Improving problem-solving skills through the physics education technology assisted problem based learning model electronic student worksheets

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The 21st century requires learning activities to put different skills into practice. Solving problems is a skill that pupils need to possess in order to succeed in the twenty-first century. In order to be able to propose strategic solutions to the problems that are presented and conclude with an evaluation of the solutions that have been chosen, students need to have the ability to analyze facts and test assumptions. The goal of this project was to create an Electronic Student Worksheets Science based on physics education technology that utilized problem based learning to assess students' problem-solving abilities. The 4D development model, which is separated into define, design, develop, and disseminate, is the development methodology utilized to create the electronic student worksheet product. The masyithoh gamping foundation madrasah tsanawiyah islamic school equivalent to junior high school hosted the product trial in May 2023. Even semester VIII grade students were used as research test subjects with an age range of 13 to 14 years. The physics material chosen in this study is in the chapter on changes in the form of substances. Ten VIII grade students grouped into low, medium, and high categories were used as test subjects. The trial was carried out using a quasi-experimental method with a one group pretest posttest design by giving individual initial tests before carrying out learning activities and then giving a final test after carrying out the activities. This activity has 2 stages, the first is a direct experimental activity by making observations, while the second activity uses the help of physics education technology. The activity is carried out by creating two groups each consisting of four or five students, who participate in the experiment. Next, the final test is given individually to each student. A total of 90% of students gave a positive response (very good) to the science electronic student worksheets in this study, according to the findings of the reading of the questionnaire given to students. Based on the findings of the analysis, 90% of students can easily learn with the help of electronic student worksheets. It can be said that after receiving the electronic student worksheets IPA treatment, students' ability to solve problems increased.

Keywords: E-LKPD; PBL; PhET; problem-solving skill.

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1. Introduction

Natural Sciences (IPA) is a science that examines natural phenomena, which are divided into the fields of biology, chemistry and physics. Products, processes and values are the main domains in learning science. As a product, IPA contains concepts and laws of nature. As a process, natural science is the ability to study objects and develop scientific products so that they are beneficial to human life. Meanwhile, scientific or affective character is a value domain in science learning [1]. It is vital to adapt the characteristics of science learning in its application to learning and to adopt the proper learning model. The Problem-Based Learning (PBL) paradigm is one of the effective teaching strategies used in science education. Students are encouraged to actively participate in the science learning process using the PBL approach during conversations that start with problem-giving and end with problem-solving.

Problem-Based Learning (PBL) is an effective model for teaching thinking processes, this learning helps students to process existing information and be able to develop their own concepts [2]. The PBL paradigm emphasizes the need for students to actively participate in order to locate and connect the material being studied to real-world situations [3]. With PBL students are trained to compile their own knowledge, develop problem-solving skills. The teacher's role in PBL is as a problem giver, facilitating investigation and dialogue, and providing motivation in learning [4]. Thus, the teacher does not convey much information to students. However, students are expected to be able to develop their thinking, build understanding, learn to act as adults, and become independent and independent learners to be able to solve problems. Problem-solving skills are needed to be able to face the demands of the 21st century.

The 21st century requires learning activities to put different skills into practice. Problem-solving is one of the abilities needed to succeed in the 21st century. Problem-solving skills are students' ability to analyze facts and test assumptions in order to be able to provide strategic solutions to solve the problems presented and end with an evaluation of the solu-

tions that have been chosen [5]. Problem-solving skills can be carried out through stages including problem discovery, problem analysis and learning problems, finding and finding solutions, as well as presentation and evaluation [6].

Electronic Student Worksheet (E-LKPD) is a sheet that contains tasks that must be done by students, which are used as a means to optimize student learning outcomes and increase student involvement in the teaching-learning process. Electronic Student Worksheets (E-LKPD) can be used to improve students' science process skills, because it contains a guide for students to carry out several activities regarding science process skills so that students gain new knowledge and skills to master. Electronic Student Worksheet (E-LKPD) can be based on the Problem-Based Learning model [8]. Based on the background that has been described, it is necessary to develop a PBL-assisted E-LKPD IPA based on the Physics Education Technology (PhET) to measure students' problem-solving skills.

2. Method

The development method used in developing the E-LKPD product uses the 4D development model, which is divided into define, design, develop and disseminate [9]. Three key tasks make up the first step: an analysis of the material, an examination of the needs of the students, and the creation of learning outcome indicators. The development of teaching materials is the second step. The creation of teaching materials is the third step.

The distribution of the created educational resources is the fourth phase. Curriculum analysis, material analysis, student characteristic analysis, and analysis of schoolwork are all included in the first phase, define. Task analysis is required to gather data via interviews and observation at Madrasah Tsanawiyah (MTSs) Masyithoh Gamping Foundation regarding the learning process in the classroom, the learning resources used by students, and issues pertaining to the preparation of teaching materials by teachers. Masyithoh Gamping Foundation Madrasah Tsanawiyah MTS is an Islamic school equivalent to junior high school. In order to learn more about students' abilities to solve problems during learning, an analysis of the students is being done. Curriculum analysis is carried out to adjust practicum activities with learning outcomes in material classification materials and their changes. The last is material analysis, which aims to identify facts, concepts, principles, especially in science material, material classification and its changes.

The second step is selecting the right media and initial product design. The researcher chose Canva-assisted media as a tool for the Science E-LKPD being developed, chose PhET as an additional media that helps to make abstract material structures real, create the structure of the Science E-LKPD and display design. The physics material chosen in this study is in the chapter on changes in the form of substances. The next stage is to create a science E-LKPD and material content combined with the Physics Education Technology (PhET) assistance and following the steps of the PBL model. In addition, it also made arrangements for the layout of the pictures and worksheets for questions, made evaluations and reflections.

The third step, develop, starts with the validation of the Science E-LKPD by validators, who are divided into two groups: material experts and media experts. Practitioners, or in this case, science teacher MTSs Masyithoh Gamping Foundation, also carry out assessments. Finally, trials are conducted on the products that are being developed. The product being developed, E-LKPD IPA on material classification material and its changes, underwent validation by experts to ascertain its viability, and E-LKPD IPA on material classification material and its changes underwent assessment by practitioners, specifically science teachers, to ascertain its applicability in the learning process. The preparation of PBL-based LKPD Student Worksheet (LKPD) is generally defined as a complement to the learning tools of the Learning Implementation Plan (RPP) [7]. The LKPD developed in this study is LKPD packaged in electronic form (E-LKPD). An electronic student worksheet known as an "E-LPKD" is one that may be used at anytime, anyplace, on a laptop or smartphone [8].

2.1. Preparation of PhET-assisted LKPD

This LKPD is packed with PhET simulations, which are presented with operational steps that are easy for students to understand. Students can access PhET via the link or scan the barcode found on the LKPD.

The test subjects in this study were students of class VIII even semester with an age range of 13 to 14 years. The test subjects were 10 class VIII students who were divided into low, medium and high categories. The trial of the IPA E-LKPD product was carried out to find out the response of students to the legibility of the product, especially in the material classification material and its changes. The trial was carried out using a quasi-experimental method with a one group pretest posttest design. This test was given individually to each student.

Among the tools used to collect data were a test instrument with ten multiple-choice questions, non-tests in the form of material and media expert validator assessment sheets for the viability of the product under development, practical learning sheets by science teachers to gauge the usability of the product, and product readability.

Questionnaires to gauge student reactions to the product under development. Data on the feasibility of E-LKPD IPA and practicality by practitioners were analyzed qualitatively using a scale with four criteria, namely very good, good, good enough, and not good enough. While the student response questionnaire data was analyzed based on the percentage of students with positive responses. Feasibility results data from material and media validators as well as assessments carried

TABLE I. Reference for changing the score to a scale of four.

No	Interval Score	Value	Category
1	$X \geq \bar{x} + 1{,}5\,\mathrm{SB}_x$	A	Very Good
2	$\bar{x} + 1.5\,\mathrm{SB}_x > X \geq \bar{x}$	B	Good
3	$\bar{x} > X \geq \bar{x}_1 - 1{,}5\,\mathrm{SB}_x$	C	Good Enough
4	$X < \bar{x} - 1{,}5\,\mathrm{SB}_x$	D	Not Enough

TABLE II. Reference for changing the score to a scale of four.

Score $\langle g \rangle$	Category
$\langle g \rangle \geq 0.7$	high
$0.7 > \langle g \rangle \geq 0.3$	Medium
$\langle g \rangle \geq 0.3$	Low

out by practitioners are converted into quantitative data with the following equation:

$$\text{Average Score} = \frac{\text{score obtained}}{\text{maximum } \textit{score}}. \tag{1}$$

The feasibility and practicality results data are then converted into a qualitative scale with criteria according to [9] as shown in Table I.

The effectiveness of the E-LKPD is analyzed using the normalized $\langle g \rangle$ gain score with the following equation:

$$\langle g \rangle = \frac{\text{posttest score} - \text{pretest score}}{\text{maximum score} - \text{pretest score}}. \tag{2}$$

Based on the above equation, $\langle g \rangle$ indicates the average gain score obtained. While the average percentage of students' posttest scores can be written in the form $\langle$%post$\rangle$. While $\langle$%pre$\rangle$ shows the average percentage of students' pretest scores obtained. The gain score obtained is then categorized based on Table II according to [10].

3. Results and discussion

This research produced E-LKPD IPA using PBL syntax and assisted by PhET to measure students' problem-solving skills. E-LKPD which consists of one problem-solving activity arranged according to curriculum and material analysis. This activity has two stages, the first is in the form of direct experimental activities by making observations, while the second activity uses PhET assistance. The appearance of the developed IPA E-LKPD can be seen in Fig. 1.

There were two groups, each with four or five pupils, that participated in the experiments. The experimental activity was conducted by first praying, reading the introduction in the Science E-LKPD, then conducting the experiments in order until students were requested to submit conclusions.

A validator made up of material specialists and media professionals evaluates the viability of the IPA E-LKPD

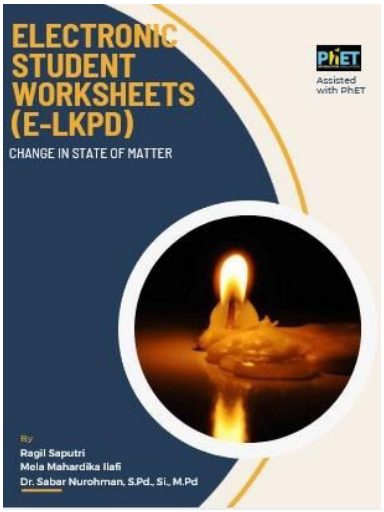

FIGURE 1. Display of PhET Assisted Science E-LKPD.

product on material classification materials and their alterations. Based on the evaluation made by the two validators, the validation procedure is used to ascertain the viability of the generated product. Expert validators' evaluation and counsel are used to determine the viability of the IPA E-LKPD. Two expert lecturers —material experts and media experts— conducted the evaluation.

The components of the assessment of media and material experts are different. The components of the media expert's assessment include graphical aspects, aspects of technical quality and usage, and aspects of the characteristics of the IPA E-LKPD. On the other hand, there is a material expert assessment component, which includes aspects of content feasibility, presentation, and aspects of the characteristics of E-LKPD IPA and language. The results of the material expert assessment are presented in Tables III and IV.

In addition to providing an assessment, the expert validator also provides suggestions and comments for improving the IPA E-LKPD. Suggestions from media expert validators such as: (1) add concept maps to make it easier for students to read learning topics; (2) the answer boxes can be enlarged to make it easier for students to fill in answers; (3) add more pictures to make the E-LKPD more interesting. Suggestions from the media expert validator are revisions to obtain pro-

TABLE III. Results of the feasibility assessment by media experts.

No	Aspect	Score	Value	Category
1	Graphic Aspects	3,71	A	Very good
2	Aspects of Technical Quality and Usage	3,8	A	Very good
3	Aspects of the Characteristics of E-LKPD	3,75	A	Very good

TABLE IV. Results of feasibility assessment by material experts.

No	Aspect	Score	Value	Category
1	Content Eligibility Aspects	3.67	A	Very good
2	Presentation Aspects	3.8	A	Very good
3	Aspects of the Characteristics of E-LKPD	4	A	Very good
4	Linguistic Aspect	3.67	A	Very good
Average		3.78	A	Very good

ducts that are suitable for use in science learning, such as choosing colors, writing fonts and adjusting image layout. According to [11] the good quality of E-LKPD can be seen based on three aspects, namely technical aspects such as operation, content, and display design or themes used. The IPA E-LKPD on material classification materials and their alterations is regarded as relevant by media professionals because it already includes these three elements. The type and size of letters greatly influence the attention and enthusiasm of students in using the Science E-LKPD. The right type and size of letters helps students understand reading so that students can easily get information. In addition, it can also provide convenience in guiding the course of the discussion. Assessment by media experts consists of graphics and characteristics. The results of the feasibility assessment conducted by media experts are shown in Table V.

After the produced E-LKPD product was declared practical by the material and media expert validator, a small trial was carried out. Trials were conducted to find out students' responses to the readability of the E-LKPD that had been developed. The readability results are presented in Table VI.

TABLE V. Results of the science teacher practicality assessment.

No	Aspect	Average Score (G1+G2)	Value	Category
1	Content Feasibility Aspect	3,67	A	Very good
2	Language	3,8	A	Very good
3	Presentation	3,78	A	Very good
4	Graphic	3,69	A	Very good
5	Characteristics	3,75	A	Very good

90% of students responded well to the created scientific E-LKPD, according to the students' overall readability scores. The results of the analysis show that 90% of students learn easily by using E-LKPD. This is in line with the results of research conducted by [12] that E-LKPD is capable of being a medium that can facilitate students in learning. The design of the Science E-LKPD was made according to the selection of colors, pictures and letters that made students interested in learning to use the Science E-LKPD. This is demonstrated by the fact that 90% of students are interested in the Science E-LKPD's design for learning and that 90%, 100%, and 90% of them say that letters, pictures, and colors are understandable and fascinating for learning, respectively. Learning media that are aligned, interesting, and creative make it easy to use in learning for students [13]. The limited test was conducted on 10 students of class VIII MTSs Masyithoh Gamping Foundation. The effectiveness of E-LKPD IPA on problem-solving skills is measured by comparing the average normalized gain score. The results of the pretest and posttest scores of problem-solving skills are shown in Table VII.

TABLE VI. Student readability results.

No	Statement	Answer		Percentage
		Yes	No	
1	The choice of letters in the PhET-assisted PBL model E-LKPD can be read properly	9	1	90
2	The picture on the PhET-assisted PBL model E-LKPD is clearly visible	10	0	100
3	The choice of colors in the PhET-assisted PBL model E-LKPD is interesting	9	1	90
4	The appearance of the PhET-assisted PBL model E-LKPD is interesting	8	2	80
5	PhET-assisted PBL model E-LKPD easy to use for learning	9	1	90
6	PhET-assisted PBL E-LKPD models are smooth to use	8	2	80
7	The sentences used in the PhET-assisted PBL model E-LKPD are clear and easy to understand	9	1	90
8	The design of the PhET-assisted E-LKPD model is interesting	9	1	90
9	The instructions for each activity in the PhET-assisted PBL model E-LKPD are easy to understand	9	1	90
10	PhET-assisted PBL model E-LKPD uses technology to make it easier to learn	10	0	100

TABLE VII. Results of N gain score.

Test	Average	N gain	Category
Pretest	50	0.701	Good
Posttest	85		

The results of the n gain normalized score are included in the good category with a score of 0.701. It can be concluded that students' problem-solving skills increased after being given the Science E-LKPD treatment.

4. Conclusion

The PBL-assisted IPA E-LKPD was created in this study to gauge students' problem-solving abilities. 90% of students responded positively (very well) to the Science E-LKPD in this study, according to the reading findings of the questionnaire given to the students. According to the analysis's findings, 90% (very good) of students can readily pick up new information utilizing E-LKPD. With a score of 0.701, the outcomes of the n gain normalized score fall into the good category. It may be said that after receiving the Science E-LKPD treatment, students' ability to solve problems improved.

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