample is that it avoids bias that may occur in taking a smaller random sample. The total research sample was 30 students who had taken the Basic Physics course. The sample for this study consisted of students enrolled in the Basic Physics course. The researchers used a saturated sample, meaning all students enrolled in the course were included in the study. This approach was chosen to avoid bias that could occur with a smaller, randomly selected sample. The total sample size was 30 students. The data collection technique used to analyse student learning styles is administering a research instrument in the form of a questionnaire. The questionnaires are digital and shared online via the Google Forms platform.

Next, the collected questionnaire data was analysed using descriptive statistics. Descriptive statistical analysis is a technique used to systematically summarise and describe research data in tables, graphs, or statistical figures. It provides information about the data distribution's spread, centre, and shape, which can be used for further analysis.

RESULTS AND DISCUSSIONS

This research describes the initial stages of research into developing basic physics electronics practicum modules using a STEM approach. The basic physics practicum module with a STEM approach is designed to integrate various concepts and skills from different fields of science [28], including physics, technology, engineering and mathematics [16]. The main goal is to provide students with practical experience applying physics concepts in authentic contexts and develop critical thinking, problem-solving and team collaboration skills. With a STEM approach, the basic physics practicum module becomes more exciting and relevant for students. It helps students develop the skills and understanding needed for the STEM approach and everyday life. Some of the research results found at the define stage can be described as follows:

Needs Analysis

The needs analysis stage aims to identify learning problems and needs, especially in the Basic Physics practicum. Several steps are taken at the needs analysis stage, including curriculum analysis, start-end analysis, and student characteristics.

In the curriculum analysis, observations and analysis have been carried out to obtain information that the curriculum applied to the Physics Education Study Program at one of the Muhammadiyah Universities in Makassar is based on the Indonesian National Qualifications Framework. The Indonesian National Qualifications Framework is regulated in the Presidential Regulation of the Republic of Indonesia Number 8 of 2012 and Minister of Education and Culture Regulation No. 49 of 2014 concerning National Higher Education Standards. The Indonesian National Qualifications Framework is an embodiment of the quality and identity of the Indonesian nation regarding the national education system, which includes an assessment of a person's (student's) performance in the aspects of science, expertise, and skills under the learning outcomes obtained through the education they have undergone. The policy implications of implementing the Indonesian National Qualifications Framework impact the physics education study program curriculum and adjust learning outcomes and teaching materials for each course.

The Physics Education Study Program at one of the Muhammadiyah Universities has made adjustments to the Merdeka Belajar Kampus Merdeka curriculum, to be precise, in 2021 through the

Merdeka Belajar Kampus Merdeka Study Program grant. This requires students to be creative, productive, and innovative and must be able to think critically and find solutions to every problem. The lecture activities implemented by the Merdeka Belajar Campus Merdeka curriculum include student exchanges, teaching assistance, and entrepreneurship.

In the initial and final analysis, a review was carried out, and it was found that the Basic Physics practicum module in the Physics Education Study Program at one of the Muhammadiyah Universities in Makassar was still conventional and in printed form. This printed practicum module was then reproduced and distributed to all students, laboratory assistants, and course lecturers.

Expected Benefits of the Module are: 1) Enhanced Learning Experience: The module is designed to provide students with hands-on experience in learning physics principles through systematic experiments. This hands-on approach is expected to deepen students' understanding of fundamental physics concepts and develop their critical thinking and analytical skills; 2) Enhanced Engagement: The module is designed to be user-friendly and digital, which is expected to increase student engagement. The use of a STEM (Science, Technology, Engineering, and Mathematics) approach is expected to make the module more exciting and relevant to students; 3) Enhanced Retention: The text states that hands-on experience in learning physics can increase students' retention by up to 70% more than the lecture method; 4) Development of Science Character: The module is expected to shape students' science character through the introduction of concepts (science); application of these concepts through skills (technology); design in a certain way (engineering); and analysis based on mathematical calculations (mathematics); 5) Ease of Access: The module is designed to be accessed via a smartphone, making it easy for students to use.

This module was developed in response to the need for more interested students to read the printed version of the practical module. The researcher found that only a few students brought the practical module when taking the Basic Physics practical. Some students had taken pictures of the introductory physics practical module, which caused them to open their smartphones continuously during the practical. This was considered a sign that students needed to understand the procedures or steps of the practical fully. The development of this module was also based on the finding that most students have a visual learning style. Therefore, this e-module was designed to direct students to visual activities, such as understanding the practical steps through pictures and reducing the narrative of the practical steps, like cooking recipes.

In the student analysis, a study of student characteristics has been carried out, namely an analysis of the learning styles of students taking Basic Physics courses. This analysis is provided by completing an online questionnaire on the Google Form platform. Based on the student learning style indicators in Table 1, data was obtained that most students have more than one learning style. This data is in line with research that has been conducted. This data is presented in Graph 1 below.

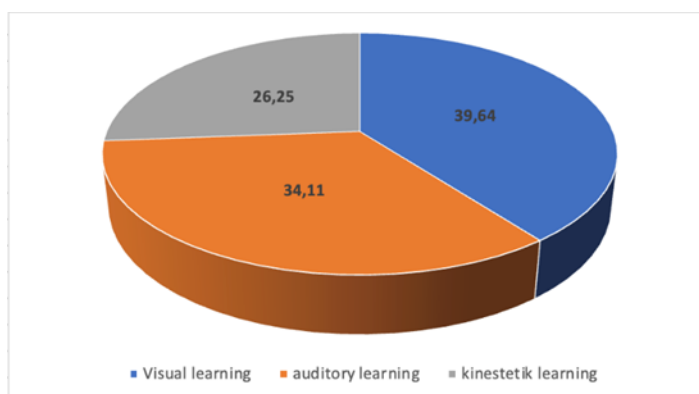


Fig 2. Trends in Learning Styles of Physics Education Students at one of the Universities in Makassar

From Figure 2, it can be seen that the majority of students' learning styles are visual learning. Relevant research showed that the visual learning style is more dominant and has a higher average score than other learning styles. Visual learning style refers to the way students learn and process information primarily through seeing or observing images. Students with a visual learning style tend to understand better, remember, and analyse information when they see visuals such as pictures, graphs, diagrams, or visual presentations. Therefore, the practicum e-module will direct students to visual activities such as understanding practical work steps through pictures, reducing descriptions of practical work steps such as cooking recipes, and using more colour play and graphics to design basic electronics physics practical modules. Each practicum unit requires students to analyse practicum data by presenting data in tables of observation results and graphs of relationships between variables or physical quantities. The practicum module also included auditory and kinesthetic elements in the e-module. This is intended to cover student learning styles dominant in auditory and kinesthetic learning.

Different learning styles significantly impact the implementation of physics learning. Most students have a visual learning style, which means they learn and process information primarily through seeing or observing images. This learning style is very effective for understanding, remembering, and analysing information when they see visuals such as pictures, graphs, diagrams, or visual presentations.

Visual Learning Style

Research has found that students with a visual learning style tend to understand and remember information better when they see visuals such as pictures, graphs, diagrams, or visual presentations. This learning style is especially effective in physics learning, where concepts can be abstract and complex. Visual aids can help students understand these concepts more quickly and remember them more effectively.

Auditory and Kinesthetic Learning Styles

Some students have both auditory and kinesthetic learning styles. Auditory learners learn best through listening, while kinesthetic learners learn best through physical activity or hands-on experience. Various methods can accommodate these learning styles in physics teaching.

Facilitating Different Learning Styles in Physics Learning

Developing a digital flipbook-based basic physics practicum module using the STEM (Science, Technology, Engineering, and Mathematics) approach is appropriate for facilitating different learning styles in physics learning. This module is designed to be easily accessible via students' smartphones.

Visual Learning Style

For visual learners, the module will guide students towards visual activities such as understanding practical work through images and reducing the narrative steps of helpful work like recipes. The module will also use more colours and graphics to design the basic electronic physics practicum module.

Auditory and Kinesthetic Learning Style

The module will combine auditory and kinesthetic elements to cover auditory and kinesthetic learners' dominant learning styles.

STEM Integration

The module is designed to integrate various concepts and skills from multiple fields, including physics, technology, engineering, and mathematics. The main goal is to provide students with practical experience applying physics concepts in authentic contexts and develop critical thinking, problem-solving, and team collaboration skills. With a STEM approach, practical basic physics modules become more exciting and relevant to students, and they help students develop the skills and understanding needed in the STEM approach and everyday life.

Identify Basic Physics Material

At this stage, the research team compiles and formulates essential material for Basic Physics that requires practicum. This step is also intended so that the practicum obtained by students will be avoided in the Basic Physics 1 practicum in the previous semester or the measuring instrument practicum and secondary school practicum in the following semester. The integration of STEM in learning has been researched on fluids [29], light [30], wave vibrations [31], electricity [32], and temperature and heat [33]. The essential material mapped to the practicum unit in the STEM-oriented basic physics practicum module can be seen in Figure 3 below. Melde's

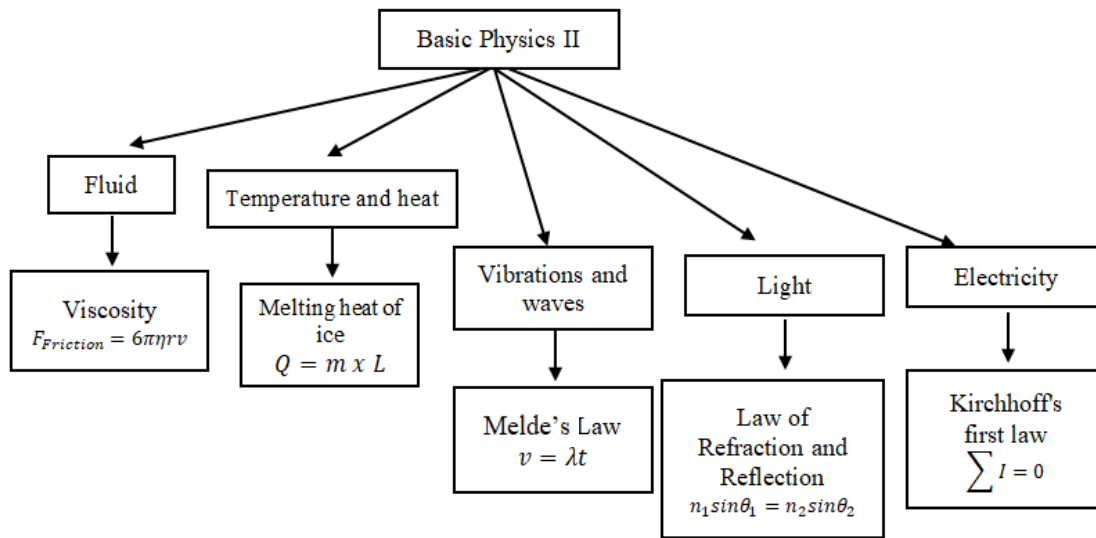


Fig 3. Mapping Essential Material for Basic Physics Practicum II

Identify Resources

At this stage, the team conducted unstructured interviews with several students and direct observations. The data shows that all students have smartphones that can access STEM-based F2D practicum e-modules if made in flipbook form. Apart from that, a flipbook can cover the contents of images and short videos needed as a practical guide. Flipbook-based e-modules can improve learning outcomes in the knowledge domain [34]. Flipbooks have become a digital learning innovation of the 21st century [35]. E-module-based flipbooks have been proven to impact learning outcomes [36].

Several studies support the effectiveness of the STEM (Science, Technology, Engineering, and Mathematics) approach and are relevant to the findings obtained. A study concluded that the STEM system used was considered helpful in overcoming misconceptions in high school physics. The researchers recommended developing and implementing teaching materials that support students' understanding of physics [37]. Research conducted by Soros et al. showed that STEM learning methods can improve critical thinking skills and problem-solving abilities in physics lessons [38]. Developing cross-platform mobile learning applications with the STEM approach is feasible and effective in physics learning [39]. Integrating physics and mathematics through modelling and student-centred approaches is valuable in STEM education. However, there is a need for more hands-on activities in the curriculum [40]. The integrated STEM-PBL (Project-Based Learning) physics module effectively increases students' interest, understanding, and effort in learning physics [41].

CONCLUSION AND SUGGESTION

The research results show that the curriculum applied to the Physics Education Study Program at one of the Muhammadiyah Universities in Makassar is the Indonesian National Qualifications Framework curriculum oriented towards Independent Learning, Independent Campus. Initial and final analysis

showed that the Basic Physics practicum module was still conventional and in printed form, distributed manually to students. Student analysis found that the student's learning style was visual. Basic Physics material identification specifications found that the essential material for the Basic Physics practicum consists of five experimental units that will be developed. From resource identification, information was obtained that all students have smartphones that can access the practicum e-module. Therefore, the practicum e-module created will direct students to visual activities like user-friendly flipbooks easily accessible via student smartphones.

Based on the research results, recommendations are given: 1) Utilization of Digital Modules: The study found that all students have smartphones that can access e-practicum modules. Therefore, it is recommended that digital practicum modules be developed and used in a way that is user-friendly and easily accessible via students' smartphones; 2) Visual Learning Approach: The study found that most students have a visual learning style. Therefore, it is recommended that e-practicum modules be designed to support visual learning. This can include the use of images, colour play, and presentation of data in the form of tables and graphs of observation results; 3) Integration of STEM Approach: This study shows that the integration of the STEM approach in the development of the Basic Physics Practicum module can improve students' understanding and skills. Therefore, it is recommended to continue using the STEM approach in developing practicum modules; 4) Utilization of Flipbooks: This study found that using flipbooks can improve learning outcomes. Therefore, it is recommended to create user-friendly e-practicum modules in the form of flipbooks that can be easily accessed via students' smartphones; 5) Ongoing Needs Analysis: This study conducted a needs analysis to identify learning problems and needs, especially for Basic Physics Practicum. Therefore, it is recommended that needs analysis be continued to ensure that the practicum module meets students' learning needs and preferences.

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