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Development of LKPD (Student Worksheets) Based on Learning Cycle 5E Assisted by PhET Simulation to Improve Scientific Reasoning Skills for Junior High School Students

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A B S T R A C T

One of the factors in achieving student learning outcomes is scientific reasoning abilities (Scientific Reasoning) which will help students understand the main concepts of science. However, the PISA study categorized Indonesian students' scientific reasoning abilities as low, ranking 70th out of 78 countries in science and mathematics. This research aims to develop LKPD based on Learning Cycle 5E assisted by PhET Simulation that is valid, practical and effective. The type of research developed is Research and Development (R&D) using the ADDIE model. The research subjects were students of class IX semester 1 at SMPN 1 Jenggawah. The research data was analyzed based on several criteria. The results of the LKPD development obtained validity test results with a score of 91% (very valid). The practicality test results obtained an average score of 92.5% (practical). The results of the effectiveness test obtained an average N-Gain of 0.67 (medium). Based on the research findings, LKPD based on Learning Cycle 5E assisted by PhET Simulation can provide innovation in learning resources as an alternative to improve the scientific reasoning abilities of junior high school students.

1. Introduction

Rapid developments in Science and Technology (IPTEK) have accelerated the pace of globalization. As a result, competition in various aspects of life, including in the field of education, has become even greater. One of the skills that is key in dealing with this phenomenon is the scientific reasoning ability of students. This ability is considered essential in the 21st century era. However, the scientific reasoning ability of Indonesian students is still relatively low (Utama *et al*., 2018). The PISA (*Programme for International Student Assessment*) study categorizes that the scientific reasoning ability of Indonesian students is in the low category,

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ranking 70th out of 78 countries in science and mathematics (OECD, 2019). This is in line with the results of observations that have been made at SMP Negeri 1 Jenggawah, where students are less trained in scientific reasoning and tend to focus on conceptual thinking skills only, as well as learning that still focuses on teachers so that students are less able to explore during the learning process.

Scientific reasoning is a logical and critical thinking process used in science to formulate arguments or conclusions based on existing evidence and data. Scientific reasoning skills are highly expected to be taught in science classes, namely as a step to prepare students for success in facing rapid changes in globalization (Handayani et al., 2020). One of the factors for achieving student learning outcomes is the ability to reason scientifically (*Scientific Reasoning*) which will help students in understanding the main concepts of science. Students with good scientific reasoning skills will be able to design investigations to solve and solve a problem through cognitive skills in conceptual and procedural aspects. These skills include scientific investigation activities such as observing, predicting, measuring, asking questions, conducting experiments, interpreting data, formulating theories, and evaluating evidence (Balqis *et al*., 2019).

Education is the most important factor in a person's life, because it can distinguish a person's ability to think (Bella, 2023). The learning process requires teaching materials that can support learning so that it goes well. The Student Worksheet (LKPD) is a learning material that can be applied in science learning (Aldiyah, 2021). These teaching materials are identical in containing guidelines or procedural steps needed in the learning process, especially science learning which is identical to the learning process through research to solve a problem (Rizkika *et al*., 2022). LKPD can be interpreted as a medium that supports the learning process and assists students in training the development of learning aspects and encourages the improvement of students' knowledge and skills (Widiyanti *et al*, 2021). Students' critical thinking abilities are very necessary to shape students' cognitive strengths (Agustia, 2024).

LKPD based on *Learning Cycle 5E* is a teaching tool designed using the stages of the *Learning Cycle 5E model*, namely *engagement*, *exploration*, *explanation*, *elaboration*, and *evaluation. Learning Cycle 5E* is a constructivism-based learning model and can be an effective tool in improving students' scientific reasoning skills (Ristia *et al*.., 2023). This model emphasizes the central role of students in the learning process so that it can build students' knowledge and understanding (Liana, 2020). This learning model has 5 stages, namely *engagement*, *exploration*, *explanation*, *elaboration*, and *evaluation*. Learning with this model is highly recommended in the science learning process because it is considered quite effective in reducing students' misconceptions, especially in abstract science concepts (Cylindrica *et al*., 2021).

PhET Simulation is an interactive virtual laboratory media that can achieve the concept of science learning, so that it is able to provide a visual representation of abstract concepts. LKPD assisted by *PhEt Simulation* is a teaching material that includes learning activities by utilizing simulations or experiments available in the

media (Fatikasari *et al*., 2020). This media can make it easier for students to build a conceptual understanding of science in learning activities which can later improve students' scientific reasoning skills (Theasy *et al*., 2021). *PhEt* contains artificial experiments that resemble real experiments so that in science learning it can help students to get to know new topics, strengthen ideas, and build concepts or skills, especially in abstract subjects (Hidayati *et al*, 2019).

Important factors such as teaching aids and learning media used can affect the course of the learning process (Setiawan & Rusmana, 2018). One of the functions of learning media is to make it easier for students to support understanding through concrete descriptions of phenomena. The resulting concrete phenomena will give rise to critical and creative scientific thinking and attitudes so that they can improve the scientific reasoning skills possessed by students (Ariya *et al*., 2021). Based on these problems, the researcher plans to implement LKPD based on *Learning Cycle 5E* with the help of *PhET Simulation* in target schools, which is expected to have an effect on improving the Scientific Reasoning ability of junior high school students in science learning. LKPD with the *Learning Cycle 5E* learning model combined with *PhET Simulation* has the potential to improve students' scientific reasoning skills because it contains aspects that can help understand the intended concept.

2. Methodology

This research was carried out in class IX E of the odd semester of the 2023/2024 school year at SMPN 1 Jenggawah. The number of students involved in this study was 32 people. SMPN 1 Jenggawah is located on Jalan Tempurejo Number 63, Wedan Gn., Wonojati, Jenggawah District, Jember Regency. The research method applied is research and development using the ADDIE development model, which includes 5 stages, namely Analysis, Design, Development, Implementation, and Evaluation. At the development stage, three types of product tests were carried out, including validity tests, practicality tests, and LKPD practicality tests based on Learning Cycle 5E with the help of PhET simulations. The instruments used involved pretest and posttest questions, as well as questionnaires that included validation sheets, observation sheets, and student response questionnaires. The validity test was carried out by one science education lecturer as an expert validator, and two science teachers as practitioner validators. The results of the validity test are in the form of validity scores which are then analyzed and interprestakin into product validity criteria. The final value of validation is the percentage of the average value of each indicator calculated through the following formula:

$$P = \frac{\sum x}{\sum xi} \text{ x } 100\%$$

(Dila *et al.*, 2024).

Then the percentage of validation criteria is sought, through the following Table 1.

Table 1. Validity Criteria

Validity criteria	Validity Level
25%-40%	Invalid
41%-55%	Less valid
56%-70%	Quite valid
71%-85%	Valid
86%-100%	Highly valid

Furthermore, a practicality test was carried out using an implementation observation sheet. Assessment using observation sheets was carried out when learning in the classroom and was carried out directly in the classroom by 3 observers. Practicality is measured based on the results of observation of the implementation of learning by observers. The final value of practicality is the percentage of the average value of each indicator calculated through the following formula:

$$Vp = \frac{TSEp}{S - max} \text{ x } 100\%$$

(Rohma *et al*.,, 2023).

Then the percentage of the practicality validity criteria is sought, through the following Table 2.

Table 2. Practicality Criteria

Practicality criteria	Practicality Level
80%-100%	Practical
60%-79%	Quite practical
50%-59%	Less practical
20%-49%	Impractical

Furthermore, an effectiveness test of the LKPD was carried out. The effectiveness analysis was carried out by analyzing the scores of students' *pre-test* and *post-test* results to determine the average improvement of students' scientific reasoning skills. The analysis uses *the N-Gain* test and is calculated through the following formula:

$$g = \frac{Xm - Xn}{100 - Xn}$$

(Sari *et al*., 2022).

Then the percentage of effectiveness criteria is sought, through the following Table 3.

Table 3. Effectiveness Criteria

N-gain	Category
g≥0.7	Tall
0.3≤g<0.7	Keep
g<0.3	Low

3. Results and Discussion

Result

The research conducted is a development research with a product in the form of student worksheets (LKPD) based on *Learning Cycle 5E* assisted by *PhET Simulation* as an effort to improve the scientific reasoning ability of junior high school students. LKPD which is implemented in learning activities on the subject of Static Electricity in grade IX junior high school students, and has been tested in the learning process at SMPN 1 Jenggawah. The results of the research with the stages of ADDIE are as follows:

a. *Analyze*

The analysis stage is carried out in three stages, namely the analysis of the character of students, needs, and curriculum. The first stage is a needs analysis that aims to obtain information related to the problems faced by students and teachers related to learning resources and problems faced in learning activities. The data collection technique used at this stage is to conduct interviews with the school. Through interviews, it is known what problems students and teachers experience in learning, so that researchers can get solutions to the problems they face. The results obtained are that teachers experience obstacles in attracting students' focus and interest in learning because the learning process carried out is considered less varied, where the learning carried out is only guided by school package books so that students tend to feel bored more quickly. Therefore, the learning process requires interesting teaching aids, one of which is LKPD.

The curriculum applied to grade IX of SMPN 1 Jenggawah is the 2013 curriculum. So that the preparation of the LKPD is adjusted to the indicators of the 2013 curriculum. The subject matter used in the LKPD is the odd semester class IX material, namely static electricity material. The preparation of LKPD is also based on core competencies and basic competencies that must be achieved. The science learning process at SMPN 1 Jenggawah is still mostly using demonstration and lecture methods, so that students become less active during the learning process. The conclusion from several analyses was obtained that learning media is needed that can increase student engagement, one of the solutions that can be done is to prepare learning media by utilizing *the Student Centered Learning approach.* The application of learning by focusing on students can make them active in the learning process. Therefore, the preparation of LKPD based on the Learning Cycle is expected to be able to help students in the learning process.

b. *Design*

This stage is the initial planning stage to make a design of a product to be developed, namely LKPD based on *Learning Cycle 5E* assisted by *PhET Simulation.* The stage of selecting the type of teaching material is adjusted to the characteristics of the participants, the characteristics of the material, and the learning objectives. The initial design of the LKPD includes titles, materials,

learning indicators, learning objectives, instructions, and work steps for each activity. The design layout can be seen in Figure 1.

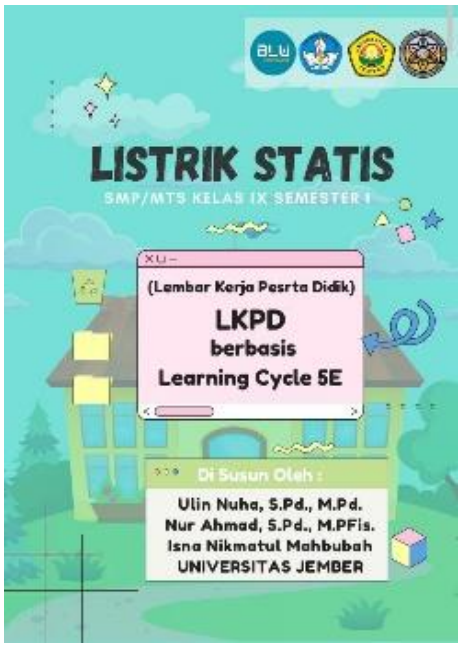

Figure 1. LKPD Cover Design

Static Electricity is the material used in this study. The design of the LKPD is also accompanied by designing learning tools such as syllabus, Learning Implementation Plans (RPP), and scientific reasoning ability test questions. The design of the syllabus and lesson plan is adjusted to the results of previous analysis, and the creation of scientific reasoning ability test questions is adjusted to learning indicators and scientific reasoning ability indicators.

LKPD based on *Learning Cycle 5E* assisted by *PhET Simulation* is designed to have advantages, including using the stages of the *Learning Cycle 5E* so that it has a clear flow and can help students in solving the problems presented in it. LKPD based *on Learning Cycle 5E* makes learning activities that focus on student activities, including activities or explanations that bring problems related to their environment. Thus, students do not have difficulty in understanding the subject matter and can improve their thinking skills. The application of PhET Simulation as a tool is considered effective and can help understand abstract concepts, make it easier for students to find these concepts, and improve their scientific reasoning skills.

c. *Develop*

This stage carried out LKPD validation activities based on *Learning Cycle 5E* assisted by *PhET Simulation* to three validators which included one expert validation by a Science Education lecturer at the University of Jember and two user validations by science teachers at SMPN 1 Jenggawah which consisted of four aspects, namely the aspects of language feasibility, content, graphics, and

presentation. The validation stage is carried out by providing a validation sheet with 4 scales, namely score (4) is very valid, score (3) is valid, score (2) is less valid and score (1) is invalid. The results of LKPD validation based on *Learning Cycle 5E* assisted by *PhET Simulation* are as shown in Table 4.

Table 4. Results of LKPD validation based on *Learning Cycle 5E* assisted by *PhET Simulation*

No.	Assessed aspects	Validator 1	Validator 2	Validator 3	Average score of each aspect
1.	Format	3.6	3.8	3.6	3.7
2.	Language	3.6	3.6	3.6	3.6
3.	Fill	3.6	3.4	3.4	3.5
4.	Graphics	3.3	3.8	3.8	3.7
	Total average score				3.6
	Validity				90%
	Validity criteria				Highly valid

Based on the results of the analysis conducted by three validators, there is an LKPD validation score of 91%, which is included in the very valid category. In addition, at this stage, an evaluation of the content and design of the product is carried out to make the necessary improvements. The suggestions given by the validator are also used as guidelines to improve the quality of LKPD, so that when implemented, the product can be better.

The development of the dissertation LKPD with several supporting tools, namely the Syllabus, RPP (Learning Implementation Plan), and scientific reasoning test questions in the form of *pretest* and *posttest* questions. The three devices also went through the validation stage by three validators with the same score criteria. The results of the syllabus validation analysis can be seen in the following Table 5.

Table 5. Syllabus Validation Results

No.	Assessed aspects	Score			Average
		V1	V2	V3	
1.	Compatibility between KD and indicators	3	4	4	3.7
2.	Compatibility between KD and the subject matter	3	4	4	3.7
3.	Compatibility between KD and learning activities	4	4	3	3.7
4.	Suitability of learning indicators with assessment	4	3	4	3.7
5.	Compatibility between material load and available time	3	4	3	3.3
6.	Suitability between learning activities and media	3	4	4	3.7
	Average	**3.3**	**3.8**	**3.7**	**3.6**
	Validity				**90%**
	Validity criteria				**Highly valid**

Based on the results of the analysis from the three validators, the validation value of the learning syllabus showed a score of 92.5% and was included in the very valid criteria. The results of the RPP validation can be seen in the following Table 6.

Table 6. RPP Validation Results

No.	Assessed aspects	Validator 1	Validator 2	Validator 3	Average score of each aspect
1.	Format	3.5	3.5	3.5	3.5
2.	Language	3.0	4.0	4.0	3.6
3.	Fill	3.3	3.8	3.8	3.6
4.	Benefit	3.5	4.0	4.0	3.8
	Total average score				3.625
	Validity				91%
	Validity criteria				Highly valid

Based on the results of the analysis from the three validators, the validation value of the learning syllabus showed a score of 91% and was included in the very valid criteria. The results of the validation of *the Pretest* and *Posttest* questions can be seen in Table 7.

Table 7. Validation Results of *Pretest* and *Posttest* Questions

No.	Assessed aspects	Validity Score			Average score
		V1	V2	V3	
1	Content Validity	16	18	18	17.3
2	Construct Validity	18	18	18	18
3	Language Questions	18	18	18	18
4	Conclusion	16	18	18	17.3
	Sum		212		
		Tse			**98,1%**
		Criterion			**Highly valid**

d. *Implement*

Implementation is a stage where LKPD, Syllabus, RPP, and scientific reasoning skills that have been considered valid, are tested in learning activities. The implementation was carried out on students in grade IX E SMPN 1 Jenggawah consisting of 32 students. The learning activities that took place were observed by 3 observers, namely 3 students of the Science Education study program at the University of Jember by filling out questionnaires/sheets for the implementation of learning. The results of the implementation sheet analysis are practical data for LKPD based on *Learning Cycle 5E* assisted by *PhET Simulation* which can be seen in Table 8.

Based on Table 8, the practicality of LKPD based on *Learning Cycle 5E* assisted by *PhET Simulation* is categorized as good with an average practicality value of 92.5%. The average practicality score is taken from three aspects of the assessment including registration activities, core and closing activities. The core activities themselves consist of several aspects, namely the use of LKPD, following each instruction, completing each instruction and assignment, discussing and presenting the results obtained.

Table 8. Practicality of LKPD based on *Learning Cycle 5E* assisted by *PhET Simulation*

No.	Aspects Observed	The meeting					Average
		1	2	3	4	5	
1.	Introduction	3.9	3.8	3.9	4	3.9	3.9
2.	Core Activities						
	a. Skilled in the use of LKPD	3	4	4	4	4	3.8
	b. Follow any instructions given	3.7	3.7	3.3	4	4	3.7
	c. Complete instructions and assignments in LKPD	3.3	4	4	4	3.7	3.8
	d. Conducting group discussions	3.7	3.7	3.7	3.7	3.3	3.6
	e. Presenting the results of the discussion in the LKPD work	3	3.7	3	3.3	3.7	3.3
3.	Cover	3.9	3.9	3.8	3.9	4	3.9
	Overall average	**3.5**	**3.8**	**3.7**	**3.8**	**3.8**	**3.7**
	The Value of Practicality Information						**92.5% Practical**

Questions about valid Scientific Reasoning skills are tested on students. This question is given during the learning process, namely students are given *a pretest* (at the beginning of learning) and *a posttest* (at the end of learning) to find out the improvement of learning outcomes so that the level of effectiveness of LKPD based on Learning Cycle 5E assisted by PhET Simulation is known in learning. The results of the analysis of the Scientific Reasoning ability test data can be seen in Tables 9 and 10.

Table 9. Scientific Reasoning Ability Test Results

	Lowest Score	Highest Scores	Average	N-Gain	N-Gain Criteria
Pretest	4	46	16.03	0.67	Keep
Posttest	42	100	72.31		

Table 10. Results of the Scientific Reasoning Ability Test for each Indicator

Scientific Reasoning Indicators	Average Pretest	Average Posttest	N-Gain	N-Gain Criteria
Proportional Reasoning	27.3	95.3	0.94	Tall
Conservation reasoning	7	73.4	0.71	Tall
Variable Control	1.6	39.1	0.38	Keep
Hypothetical-Deductive Reasoning	0	63.3	0.63	Keep
Correlation Reasoning	53.1	100	1	Tall
Probabilistic Reasoning	12.5	63.3	0.58	Keep

Based on the results in Table 9, it can be seen that there has been an increase in students' scientific reasoning ability, where there is an increase in the average *pretest* and *posttest* scores. The average result of the pretest was 16.03 while the average posttest score was 72.31 with a difference of 56.28. Referring to the *Normalized gain* criterion, it shows that the scientific reasoning value of students is 0.67 so that the *N-Gain* value is in the medium category. Meanwhile, based on

table 10, students' scientific reasoning ability has improved in each indicator. The highest improvement in the indicator of Scientific Reasoning ability is in the correlation reasoning indicator, on the other hand, the indicator with the lowest improvement is the probabilistic reasoning indicator. It can be concluded that LKPD based on *Learning Cycle 5E* assisted by *PhET Simulation* can be used in science learning in improving the scientific reasoning ability of junior high school students. The results of the analysis of student responses were obtained from filling out questionnaires by 32 students who had used LKPD based *on Learning Cycle 5E* assisted by *PhET Simulation.* The results of the analysis are presented in the following Table 11.

Table 11. Results of Student Response Analysis

Aspects	**Score**	**Sum**	**Result**	**Category**
Display	299			
Fill	522	1046	81,72%	Highly satisfied
Language	215			

Based on Table 4.8, it is known that the students' responses to the LKPD based on *Learning Cycle 5E* assisted by *PhET Simulation* in the display aspect obtained a score of 299, in the content aspect obtained a score of 522, and in the language aspect obtained a score of 215. The total score obtained from 3 categories is 1046. The final result of the student response was obtained at 81.72%, thus the response of students in the use of LKPD based on *Learning Cycle 5E* assisted by *PhET Simulation* in the learning process was in the category of very satisfied.

e. *Evaluate*

Syllabus, lesson plans, LKPD based on *Learning Cycle 5E* assisted by *PhET Simulation*, and scientific reasoning ability questions are improved according to comments and suggestions from supervisors before validation. After revision and validation, the Syllabus, RPP, LKPD based on *Learning Cycle 5E* assisted by *PhET Simulation*, and Scientific Reasoning proficiency questions were corrected in accordance with comments and suggestions from validators. Although there are several improvements to the LKPD and the questions at the time of validation, both have been declared valid or suitable for use after going through minor revisions. The results of the revision can be seen in the following Table 12.

Table 12. LKPD Revision Results and Questions

Product	Improved components	Advice from validators	Before revision	After the revision
LKPD	Graphics	It is recommended that the indicator be placed on top horizontally, not on the side vertically	Indicators are placed vertically	Indicators are placed horizontally
	Serving	The formula on page 5 could be clearer and thicker	The formula on page 5 is not clear	The formula on page 5 is clear and bold

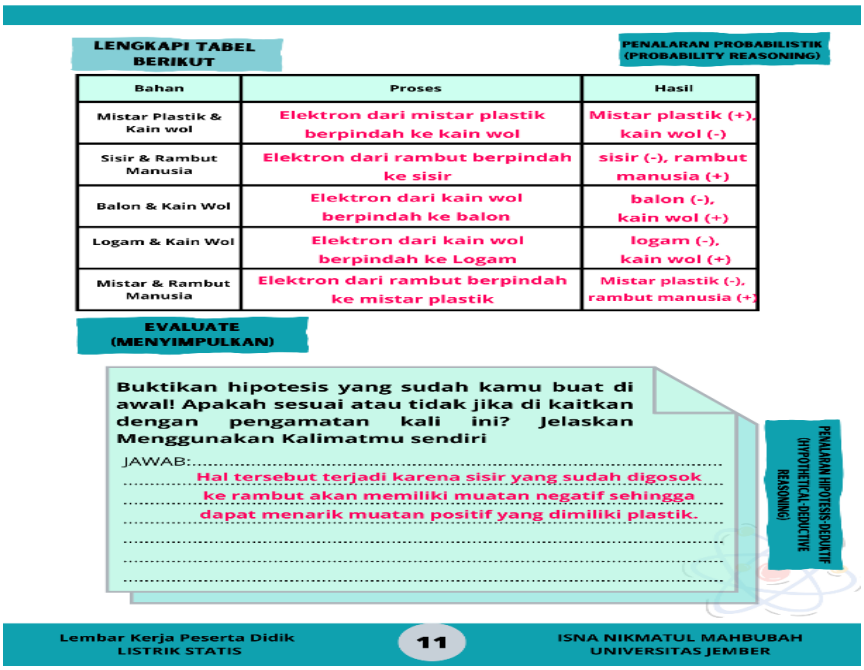

Figure 2. LKPD Display Before Revision

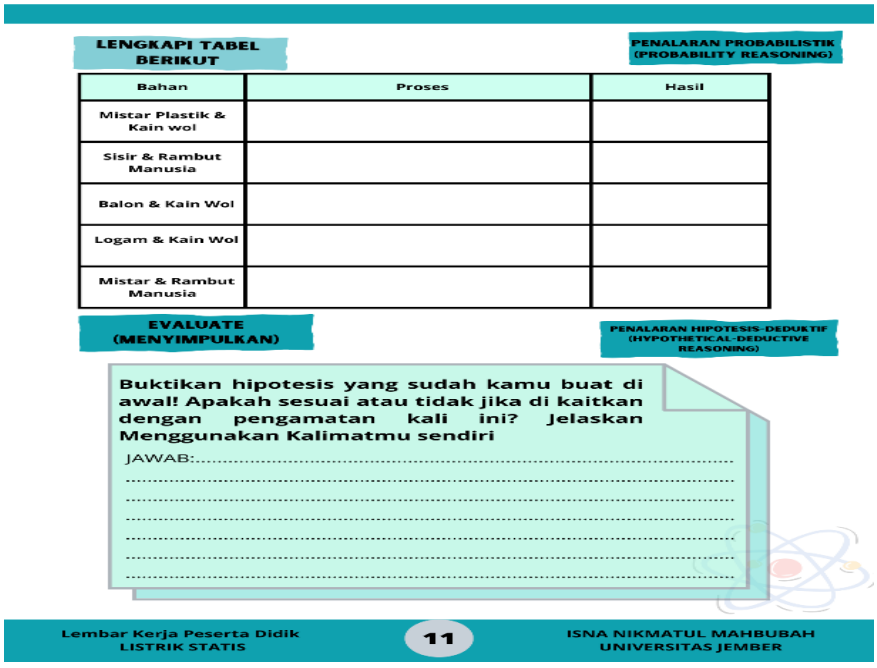

Figure 3. Graphical Display of LKPD After Revision

Discussion

The resulting research and development product is LKPD based on *Learning Cycle 5E* assisted by *PhET Simulation* to improve the scientific reasoning ability of junior high school students. LKPD that is well used must be valid, practical, and effective. Validation is carried out to assess and research a product that is

developed until it is said to be valid and can be used in learning (Nisa *et al*., 2017). A product can be said to be valid if it meets the criteria for valid content and valid construction, where valid construction includes valid aspects of language, presentation, and graphics. The LKPD produced in this study obtained very valid validity results on the valid content and valid construction criteria (Muthoharoh *et al*.,2017). LKPD based on *Learning Cycle 5E* assisted by *PhET Simulation* can be said that based on the aspect of presentation, the LKPD format has been presented in accordance with the structure of the LKPD, the completeness and completeness of the material, and provides space for students to explore. The LKPD is prepared in a segregated, consistent manner and contains various indicators to be achieved (Lestari and Mukhlis, 2021). Based on the language aspect, LKPD is prepared using language that is in accordance with the rules of correct and good writing, the sentences used are in accordance with the level of student understanding, clear instructions and directions, and do not make double interpretation. This is in accordance with Safitri *et al.,* (2022), that in writing LKPD must use the correct and good language rules and contain clear information. The graphic aspect of the LKPD also obtained very valid results which indicates that the LKPD based on *Learning Cycle 5E* assisted by *PhET Simulation* is quite interesting in terms of its design.

Validation is also recorded in the syllabus, lesson plans and questions for students' scientific reasoning ability tests. The validation results were obtained from the average percentage of the three validators, in the syllabus validation a score of 92.5% was obtained with a very valid category. The results of the validation of the Learning Implementation Plan (RPP) from the third percentage of validators were obtained by 91% with a very valid category. The results of the validation of *the pretest-posttest* questions from the three percentage of validators were obtained at 98.1% with a very valid category. The validation of the three tools is used to support the development process of LKPD based on *Learning Cycle 5E* assisted by *PhET Simulation.*

The practicality of the LKPD was analyzed based on the observation sheet of the implementation of learning. According to Safitri *et al.,* (2022) practicality is convenience in terms of preparation, use, and interpretation of a product being developed. The results of the analysis of the learning implementation sheet shown in table 8, learning with LKPD based on *Learning Cycle 5E* assisted by *PhET Simulation* in class IX E is classified as good with an average practicality of 92.5%. The LKPD developed is categorized as practical because it can help students in the learning process and learning steps can be carried out properly. Nisri *et al.,* (2020) stated that a teaching tool can be said to be practical if it is easy to use and can be said to be complete if the learning steps can be carried out properly.

The effectiveness of LKPD based on *Learning Cycle 5E* assisted by *PhET Simulation* in improving the Scientific Reasoning ability of junior high school students was obtained from the test scores of students' Scientific Reasoning ability. The test is carried out by providing *a pretest* and *posttest*. The *pretest* and *posttest* scores can be seen in tables 9 and 10 which show that the results of *the N-*

Gain analysis have improved students' Scientific Reasoning skills. *N-Gain* analysis showed that the Correlation reasoning indicator experienced the highest improvement, namely with the result of *N-Gain* 1. This score shows that students have been able to determine whether or not there is a relationship between events and the consequences of these events through the relationship between cause and effect. This is in accordance with the statement of Hadi (2021), that correlational reasoning is reasoning used to determine and identify a reciprocal relationship between variables. In the question, students were asked to predict the relationship between the electrical event of the Echidna animal and its snout.

The Proportional Reasoning indicator experienced the second highest increase with the high category and *an N-Gain* value of 0.94. The results show that students have been able to solve problems by setting and comparing ratios. Proportional reasoning can be seen when learning in the classroom students are able to compare various interactions between two charged when given treatment or not. Students compare how the type of charge possessed by an object when an object is treated and not treated. The treatment given can make an object have a positive or negative type of charge. In line with the research of Maharani *et al*., (2023) which states that proportional reasoning arises when students are able to give the right answers and understand the questions related to proposition problems and ratio comparisons.

The Conservation Reasoning Indicator experienced the third highest increase with a high category and *an N-Gain* value of 0.71. The results show that students are able to maintain their knowledge even though the appearance of the object changes, so the nature will remain (Handayani *et al*., 2022). Students are able to know whatever the value of the magnitude of the charge, when the two contents have the same type of content, it will produce a push-pull interaction, and when it has a different type of load, it will produce a pull-pull interaction. This is in accordance with the principle of electric charge, when the charge is negative, it will produce an inlet force line or pull a charge from the outside, while a negative charge will produce an outgoing force line.

The hypothetical-deductive indicator experienced a fourth increase with a medium category and *an N-Gain* value of 0.63. This shows that students are able to make conclusions after testing the hypothesis that has been done previously, although there are still some students who are still not able to determine the hypothesis at the beginning before conducting the experiment (Nurdyansyah, 2018). Scientific reasoning is a hypothetical-deductive process that includes observation of the phenomenon that occurs, then formulating a hypothesis, and testing the hypothesis through experiments (Indah *et al*., 2021). In the question, students are asked to design a hypothesis about the energy of two batteries that have different charges, which is then proven by calculating the energy of the two batteries.

The Probabilistic Reasoning indicator experienced a fifth increase with a medium category and *an N-Gain* value of 0.58. This shows that there are students who are able to predict a possibility that will occur in an event, but there are also students who are less able to predict a possibility that will occur in an event. Handayani *et*

al., (2020) stated that probabilistic reasoning is a form of reasoning that relies on information to determine whether a conclusion has the possibility of truth or error. It involves evaluating the likelihood of various events occurring in the calculation of opportunities.

The variable control indicator obtained the lowest increase, namely with medium criteria and *N-Gain* value of 0.4. This shows that students are less able to control a variable that affects a problem. Students are less able to distinguish between control and bound variables that can affect an experiment, thus causing misunderstandings and affecting the results obtained. This is in line with the results of research by Yediarani, Maison and Syarkowi (2019), where scientific reasoning in junior high school students in Jambi shows a low level, especially in variable control indicators which only reach a percentage of 8.7%, with a very low category. Students who have difficulty controlling dependent and independent variables are also likely to face difficulties in testing hypotheses.

The results of the analysis in table 9 obtained an *N-Gain* value of 0.67 which is included in the medium category. This shows that the LKPD based on *Learning Cycle 5E* assisted by *PhET simulation* developed is quite effective in improving the Scientific Reasoning ability of grade IX E students at SMPN 1 Jenggawah. This research is in accordance with the research of Utama *et al*., (2019) The application of the model in the design of LKPD can inspire and arouse students' curiosity about the subject matter. This can be achieved by using models that are relevant to the learner's environment or focusing on learners' activities. According to Hidayati *et al*., (2019), the use of PhET simulations in learning media can provide visual representations of abstract concepts, making it easier for students to build a conceptual understanding of science so that it can improve students' scientific reasoning skills during learning activities.

The research conducted did not run smoothly completely. The obstacles experienced in learning activities are that the time needed in the learning process is felt to be insufficient because of the many stages in the *Learning Cycle 5E* in the LKPD. The solution is that teachers must be smarter in managing time and adjusting to the time that has been allocated in the lesson plan.

4. Conclusion

Based on the results of research that has been carried out by applying LKPD based on Learning Cycle 5E assisted by PhET Simulation on Static Electricity material in class, the results of students' scientific reasoning skills have increased, as evidenced by the average Pretest and Posttest scores. In addition, the improvement of students' scientific reasoning ability can also be proven that there is an increase in N-Gain values in each scientific reasoning indicator, ranging from Proportional Reasoning, Conservation Reasoning, Variable Control, Hypothesis-Deductive Reasoning, Correlation Reasoning, and Probabilistic Reasoning. Thus, the LKPD based on Learning Cycle 5E assisted by PhET Simulation developed was declared effective to be applied to improve the

scientific reasoning ability of junior high school students. In terms of validity and practicality, LKPD based on Learning Cycle 5E assisted by PhET Simulation meets practical and valid criteria so that it can be applied in the learning process

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