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The Development of LKPD (Student Worksheet) Assisted by PhET Simulation on Sound Wave Material

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ABSTRACT

The development of a Student Worksheet (LKPD) assisted by PhET Simulation was motivated by the lack of practical equipment in school laboratories. This research aims to develop a Student Worksheet (LKPD) assisted by PhET Simulation on the subject of Sound Waves for Grade XI of Senior High School/Madrasah Aliyah (SMA/MA). The type of research used in this study is Research and Development (R&D) with a 4D development model (Define, Design, Develop, and Disseminate). During the development stage, the draft LKPD was described in terms of its feasibility and practicality. The feasibility data of the developed LKPD was obtained from the validation results by four experts consisting of two subject matter experts and two media experts using a questionnaire instrument. The practicality data of the LKPD was obtained from the responses of students and teachers to the use of the LKPD using a questionnaire instrument. The research involved 15 students in a limited trial. The results of this study indicate that the average score for the material aspect was categorized as "Very Feasible," and the media aspect was categorized as "Feasible." The data on students' responses to the LKPD was categorized as "Very Practical." The teachers' responses to the LKPD were categorized as "Very Practical." The conclusion of this study is that the LKPD assisted by PhET Simulation is Feasible and Very Practical for learning.

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INTRODUCTION

Education is an aspect that plays a significant role in life. One of its functions is to prepare human resources as the next generation for the nation and its development. This is explained in the Minister of Education and Culture Regulation (Permendikbud) Number 15 of 2019. Therefore, education must be able to produce quality human resources who possess knowledge competencies, master and develop technology that is beneficial for life. Students are expected to engage in active learning, selecting their learning interests based on their talents to achieve comprehensive knowledge development (Permendikbud Number 65 of 2013). One of the subjects aimed at achieving educational goals in Indonesia at the high school (SMA/MA) level is physics.

Physics is a subject that studies various phenomena in the surrounding environment. During the learning process, students will be involved in various activities, such as observation and practical experiments (Deva Kurniawati & Wahono Widodo, 2023). Physics is one of the fields of science taught in secondary schools with the aim of observing phenomena that occur in the surrounding environment in everyday life. Students need learning tools or media provided by teachers and the school to achieve the learning objectives.

Instructional materials, such as textbooks and Student Worksheets (LKPD), are essential tools for achieving learning objectives. According to the Ministry of Education (2010), LKPD can be defined as a collection of assessments that students can work on, enabling them to learn from the LKPD to solve a problem (Farisma et al., 2023). The LKPD includes a title, basic skills, necessary materials/equipment, a summary of information, implementation steps, tasks to be completed, and reports that need to be prepared. LKPD plays an important role in supporting more effective learning, especially in the context of learning that requires understanding through practice problems, as is the case in science education. According to (Sholikhah & Sucahyo, 2021), the use of LKPD received positive responses from students because of its benefits, which are engaging and able to stimulate students' interest and motivation to learn.

LITERATURE REVIEW

LKPD is a Student Worksheet that will include a trial program and will be developed to encompass a series of tasks that students must perform, one of which is experimental activities. Experimental activities are divided into two types: physical experiments and virtual experiments conducted online. Based on a needs analysis at a high school in Merauke, there is a limitation of practical tools in the laboratory that can support practical activities, thus requiring a virtual laboratory. A virtual laboratory is a laboratory where students can conduct experiments by accessing equipment and practical materials through computer or mobile programs (Anggereni et al., 2021), The use of virtual laboratories is very useful in helping students understand learning materials that require practical experience, especially when physical laboratory equipment at school is unavailable or incomplete. Many virtual practice applications can be downloaded for free from the Play Store or App Store;

however, this trial will use the PhET (Physics Education and Technology) simulation application (A. P. Putri et al., 2021).

PhET (Physics Education and Technology) is developed by the University of Colorado, USA. The PhET Simulation application can be easily accessed through computers or smartphones, both online and offline. Using PhET Simulation with students has the potential to enhance learning interest because students enjoy technology-based learning (Puspita et al., 2020). The PhET Simulation application is designed with physics concepts that can help students understand them and can even be used as an alternative to physical laboratories. PhET Simulation can complement real experiments or serve as an alternative to physical laboratories (Dewa et al., 2020). Simulations in the PhET application provide students with the opportunity to explore new experimental topics that might not be feasible in a real laboratory. New experimental activities can sharpen concepts or skills and train students' abilities to communicate ideas or results both to their peers and to their teachers. Previous research also shows that the use of PhET Simulation has a positive impact on cognitive control, learning outcomes, and problem-solving abilities because PhET Simulation can enhance thinking skills and physics learning. Another advantage is that the use of PhET Simulation requires neither significant time nor cost (Fauziyah & Sucahyo, 2021).

Based on observations at a school in Merauke, the teaching and learning process at that school primarily involves presenting material using teacher's guidebooks and conducting traditional experiments with minimal equipment. According to a needs analysis questionnaire with 18 students, 88% of students disagreed with the statement that the school has LKPD to assist in learning physics, indicating that the school does not have LKPD to support physics education. Additionally, 33% of students do not find the provided physics instructional materials engaging, and 80% of students agreed with the statement that they want more engaging physics learning media in the form of LKPD to enhance their enthusiasm for learning physics.

One of the high schools in Merauke, which has facilities including a computer laboratory with internet access, can support learning activities by leveraging current technological advancements. Given the school's facilities, which include a sufficient number of computer labs for student use, technology-based learning can indeed be implemented at the school. Based on the current situation, a solution is needed to improve the learning process, thereby enhancing the quality of education and fostering a greater interest in physics. Therefore, the development of LKPD assisted by PhET Simulation is necessary.

Learning using technology-based LKPD such as PhET Simulation has been shown to improve students' understanding of the material, as evidenced by previous research conducted by Fauziyah Nur Isro'atul and Imam Sucahyo in 2021. This study indicated that the LKPD developed had high validity, received very positive responses from students, and was effective in enhancing their understanding of Black Body Radiation (Fauziyah & Sucahyo, 2021).

METHODOLOGY

The type of research used is Research and Development (R&D). Research and Development is a type of research used to produce specific products and test the effectiveness of those products (Arifin et al., 2019).

Research Design and Procedures

This research uses the 4-D design model, which includes four development stages: define, design, development, and disseminate.

Data Collection and Instrument

The research instrument used for data collection is a questionnaire. The questionnaire serves as a measurement tool to determine the extent of the feasibility and benefits of the Student Worksheet (LKPD). The questionnaires used in this research include three types: needs analysis questionnaire, feasibility questionnaire, and student and teacher response questionnaire. The needs analysis questionnaire is used to measure students' needs regarding physics learning. The expert validation questionnaire assesses the feasibility of the developed LKPD, while the student and teacher response questionnaires aim to gather feedback from students and teachers on the developed LKPD.

Data Analysis

The LKPD's feasibility is assessed by 4 validators, consisting of 2 validators who review the material aspects and 2 validators who review the media aspects. The feasibility results from the experts are presented as a percentage of feasibility, calculated using the following formula:

$$\text{Percentage of Feasibility (\%)} = \frac{\text{Obtained Score}}{\text{Maximum Score}} \times 100\%$$

The percentage of feasibility is adjusted according to the categories in Table 1.

Table 1. Validation Testing

Percentage Range (%)	**Category**
< 39 %	Not Feasible
40 % - 59 %	Needs Improvement
60 % - 79 %	Feasible
80 % - 100 %	Very Feasible

The data obtained from the teacher and student response questionnaires were analyzed using quantitative data to assess the practicality of the LKPD developed by the researchers (Hermawan et al., 2020). The formula used to process the test scores from the response trials is as follows:

$$\text{Percentage practicality (\%)} = \frac{\text{Obtained Score}}{\text{Maximum Score}} \times 100\%$$

The percentage of practicality is adjusted according to the categories in Table 2.

Table 2. Response Test

Percentage Range (%)	Category
< 39 %	Not practical
40 % - 59 %	Fairly practical
60 % - 79 %	Practical
80 % - 100 %	Very practical

RESEARCH RESULT

Result

The results obtained from this study include data on the feasibility and practicality of the PhET Simulation-assisted LKPD that has been developed. Feasibility is assessed through the product feasibility testing phase, where the LKPD product is reviewed by validators. The validators examine the LKPD based on two aspects: material aspects and media aspects. Practicality is assessed based on the data analysis from a limited trial conducted by 15 Grade XI students and 1 teacher at a high school in Merauke. Below are the results of each analysis:

1) Feasibility of the LKPD

The percentage results of the LKPD feasibility from 2 material expert validators and 2 media expert validators can be seen in Table 3 and Table 4.

Table 3. Material Expert Percentage

Validators	Score	Average score	Percentage	Category
I	42	46,5	83%	very feasible
II	51			

Table 4. Media Expert Percentage

Validators	Score	Average score	Percentage	Category
I	54	52,6	66%	feasible
II	51			

The results of the validation review show that the PhET Simulation-assisted LKPD on the topic of Sound Waves received the following evaluations: for material expert validation, it was rated as "Very Feasible with revisions according to suggestions," and for media expert validation, it was rated as "Feasible with revisions according to suggestions." The revised LKPD based on the validators' suggestions and ready for testing shown in Figure 1.

Figure 1. The revised LKPD (source: personal documentation)

2) Practicality

The practicality of the PhET Simulation-assisted LKPD is assessed based on the results of a limited trial conducted at a high school in Merauke with 15 students. The data obtained from the limited trial is presented in Graph 1.

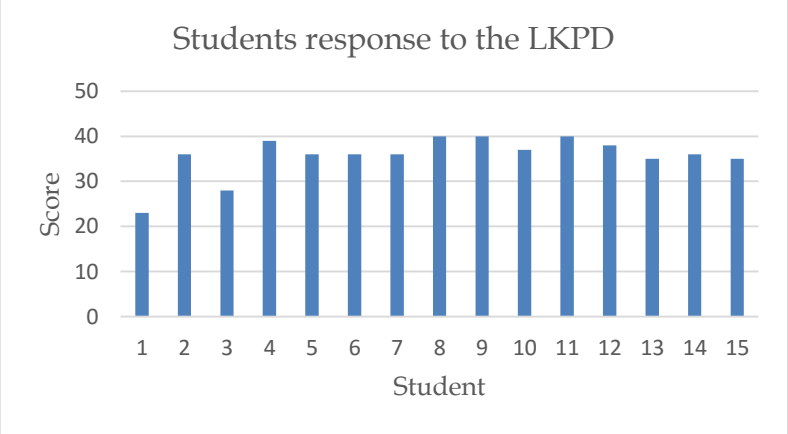

Figure 2. Graph of student response data to the LKPD

The student response data to the LKPD was averaged to determine the practicality level of the LKPD. The percentage data obtained from the limited trial is presented in Table 5.

Table 5. Student response percentage

Student	Score
1	23
2	36
3	28
4	39
5	36
6	36
7	36
8	40
9	40
10	37
11	40
12	38
13	35
14	36
15	35
Average score	35,66
Percentage	89%
Category	Very practical

Based on the students' responses to the LKPD, the average score obtained is 35.66 with a percentage of 89%. Therefore, the practicality of the developed LKPD is categorized as "Very Practical." The practicality of the LKPD is also reviewed based on the limited trial conducted by the physics teacher at the school, and the results are presented in Table 6.

Table 6. Physics Teacher Percentage

Physics teacher	Score	Average score	Pecentage	Category
1	51	3,923	98%	Very practical

Based on the responses from the physics teacher regarding the LKPD, the average score obtained is 3.923 with a percentage of 98%. Therefore, the practicality of the developed LKPD is categorized as "Very Practical".

DISCUSSION

Characteristics of LKPD Assisted by PhET Simulation

PhET Simulation-Assisted LKPD is a learning worksheet that uses interactive simulations from PhET Simulation as a tool to understand concepts in science. (Endang Susilawati & Agustinasari, 2022). This LKPD is tailored to core competencies, basic competencies, indicators to be developed, and material analysis, and is structured according to the 2013 Curriculum syllabus (A. Putri

et al., 2016.). The learning material is adjusted to the level of knowledge of high school students (SMA/MA). The teaching materials provided by teachers or schools are less engaging, leading students to desire more interesting physics learning media in the form of LKPD to enhance their motivation to study physics (Zulfikar, 2023). One of the educational media that uses technology is PhET Simulation. PhET Simulation was chosen because based on the results of questionnaire distributed at the school, it was found that the practical equipment especially for the topic of sound waves is not yet fully available. The PhET Simulation-assisted LKPD on the topic of sound waves is expected to be a solution for both teachers and students, allowing them to use the PhET Simulation virtual laboratory when conducting experiments related to the topic of sound waves.

Feasibility of LKPD Assisted by PhET Simulation

The feasibility of the PhET Simulation-assisted LKPD on the topic of sound waves, which was developed, is obtained from questionnaires filled out by material experts and media experts, specifically lecturers from the Physics Education Department at Musamus University. The feasibility results are calculated based on the questionnaires using a Likert scale as the benchmark for assessment, accompanied by categories (Sholikhah & Sucahyo, 2021). Validators assess the LKPD using validation questionnaires by marking the score columns and providing comments and suggestions at the end of their evaluation. Comments and suggestions are used to improve the quality of the developed LKPD. The feasibility results from material experts are used as a basis for evaluating the LKPD to ensure it is suitable for testing with students. After analysis, the validation result from material experts is 83%, categorized as very feasible. The researcher developed the LKPD according to the teaching material feasibility criteria set by the National Education Standards Agency (2006), including material coverage and accuracy. Therefore, the developed LKPD includes material that aligns with concepts and theories through core competencies and basic competencies referring to the 2013 Curriculum syllabus (A. Putri et al., 2016).

The media feasibility component data received a percentage of 66% and can be categorized as feasible. This is supported by the presentation of images/covers, text appearance, layout/format, and the clarity of the material presented. This aligns with the teaching material feasibility criteria set by the National Education Standards Agency (2006) regarding the components of LKPD presentation, which include size/format, external design, internal design, and the quality of the LKPD paper. These components are also consistent with the preparation of teaching materials according to (Anggereni et al., 2021), which emphasize the inclusion of innovative teaching materials to make the learning process more engaging.

Practicality of LKPD Assisted by PhET Simulation

The limited trial of the LKPD was conducted offline at a high school in Merauke by providing printed LKPDs to the students. Subsequently, a brief introduction and explanation of the developed LKPD were given. The purpose

of the limited trial was to assess the responses from students and teachers as users of the LKPD. Respondents provided their evaluations through response questionnaires by marking scores in the designated columns.

The practicality data of the LKPD, based on the responses from students and teachers, shows that the results from students are 89% and the results from teachers are 98%. Both data sets fall into the "Very Practical" category. The high practicality rating is due to the LKPD being designed to be user-friendly, and it includes sources of information such as text, images, and guidance on using the PhET Simulation virtual laboratory. These components are also consistent with the practicality of technology-based teaching materials developed by (Dan & Nurohman (2014)), which involve combining various aspects such as technology, animation, and interactivity in the development of teaching materials.

Advantages and Disadvantages of PhET Simulation-Assisted LKPD

The development of this LKPD (Student Worksheet) has advantages and disadvantages. The advantages of the LKPD assisted by PhET Simulation are as follows:

a) This LKPD utilizes technology such as the PhET Simulation virtual laboratory for a more enjoyable, efficient, and high-quality learning experience, in accordance with Permendikbud Number 65 of 2013 regarding standards for basic and secondary education processes. This finding aligns with research (Simbolon et al., 2021), which indicates that information and communication technology can be used to enhance the efficiency and effectiveness of learning in primary and secondary education standards. Therefore, by developing LKPD assisted by PhET Simulation, it is hoped that it can help and improve the effectiveness of learning.
b) The PhET Simulation-assisted LKPD is in print format, making it easier for students to read and understand the material contained within the LKPD.
c) The LKPD provides guidance for practical activities, enabling students to better understand sound wave material through the PhET Simulation virtual laboratory. Statements (b) and (c) align with the research findings of (Algiranto, 2021), which suggest that printed LKPDs with included materials and guides are more engaging."
d) The use of the PhET Simulation virtual laboratory in the LKPD can inspire enthusiasm and curiosity in students because PhET Simulation features engaging and entertaining simulations with images. This is consistent with the research by (Pertiwi & Ferdian, 2022), which found that PhET Simulation's images support the lessons and make students more interested.
e) The PhET Simulation virtual laboratory can be accessed both online and offline in school computer labs. This PhET Simulation-assisted LKPD can be used for instruction with a teacher or for independent study in schools/classes.

The PhET Simulation-assisted LKPD that has been developed has some drawbacks, including:

a) The PhET Simulation-assisted LKPD is not developed in an electronic format but rather in a printed format, so it cannot be accessed or obtained online. Since it is developed in a printed format, it is prone to damage or tearing if not handled carefully. Therefore, it is recommended that the LKPD be created in both print and electronic formats. The LKPD in print format will make it easier for students to read, study its content, and prevent eye strain from reading the text. The electronic format will allow students to study the LKPD anywhere and anytime, as it can be accessed through their smartphones.
b) The PhET Simulation-assisted LKPD is developed only for sound wave material.
c) The practical activities included in the PhET Simulation-assisted LKPD can only be accessed using a computer. This makes it difficult for schools that do not have computer laboratories to use it.

CONCLUSIONS AND RECOMMENDATIONS

The results of this study conclude that the feasibility of the PhET Simulation-assisted LKPD on the topic of sound waves, based on the assessments from material experts, is categorized as "Very Feasible," and the feasibility based on media experts is categorized as "Feasible." The practicality of the PhET Simulation-assisted LKPD on the topic of sound waves, based on student responses, is categorized as "Very Practical," and the practicality based on the physics teacher's evaluation is also categorized as "Very Practical".

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