JPPIPA 8(3) (2022)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

The Effect of Object-Oriented Physics Learning on Students' Abilities to Interpret and Make Reasoning about Data

Suryadi[1*], I Ketut Mahardika[2], Sudarti[2], Supeno[3]

[1] SMA Negeri Jenggawah, Jember, Indonesia
[2] Physics Education Department, University of Jember, Jember, Indonesia
[3] Science Education Department, University of Jember, Jember, Indonesia

DOI: 10.29303/jppipa.v8i3.1746

Article Info
Received: May 30, 2022
Revised: July 20, 2022
Accepted: July 24, 2022
Published: July 31, 2022

Abstract: This study aims to develop students' abilities in interpreting and making reasoning about physics data. The type of research used is experimental research. Physics learning was carried out in two classes: control and experimental groups. In the experimental group, physics learning was oriented to student activities where students dealt with physics objects. In contrast, in the control group, physics was taught conventionally by applying direct learning. The ability to interpret and to make reasoning about data was obtained through written tests conducted on pre-test and post-test. Analysis of research data was carried out by qualitative descriptive and t-test statistical analysis. The descriptive analysis was performed to describe students' abilities to interpret and to make reasoning about data. A statistical t-test analysis was conducted to determine the difference in the impact of treatment on the two groups. The results showed that the average ability to interpret data and to make reasoning about data in the experimental group was 76.91 and 76.99, respectively, while in the control group, it was 53.33 and 63.08, respectively. The results of the t-test analysis showed that the 2-way (t-tailed) significance value was 0.000 < 0.05, so it could be stated that there was a difference in ability between the control group and the experimental group. Based on the results of these studies, it can be noted that learning physics that involves a lot of student activities that interact directly with physics objects can improve the skills of high school students in interpreting and reasoning scientific data.

Keywords: Interpretation skills; Seasoning skills; Object-oriented; Physics instruction.

Citation: Suryadi, S., Mahardika, I.K., Sudarti, S., & Supeno, S. (2022). The Effect of Object-Oriented Physics Learning on Students' Abilities to Interpret and Make Reasoning about Data. *Jurnal Penelitian Pendidikan IPA*, *8*(3), 1519–1523. https://doi.org/10.29303/jppipa.v8i3.1746

Introduction

The general objective of learning science, including learning physics, is to develop mastery of science concepts and various skills so that students can understand the natural environment. The various skills are referred to identifying, interpreting, and reasoning relevant scientific data and evidence and communicating ideas about science (Doyan et al., 2022; Harlen, 2000). For this reason, science learning must prioritize the process of interaction among students, students and teachers, and students with learning resources in a learning environment. Learning resources with the learning environment are closely related to supporting the learning process because both affect student learning activities. The learning process dominated by student activities is expected to develop various thinking skills, including the ability to interpret and make reasoning.

Interpreting and reasoning are abilities related to formulating scientific explanations based on the analysis results of scientific data obtained from an experiment (Elmas et al., 2018). Interpretation means explaining the meaning of something (Kurniawan, 2018; Luedo et al., 2021). When students analyze scientific data from observations of a scientific phenomenon, students have carried out activities to find out, identify variables, and look for differences between variables. When students interpret scientific evidence and formulate conclusions,

* Corresponding Author: zuryathee@gmail.com

students have used specific patterns to explain scientific phenomena according to scientific concepts (Harlen et al., 2003). Thus, students have carried out the process of seeking and finding scientific knowledge, scientific investigations, problem-solving, and decision-making related to scientific problems (Limatahu & Mubarok, 2020; Dianty et al., 2020).

The skill of interpreting and reasoning about scientific data and evidence is one of the scientific literacy needed in scientific investigation (Winata et al., 2017). It helps students in logical and scientific thinking (Adikalan et al., 2022). Interpreting and reasoning about scientific data is part of scientific literacy obtained from understanding science and applying science to solve problems and observe scientific phenomena related to everyday life. Data interpretation skills can increase attitude and high sensitivity to oneself and the surrounding environment in making decisions based on scientific considerations. Students' skills in interpreting and reasoning scientific data and evidence need to be developed because scientific information in today's global era is often presented in graphs, tables, and images, so interpretation skills are required to interpret scientific information (Sarah et al., 2020).

Although students need the ability to interpret and reason about scientific data, the existing conditions show that students still lack mastery of these abilities. The study results show that students are still weak in interpreting data and providing scientific explanations (OECD, 2019). Students are less able to solve problems related to science process skills (Mahcepat et al., 2019), including skills in interpreting data and providing scientific explanations (Harrison, 2014; Karmila et al., 2019; Rani et al., 2019), so that they are less able to connect science content with its application in everyday life (Sofyan et al., 2017). The results of other studies show that students' abilities to interpret and evaluate data are still in the poor category (Suryadi et al., 2021). This happens because many teachers have not applied learning and assessment to the ability to interpret data and scientific evidence (Rahmawati et al., 2014; Yanti et al., 2020). In addition, the power of teachers to design appropriate assessment tools still needs to be developed (Sarah et al., 2020). These problems require a solution, both from the aspect of students and teachers in the implementation of learning. On the student aspect, the learning process needs to be designed to facilitate students' active learning, both physically and mentally, and involve many activities dealing with scientific data processing.

Efforts to develop students' abilities in interpreting and reasoning scientific data have been carried out in several previous studies but are still experiencing various obstacles. The learning process that facilitates students in science activities by utilizing virtual-based science tasks has not been optimally able to develop students' abilities in interpreting data (Harahap et al., 2019). Implementing problem-based learning models in learning has not optimally designed students' abilities to solve information or data (Pradasti et al., 2019; Nasir et al., 2019). Rani et al. (2017) tried to develop unique worksheets designed to improve science process skills, but students' abilities in classifying data and interpreting information were still in the low category. The skills of analyzing and evaluating data must be developed through formal learning and assessment. One of the alternatives that can be applied is science learning which involves many students in science activities, both physically and mentally (Huppert et al., 2002). Science learning can occur optimally if it consists of many students doing physical practice because science is related to actual events in life.

For this reason, object-oriented physics learning is arranged to develop students' abilities in interpreting and reasoning physics data in this study. Physics learning is carried out by optimizing the activities of students dealing intensely with physics objects. Students are given the freedom to explore information, compile, analyze, and reason about data during the learning process. The learning design is expected to develop students' abilities in interpreting and reasoning about scientific data obtained from physics learning activities.

Method

This research is quasi-experimental research involving high school students as research subjects. The research design used was a pre-test – post-test control group design. In the experimental class, object-oriented physics learning is carried out where students dominate activities that deal with and interact with physics objects. In the control class, conventional physics learning was carried out by using direct learning. Respondents tested were high school students in class X. The research sample in the control group was students class of IPA-1, while in the experimental group, they were students class of IPA-4. The number of IPA-1 students was 38 students, consisting of 10 male students and 28 female students. The number of IPA 4 students is 38 students, consisting of 12 male students and 26 female students.

The physics learning process carried out in the experimental group was object-based physics learning within six sessions for two weeks with an allocation of three meetings a week, with each meeting lasting 90 minutes. The physics learning process is oriented to student activities where students deal with physics objects a lot, while in the control class group learning physics is carried out directly.

The data collection instrument in this study used pre-test and post-test questions in the form of essay tests. The score of the test results for the ability to interpret and reason about the data was obtained from the scores obtained from the pre-test and post-test results of students in solving problems of interpretation and reasoning about data. In this test, students are assigned to evaluate the physics concept of motion with four questions for data interpretation ability and four questions for data reasoning. The test results for the ability to interpret and reason about the data are assessed based on the scoring guidelines that have been made. The data analysis technique used is descriptive statistics and statistical analysis using different tests. Descriptive statistical analysis is based on the results of the central tendency analysis, including the number of students, the highest score, the lowest score, the average, and the standard deviation. The t-tests were conducted to determine whether object-oriented physics learning impacted the ability to interpret and reason physics data.

Result and Discussion

The pre-test and post-test results from 76 students of Public Senior High School 1 Jenggawah were divided into two groups, namely the control group (science class 1) and the experimental group (science class 4). In the control group, there are 38 respondents, and in the experimental group, there are 38 respondents. The average scores obtained from the students' pre-test and post-test results are presented.

Table 1. Interpretation and reasoning ability

Component	Interpretation		Reasoning	
Data	Control	Experiment	Control	Experiment
Number of Students	38	38	38	38
Highest Score	75	85	75	85
Lowest Score	50	60	50	70
Average	65.39	76.25	65.51	78.13
Deviation Standart	4.47	3.54	3.16	6.32

Based on these data, it can be explained that the ability to interpret the experimental group's data is higher than the control group. The average ability to interpret data in the experimental group was 76.25 and in the control group was 65.39. Likewise, with reasoning ability, the experimental group was higher than the control group. The average reasoning ability in the experimental group was 78.13 and in the control group was 65.51. The highest average is found in the reasoning ability of the experimental group.

The ability to interpret and reason about the data in the experimental group was higher than the control group. This shows that learning physics which involves a lot of student activities in interacting with physics objects, has a positive effect on the learning process. Students will have more physical and mental activities to construct knowledge by interacting with physical objects. Students optimally carry out the stages of the thought process in building knowledge according to the physics object at hand. Physics learning that has been applied affects students' ability to interpret and reason.

Table 2. Analysis of t-test of interpretation ability (One-Sample Test)

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Control Interpretation	71.716	37	0.000	65.39474	63.5471	67.2423
Eksperiment I Interpretation	69.320	39	0.000	76.25000	74.0251	78.

The results of the different test analysis on the ability to interpret data are shown in Table 2. The results of the study show that the 2-way (t-tailed) significance value is 0.000 < 0.05. Thus, there is a difference in the average ability to interpret data between the control and experimental groups. Based on the descriptive value, it can be seen that the experimental group has a higher average than the control group. This indicates that object-oriented physics learning positively affects students' abilities to interpret data.

Table 3. Analysis of t-test of reasoning ability (One-Sample Test)

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Control Interpretation	73.118	38	.000	65.51282	63.6990	67.3267
Eksperiment I Interpretation	97.099	37	.000	78.13158	76.5012	79.7620

The results of the analysis of the different tests on the reasoning ability data are shown in Table 3. The analysis results show that the 2-way (t-tailed) significance value is 0.000 < 0.05. Thus, there is a difference in the average reasoning ability between the control and experimental groups. Based on the descriptive aspect, it can be seen that the experimental group has a higher average than the control group. This indicates that object-oriented physics learning positively affects students' abilities to make reasoning.

Object-oriented physics learning emphasizes actual events or phenomena in everyday life so that it triggers students to think critically in solving problems that occur. Students' curiosity increases by seeing physical phenomena and interacting directly with physics objects. When observing a thing that the teacher has presented, students try to synchronize the physics problems given by the teacher with the objects they see. Students learn physics based on phenomena or actual events in everyday life. When learning takes place, students are given problems related to physical phenomena or events so that students try to solve related issues by involving data interpretation and reasoning about the data.

Physics objects that students face can be in the form of natural phenomena related to events definitely. Physical events can be presented in a simple form and associated with the activity of interpreting and reasoning about data. Students can conduct research, experiment, measure, and present data systematically. One of the examples of a physics object that students frequently face is the implementation of events about motion. Students ride a motorcycle from home to school at a constant 15 km/hour speed, so students can analyze the dynamic quantities associated with this motion.

Another example is when students take the bus on their way to school, then suddenly stop and change to public transportation, then walk. Based on this incident, students must determine the data related to the magnitude of motion and analyze and interpret the data obtained. Everyday events can be interpreted and reasoned by students in learning physics.

Conclusion

Based on the results of the data analysis, several conclusions can be formulated. Object-oriented physics learning has a significant effect on the ability to interpret and reason. Students deal directly with physics objects and solve problems based on the objects they see during the learning process. Based on the results of these studies, some suggestions can be given. In physics learning, teachers should involve their students a lot in solving physics problems close to students' lives. Teachers should provide many opportunities for students to interact with physical objects and events when solving problems. For physics learning in the classroom to occur contextually, it is necessary to prepare adequate facilities and infrastructure.

References

Adikalan, T. H., Supeno, & Wicaksono, I. (2022). Kemampuan inkuiri siswa SMP dalam pembelajaran IPA memanfaatkan media E-LKPD. *Jurnal Ilmu Pendidikan*, *22*(1), 39-45. https://doi.org/10.24036/pedagogi.v22i1.1271

Dianty, A. P., Supeno, dan Astutik, S. (2020). Kemampuan decision making siswa SMA dalam pembelajaran fisika berbasis inkuiri terbimbing. *Jurnal Pembelajaran Fisika*, *9*(1), 1-10. https://doi.org/10.19184/jpf.v9i1.17935

Doyan, A., Susilawati, S., Hadisaputra, S., & Muliyadi, L. (2022). Effectiveness of quantum physics learning tools using blended learning models to improve critical thinking and generic science skills of students. *Jurnal Penelitian Pendidikan IPA*, *8*(2), 1030–1033. https://doi.org/10.29303/jppipa.v8i2.1625

Elmas, R., Bodner, G. M., Aydogdu, B., & Saban, Y. (2018). The inclusion of science process skills in multiple choice question: are we getting any better?. *European Journal of Science and Mathematics Education*, *6*(1), 13-23. https://doi.org/10.30935/scimath/9519

Harahap, F., Nasution, N. E. A., & Manurung, B. (2019). The effect of blended learning on student's learning achievement and science process skills in plant tissue culture course. *International Journal of Instruction*, *12*(1), 521-538. http://dx.doi.org/10.29333/iji.2019.12134a

Harlen, W. (2000). *Teaching, Learning, & Assessing Science 5-12*. London: Paul Chapman Educational Publishing.

Harlen, W., Macro, C., Reed, K., & Schilling, M. (2003). *Making Progress in Primary Science: A Guide for Teachers and Student Teachers*. London: Routledge Falmer

Harrison, C. (2014). Assessment of inquiry skills in the SAILS project. *Science Education International*, *25*(1), 112-122.

Huppert, J., Lomask, S. M., & Lazarowitz, R. (2002). Computer simulations in the high school: Students' cognitive stages, science process skills and academic achievement in microbiology. *International Journal of Science Education*, *24*(8), 803-821. https://doi.org/10.1080/09500690110049150

Karmila, D. D., Supeno, & Subiki. (2019). Keterampilan inkuiri siswa SMA dalam model pembelajaran inkuiri berbantuan virtual laboratory. *Jurnal Pembelajaran Fisika*, *8*(3), 151-158. https://doi.org/10.19184/jpf.v8i3.15218

Kurniawan, Y. (2018). The Enhancement of consistency of interpretation skills on the newton's laws concept. *Jurnal Ilmu Pendidikan Fisika*, *3*(1), 28-30. https://dx.doi.org/10.26737/jipf.v3i1.411

Limatahu, I., & Mubarok, H. (2020). CCDSR Learning Model: Innovation in physics learning. *International*

Journal of Recent Educational Research, *1*(1), 19-29. https://doi.org/10.46245/ijorer.v1i1.13

Luedo, M., Supeno, & Maryani. (2021). Kemampuan interpretasi grafik siswa sekolah swasta di Thailand Selatan pada materi kinematika gerak dalam pembelajaran fisika. *Jurnal Penelitian Pendidikan Fisika*, *6*(2), 132-136. Retrieved from http://ojs.uho.ac.id/index.php/JIPFI/article/view/16409

Nasir, M., Fakhrunnisa, R., & Nastiti, L. R. (2019). The implementation of project-based learning and guided inquiry to improve science process skills and student cognitive learning outcomes. *International Journal of Environmental & Science Education*, *14*(5), 229-238. Retrieved from http://www.ijese.net/makale/2118.html

OECD. (2019). *PISA 2018 Results (Volume I): What Students Know and Can Do*. Paris: OECD Publishing.

Pradasti, K. Z., Susilowati, S. M. E., & Martin, F. P. (2019). The effectiveness of problem based learning model on virus material of senior high school on science process skills and student learning outcomes. *Journal of Biology Education*, *8*(3), 266-278. https://doi.org/10.15294/jbe.v8i3.30084

Rahmawati, D., Nugroho, S. E., & Putra, N. M. D. (2014). Penerapan model pembelajaran kooperatif tipe numbered head together berbasis eksperimen untuk meningkatkan keterampilan proses sains siswa SMP. *Unnes Physics Education Journal*, *3*(1), 40-45. https://doi.org/10.15294/upej.v3i1.3109

Rani, I. M., Hidayat, S., & Fadillah, E. N. (2019). Analisis keterampilan proses sains peserta didik SMA Kelas X di Kecamatan Seberang Ulu I dan Kertapati Palembang. *Jurnal Biologi dan Pembelajarannya*, *6*(1), 23-31. https://doi.org/10.29407/jbp.v6i1.12515

Rani, S. A., Wiyatmo, Y., & Kustanto, H. (2017). Concept attainment worksheet to enhance concept knowledge and science process skills in physics instruction. *Jurnal Pendidikan IPA Indonesia*, *6*(2), 326-334. https://doi.org/10.15294/jpii.v6i2.10520

Sarah., Wulan, A. R., & Kusnadi. (2020). Needs Analysis on Developing Instruments of Interpreting Data Skills and Scientific Evidence for Biology Learning in the 21st Century Era. *In The 4th International Conference on Education and Multimedia Technology,* pp. 188-192.

Sofyan, M.A., Wasis, W., & Ibrahim, M. (2017). Pengembangan perangkat pembelajaran berdasarkan masalah berbasis edutainment untuk melatihkan kreativitas siswa SMK Jurusan Otomotif pada materi fluida statis. *Jurnal Penelitian Pendidikan Sains*, *7*(1), 1431-1440. https://doi.org/10.26740/jpps.v7n1.p1431-1440

Suryadi., Mahardika, I.K., Supeno., & Sudarti. (2021). Data literacy of high school students on physics learning. *Journal of Physics: Conference Series*, 1839 (2021), 012025. https://doi.org/10.1088/1742-6596/1839/1/012025

Winata, A., Cacik, S., & Seftia, R. W., I. (2017). Analisis kemampuan awal literasi sains mahasiswa pada konsep IPA. *Education and Human Development Journal*, *1*(1), 40–47. https://doi.org/10.33086/ehdj.v1i1.291

Yanti, L., Miriam, S., & Suyidno. (2020). Mengembangkan keterampilan proses sains peserta didik melalui creative responsibility based learning. *Jurnal Penelitian Pendidikan Sains*, *9*(2), 1790-1796. https://doi.org/10.26740/jpps.v9n2.p1790-1796