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ANALYSIS OF JUNIOR HIGH SCHOOL STUDENTS' SCIENCE PROCESS SKILLS THROUGH THE IMPLEMENTATION OF PHET SIMULATION MEDIA ON THE SUBJECT OF LIGHT AND OPTICS

Fenno Farcis[1*], Rahmiyati[2]
[1,2] Departement of Physics Education, Palangka Raya University , Palangkaraya, Indonesia
email: fenno.farcis@fkip.upr.ac.id

Abstract: The purpose of this study was to determine students' science process skills in the subject matter of Light and Optics learning process with PhET simulation media. The parameters of four (4) aspects of basic science process skills indicators, namely observation, measurement, prediction and conclusions.. This research is a quasy experiment using quantitative descriptive analysis. The research subjects were 32 students of State Junior High School 4 Palangkaraya. The assessment instrument used is a science process skills assessment sheet with skill scores in the form of a Likert scale. The results of the science process skills assessment per component at each meeting showed several results. Quite good results in the observation and prediction components, good results in the measurement component, and very good results in the conclusion component. The results of the science process skills assessment per aspect at each meeting showed quite good results in the aspect of accuracy in making hypotheses, accuracy in answering questions related to observation results. Good results in the aspects of accuracy in conducting experiments in accordance with work procedures, accuracy in processing data, and accuracy in proving hypotheses. Very good results in the aspect of summarizing experimental results. The highest aspect value is concluding the experimental results at 89.58% in the very good category. The average results of the science process skills assessment per group at all meetings were obtained as quite good and good. Group I scored 68.06% (quite good), group II scored 70.83% (good), group III got 66.67% (quite good), and group IV got the highest score, namely 72.22. % (Good).

Keywords: science process skills; PHET simulation media; physics learning

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INTRODUCTION

Learning is a process of creating conditions that are conducive to teaching and learning communication interactions between teachers, students and other learning components to achieve learning goals. The learning process using a scientific approach aims to provide an understanding of students to know and understand some material and information from various sources, time and place in the same direction from teacher (Prastowo, 2019). Teachers are obliged to create a learning atmosphere that is focused, interesting, and so

on, so it is clear that every teacher is required to be able to work professionally. This education can be achieved through teaching and learning activities at school which are based on curriculum. Learning in the 2013 curriculum is expected to be able to answer the demands of the 21st century where students are able to have critical and analytical thinking skills with learning based on a scientific approach in all subjects (Kemendikbud, 2014).

The implementation of current curriculum (2013 Curriculum) emphasizes the need to develop process skills in students. The orientation of 2013 Curriculum is balancing and improving between attitude, skill, and knowledge competencies. In the 2013 curriculum the school was aspired to be able to get a new generation that was intelligently comprehensive, not only intellectual, but also emotional, social and spiritual. Therefore, graduates' abilities should include attitudes, knowledge, and skills in accordance with established national standards (Mutmainah e*t al*., 2020). There are three competencies are demands that must be met by schools in accordance with the provisions of the Physics 2013 Curriculum in the learning process expects students to have balanced competencies between cognitive (knowledge), affective (attitude) and psychomotor (skills).

Natural Sciences is based on the concepts of relationships between objects in nature and contains mathematical calculations. Mathematics is a science that supports natural science as a basis for calculation and logic. In its development, science has never been separated from mathematics, in fact science would not have been able to develop without mathematics (Silaban, 2017). Science must also be viewed as a way of thinking, as a way to carry out investigations and as a collection of knowledge about nature. Science/science is essentially: (1) a body of knowledge; (2) as a way of thinking; and (3) as a way of investigating this universe.

Physics, as part of science, in school learning is actually considered a lesson that is difficult for most students to understand because of the use of formulas and the involvement of mathematics in it. Physics as part of natural science is actually related to how to find out about nature systematically, so that Physics is not only about mastering a collection of knowledge in the form of facts, concepts or principles but is also a process of discovery (Silaban, 2017). This view emphasizes that physics is not only concerned with mathematical formulas, but also with important natural concepts obtained through discovery. Physics practicum is one of the obligations for students majoring in mathematics and science education which aims to prove the truth of theories, principles, concepts and laws in physics (Astalini, Darmaji, *et al*., 2019). However, the current learning system has experienced a paradigm shift, where previously the learning system emphasized knowledge, now it focuses on science process skills.

Science process skills are learning outcomes achieved by a person in the form of the ability to solving problem, carry out and determining scientific work, scientific research or scientific product, communicate the results of scientific research and behave scientifically (Dori *et al*., 2018; Fitriyani, 2019; Sari *et al.*, 2019; Deratama *et al.*, 2020). Science process skills are a reflection of the methods used by scientists in producing

comprehensive information about science such as product, attitude, process, and application dimensions (Setyawarno et al., 2020).

Students' science process skills are a learning approach that is oriented to the science process and is an elaboration of the scientific method. Students' abilities in acquiring knowledge based on phenomena which include students' ability to observing, grouping, interpreting, predicting, asking questions, hypothesizing, planning experiments, applying concepts, communicating and carrying out experiments (Widyanti *et al*., 2020). The development of critical thinking skills is carried out by teachers by practicing critical thinking skills and facilitating learning activities with critical thinking indicators. It is necessary to direct students to solving science problems by involving students' thinking skills and process skills. Students' science process skills need to be trained in learning in order to form an ability in themselves that is not just based on academic abilities, but also trains students' skills, so it is necessary to carry out laboratory-related activities that refer more to students' science process skills.

Learning media needs to be paid attention to, because media is a means that helps the learning process, especially those related to the senses of hearing and sight. Learning media in general are tools to help the teaching and learning process. Learning media can be understood as media used in the learning process and objectives. One form of learning media is virtual laboratory. Virtual laboratories are a form of learning media which is a product of developments in digital information technology. The use of various applications, including virtual laboratories, is a logical consequence of adapting to developments in information and communication technology. As technology and information develop, there is a shift in the form of learning media from print to digital. Various digital learning media were developed as a response to advances in technology and information (Yusro *et al*., 2021). One of the virtual laboratory applications that is currently widely used, familiar and complete is PhET.

PhET is a simulation created by the University of Colarodo which contains physics, biology and chemistry learning simulations for classroom teaching or individual study purposes. PhET simulation can be accessed easily and free of charge by students not to burden students financially. Layson's research (2022) results concluded that PhET simulation is easy to use aside from its fun and engaging features. In addition, most of the basic physics practicum titles are available in the PhET simulation application. Students also have experience in the previous semester's practicum using PhET simulation (Affa, 2022). Several study describes the application of computer- based scaffolding with the help of PhET simulation and analysis of students' science process skills. Science process skills are closely related to experimental and practical activities (Lestari *et al*., 2018; Utami *et al*., 2019; Dasilva *et al*., 2019). Thus, PhET simulation can be integrated with a scaffolding approach to improving students' science process skills. Sulisworo *et al*,. (2019) looked into a hypothetical deductive technique helped by PhET simulations on tenth-grade learners' critical thinking skills. The Critical Thinking Skills were measured using non-routine issues, and the results show that PhET simulations can considerably increase CTS.

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METHOD

This type of research is Pre-Experimental research using a oneshot case study design, namely research carried out without a comparison group and also without an initial test (Arikunto, 2019). In this research design, there is one group selected at random, the selected group is given treatment in the form of learning using the discovery learning model assisted by PhET Simulation media, then the group is given a science process skills assesment to determine the final condition of the students after learning. The science process skills has several aspects that can be assessed as a benchmark for the strengths and weaknesses of student groups in working on the LKPD given by researchers. The science process skills components assessed are observation, measurement, prediction, and conclusions. The science process skills aspects of student groups will be assessed by observers by providing criteria that are appropriate to the group's performance with reference to the science process skills assessment rubric that has been provided. This research was carried out at class VIII semester 2 SMP Negeri 8 Palangkaraya for the 2022/2023 academic year on the Light material. This research seeks to answer the problems posed by researchers to find out students' science process skills are when implementing the discovery learning model assisted by PhET Simulation media.

RESULT AND DISCUSSION

The teaching and learning process carried out in this research uses a discovery learning model assisted by PhET simulation media to determine students' science process skills. The assessment of science process skills was carried out in 3 meetings with the help of 4 observers. Group science process skills are assessed in 3 (three) meetings and scoring is given by observers when students work on the Student Activity Sheet, namely LKPD, with the assessment rubric that has been prepared. Observers put a tick (√) on the assessment sheet which has been prepared with 4 scoring criteria, namely very good (score four), good (score three), quite good (score two) and poor (score one) where the assessment results are in the form of numbers on a scale. 0 – 100. The science process skills instrument consists of 4 components, namely observation, measurement, prediction and conclusions. Each component is broken down into aspects that are measured and assessed by observers. The table of science process skills for groups of students in each meeting can be seen in Table 1, Table 2, and Table 3.

RESULT

a. Science Process Skills for Each Meeting

Table 1. Results of Science Process Skills Meeting I

Topic	Group	Komponen						Total Score	Score (%)	Category
		Observation	Measurement		Prediction		Conclusion			
		1	2	3	4	5	6			
The Nature of Light	I	2	3	3	2	3	3	16	66,67	Quite Good
	II	2	3	3	2	3	4	17	70,83	Good
	III	2	3	3	2	3	3	16	66,67	Quite Good
	IV	2	3	3	2	3	4	17	70,83	Good
Number per aspect		8	12	12	8	12	14	66		
Score per aspect (%)		50	75	75	50	75	87,5	68,75		

Category	Quite Good	Good	Good	Quite Good	Good	Very Good	Good
Score per Component (%)	50	75		62,5		87,5	

Table 2. Results of Science Process Skills Meeting II

Topic	Group	Komponen						Total Score	Score (%)	Category
		Observation	Measurement		Prediction		Conclusion			
		1	2	3	4	5	6			
Flat Mirrors and Curved Mirrors	I	2	3	3	2	3	4	16	70,83	Good
	II	2	3	3	2	3	4	17	70,83	Good
	III	2	3	3	2	3	3	16	66,67	Quite Good
	IV	2	3	3	2	3	4	17	70,83	Good
Number per aspect		8	12	12	8	12	15	67		
Score per aspect (%)		50	75	75	50	75	93,75	69,79		
Category		Quite Good	Good	Good	Quite Good	Good	Very Good	Good		
Score per Component (%)		50	75		62,5		93,75			

Table 3. Results of Science Process Skills Meeting III

Topic	Group	Komponen						Total Score	Score (%)	Category
		Observation	Measurement		Prediction		Conclusion			
		1	2	3	4	5	6			
Formation of Images on The Lens	I	2	3	3	2	3	3	16	66,67	Quite Good
	II	2	3	3	2	3	4	17	70,83	Good
	III	2	3	3	2	3	3	16	66,67	Quite Good
	IV	3	3	3	2	3	4	18	75	Good
Number per aspect		9	12	12	8	12	14	67		
Score per aspect (%)		56,25	75	75	50	75	87,5	69,79		
Category		Good	Good	Good	Quite Good	Good	Very Good	Good		
Score per Component (%)		56,25	75		62,5		87,5			

Note:
Aspect Category science process skills: 1 = make a hypothesis, 2 = carry out experiments in accordance work procedures, 3 = processing data, 4 = answer questions related to the results of observations, 5 = prove the hypothesis, 6 = summarize the experimental results.

b. Science Process Skills for Each Component

The components of science process skills observed in this research are observation, measurement, prediction and conclusion. A recapitulation of the science process skills results for each component is presented in Table 4.

Table 4. Average Score of Science Process Skills for Each Component

Meeting	Topic	Component Science Process Skills (%)			
		Observation	Measurement	Prediction	Conclusion
1	The Nature of Light	50	75	62,5	87,5
2	Flat Mirrors and Curved Mirrors	50	75	62,5	93,75
3	Formation of Images on The Lens	56,25	75	62,5	87,5
Average Score Science Process Skills Each Component (%)		52,08	75	62,5	89,58
Category		Quite Good	Good	Quite Good	Very Good

The average value of science process skills for each component can be seen that the average value of science process skills for the highest component is the conclusion component with a value of 89.58% in the very good category, and the lowest component value, namely the observation component, obtained a value of 52.08%.

c. Science Process Skills Every Aspect

There are six aspects of science process skills for each aspect observed in this research, namely creating hypotheses, conducting experiments in accordance with work procedures, processing data, answering questions related to observation results, proving hypotheses, and concluding experimental results. A recapitulation of the average results of science process skills for each aspect is presented in Table 5.

Table 5. Average Score of Students' Science Process Skills Each Aspects

Meeting	Topic	Aspect Science Process Skills (%)					
		Observation	Measurement		Prediction		Conclusion
		1	2	3	4	5	6
1	The Nature of Light	50	75	75	50	75	87,5
2	Flat Mirrors and Curved Mirrors	50	75	75	50	75	93,75
3	Formation of Images on The Lens	56,25	75	75	50	75	87,5
Average Score Science Process Skills Each Component (%)		52,08	75	75	50	75	89,58
Category		Quite Good	Good	Good	Quite Good	Good	Very Good

The aspect of accuracy in making hypotheses received an average score of 52.08% in the quite good category, the aspect of accuracy in carrying out experiments in accordance with work procedures obtained an average score of 75% in the good category, the aspect of accuracy in processing data obtained an average score of 75 % in the good category, the accuracy aspect in answering questions related to observation results obtained an average score of 50% in the quite good category, the accuracy aspect in proving the hypothesis obtained an average score of 75% in the good category, and the aspect in concluding experimental results obtained The average score is 89.58% in the very good category.

d. Group Science Process Skills Data

Data on the average results of the assessment of science process skills for each group at all meetings, namely meeting 1, meeting 2 and meeting 3 on the topic of light, are presented in the table. The results of science process skills are obtained from scoring the performance of each group. Scoring is given by observers to students' abilities in carrying out experimental activities in accordance with the scoring rubric that has been prepared. The table of average values for the science process skills of student groups can be seen in Table 6.

Table 6. Average Score Science Process Skills Each Meeting

Meeting	Average Score Group (%)	Category
1	68,75	Quite Good
2	69,79	Quite Good
3	69,79	Quite Good
Average Score Each Meeting	69,44	Quite Good

DISCUSSION

The results of the students' work during three meetings showed that the students were able to carry out the 4 aspects of science process skills correctly, although it was still necessary to provide stimulation to the students in making observation, measurement, prediction, and conclusion.There was an increase in students' scientific process skills on the indicators of observing with a good category in the third meeting. Teachers must provide more guidance to students. Scaffolding can be applied to improve observation skills (Affa, 2021). Darmaji *et al*. (2018) expressed his opinion that observation is an initial step in experimental activities so it needs to be strengthened. Indicators of measurement skills have not increased. Measurement skill is important indicator because it involves students thinking about the relationships and interrelationships between variables tested through practicum (Maison et al., 2019). Prediction skills are in the quite good to good category. Prediction skills are carried out by connecting patterns or relationships to suggest what might happen in circumstances that have not been observed. Zeidan (2015) predicting skills are the skills to predict future events based on observations or data in the past. In prediction skills, students are trained to connect previous knowledge to solve the problem at hand. The aspect of making conclusions is a very good indicator. The conclusion indicator lies at the last level, namely developing conceptual thinking. Students conclude the concept of physics based on the results of the practicum carried out and relate it to contextual phenomena in everyday life. Students' skills in making conclusions can be trained by asking scaffolding questions. Direction is carried out until students can form concepts according to what they experience in the process of activities in the laboratory (Isrokatun *et al*., 2019; Jufriadi *et al*., 2019).

The results of interviews with students explained that the use of PhET application for laboratorium activity was more interesting, effective and efficient. Students explained that the advantages of the PhET application are in the ease to use. They can upload the application for free. The use of electronic environments in educational technology started fairly recent affect science process skills and to make the learning process easier and increase the accessibility of learning and teaching (Seraj & Wong, 2014; Cahyono *et al*., 2017). The use of PhET application can contain unlimited information so that the steps given to students in carrying out practicum are really detailed. Students develop their concepts based on the practicum results to analyze solutions to problems given by the teacher. Concept understanding is closely related to science process skills (Magfirah *et al*., 2019).

CONCLUSION

The results of research data analysis can be concluded that:
Students' science process skills when implementing the discovery learning model assisted by PhET simulation media are obtained:

a. The results of the science process skills assessment per component at each meeting showed several results, namely quite good, good and very good. Quite good results in the observation and prediction components, good results in the measurement component, and very good results in the conclusion component.
b. The results of the science process skills assessment per aspect at each meeting showed several results, namely quite good, good and very good. Quite good results in the aspect of accuracy in making hypotheses, accuracy in answering questions related to observation results. Good results in the aspects of accuracy in conducting experiments in accordance with work procedures, accuracy in processing data, and accuracy in proving hypotheses. Excellent results in the aspect of summarizing experimental results. The highest aspect value is concluding the experimental results at 89.58% in the very good category.
c. The average results of the science process skills assessment per group at all meetings were obtained as quite good and good. Group I scored 68.06% (quite good), group II scored 70.83% (good), group III got 66.67% (quite good), and group IV got the highest score, namely 72.22. % (Good).

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