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The Influence of Inquiry-Based Learning Model on Scientific Literacy in the Rotational Dynamics of a Rigid Bodies

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Abstract: This study aims to determine the influence of the Inquiry-Based Learning model on students' scientific ability in Rotational Dynamics of a Rigid Bodies. This influence is seen from whether or not students can achieve the criteria of completeness by mastering three PISA (Program for International Student Assessment) indicators in 10 items on the test consisting of two questions to identify scientific problems, five question to explain phenomena scientifically, and three questions to interpret data and scientific evidence. The research method applied is the experimental method and uses the One Group Pretest-Posttest Design as a research design involving 4 classes, where 1 class acts as the experimental class and 3 classes as the replication class. Based on the statistical results of the t-test to test the research hypothesis, the t-count value for each sample class is greater than the t-table value. This shows that the use of the Inquiry-Based Learning learning model has an effect on students' scientific literacy abilities in the rotational dynamics of a rigid bodies.

Keywords: Inquiry based learning; Physics learning; PISA; Science literacy

Introduction

Physics is one of the compulsory subjects in the 2013 curriculum and allows students to develop analytical and inductive critical thinking skills. Physics learning activities are carried out by exploring, experimenting, and solving problems to explain various phenomena encountered in everyday life. The research activities carried out are designed to provide opportunities for students to obtain information and facts about the core competencies covered in the curriculum. Experimental activities are carried out in the laboratory to prove or discover concepts and principles based on basic skills. Physics subjects cannot be separated from these two activities, therefore students are required to think scientifically based on scientific methods (Usmeldi, 2016).

The way to develop analytical and problem-solving skills in learning physics is to improve students' basic scientific literacy skills. According to Zulaiha et al. (2021), scientific literacy is defined as the ability to understand scientific concepts and processes and use science to solve everyday problems or the ability to use scientific knowledge, define questions scientifically, draw conclusions based on scientific knowledge, change human nature and behavior as a result of human activity, and make decisions (Abdjul et al., 2022; Amali et al., 2023; Ntobuo et al., 2023).

One of the programs used to measure students' scientific literacy level is the PISA survey. In Pusat Penelitian Kebijakan (2021) PISA or Program for International Student Assessment conducted by the Organization for Economic Co-operation and Development (OECD), is an international survey conducted to measure the basic scientific literacy of 15-year-old students such as reading mathematics and natural sciences. The PISA survey not only reports literacy rates for each country, but also provides information on demographics, habits, understanding, and expectations obtained from survey data on schools and students.

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Indonesia has participated in PISA since 2001. Since that time, performance in science has fluctuated but remained flat overall. Some 40% of students in Indonesia attained Level 2 or higher in science (OECD average: 78%). At a minimum, these students can recognise the correct explanation for familiar scientific phenomena and can use such knowledge to identify, in simple cases, whether a conclusion is valid based on the data provided. In Indonesia, a negligible percentage of students were top performers in science, meaning that they were proficient at Level 5 or 6 (OECD average: 7%). These students can creatively and autonomously apply their knowledge of and about science to a wide variety of situations, including unfamiliar ones (OECD, 2019).

The low scientific literacy ability of Indonesian students is generally caused by a lack of learning activities that aim to develop scientific literacy. Zulaiha et al. (2021) shows that the low ability of scientific literacy of Indonesian students is influenced by the curriculum and education system, the selection of learning methods and models by teachers, teaching tools and equipment, and teaching materials. It is necessary to emphasize again that scientific literacy does not mean that students must only master science subjects. But how students can think and act based on the scientific method. When faced with a problem, students use the scientific method to solve the problem or their solution model follows a scientific path. This statement agrees with Hafizah et al. (2021) that the selection of a learning model is one of the factors in designing learning activities that can optimally achieve the foundation of students' scientific literacy.

One learning model that can potentially increase scientific literacy is an inquiry-based learning model. According to Putri et al. (2019) Inquiry Based Learning model is a learning process that allows students to form their own knowledge. By applying this learning model, students become active, creative, independent learners, so that learning is student-centered.

Inquiry Based Learning model is a process in which students are trained to actively participate in learning, formulate questions, conduct extensive research, produce new understandings, and understand to build knowledge. This knowledge is new to students and can be used to solve existing problems, develop ways of solving problems, and strengthen situations and opinions (Payu et al., 2023; Putri et al., 2019).

This research is relevant to the research conducted by Shalehah (2022), the difference is with this study, uses a replication class to see the consistency of the results after being given treatment in the experimental class. In the research results, there is an N-gain test that aims to categorize the magnitude of the increase in scientific literacy from each PISA indicator that is implemented in the research instrument.

Method

This study used an experimental method with a research design using the One Groups Pretest-Posttest Design. The research subjects consisted of 1 experimental class and 3 replication classes. The experimental class means the class that is given the treatment. The use of a replication class is because all classes are homogeneous, so it is necessary to repeat the treatment from the experimental class which aims as reinforcement to see the consistency of the results obtained in the experimental class. The pretest is given to determine students' initial scientific literacy skills while the posttest is to determine the final result of whether there is an increase in scientific literacy skills. This method makes it easier for researchers to know that there is an influence of the Inquiry Based Learning model in increasing scientific literacy. The design can be seen in Table 1.

Table 1. Research Design

Class	Pretest	Treatment	Posttest
Experiment	O_1	X	O_2
Replication 1	O_1	X	O_2
Replication 2	O_1	X	O_2
Replication 3	O_1	X	O_2

The population in this study were all students of class XI IPA at SMAN 1 Gorontalo in the odd semester of the 2022/2023 school year with a total of 249 students divided into seven classes. Of the seven classes, four classes will be selected to serve as research samples using the Cluster Random Sampling Technique. This technique is used because the object to be studied or the data source is very broad Sugiyono (2018). The samples selected were XI MIPA 1 as the experimental class and XI MIPA 4, XI MIPA 5, and XI MIPA 3 as the replication class.

Data analysis techniques apply inferential statistical techniques, namely techniques used to analyze all sample data and the results are applied to the population (Sugiyono, 2017). Data processing in this study consisted of a Normality test using the Chi-Square testhypothesis test with t test statistic, and N-gain test.

Learning Scenario

Learning will be carried out in four meetings with the subject of Rotational Dynamics of a Rigid Bodies. The initial meeting was given a pretest in the form of 10 questions containing 3 PISA indicators in them, namely identifying scientific problems, explaining phenomena scientifically, and interpreting data and scientific evidence to students in order to find out their initial level of scientific literacy on the material Rotational Dynamics of Rigid Bodies. Then the second and third meetings, the process of teaching and learning activities will be carried

out in accordance with the steps of the Inquiry Based Learning model whose learning indicators are also developed from 3 PISA indicators. At the end of the fourth meeting, the researcher will distribute the post-test to students to see the increase in students' scientific literacy skills on the subject of Rotational Dynamics of a Rigid Bodies.

Result and Discussion

Scientific literacy skills cover the field of Natural Sciences, one of which is glasses, which play an important role in the advancement of science and technology. Developing students' expertise in the physical aspect is one of the keys to success in increasing skills in self-introduction to entering the world of technology (Indrawati, 2018). According to (Millenia et al. (2022) through subject matter students can improve their skills in inductive and deductive analytical reasoning in solving problems related to surrounding natural events. So according to Nuayi (2020) based on this, in learning physics it is not enough to learn from books or hear explanations from other people, but must go through a process of scientific inquiry. The activities of students during the research are shown in Figure 1 and Figure 2.

Figure 1. Worksheet part one

Figure 2. Worksheet part two

This study, 4 classes were used, namely 1 experimental class and 3 replication classes. The replication class will further strengthen the results obtained in the experimental class (Muflikah et al., 2019). The treatment concept presented in this study uses the Inquiry-Based Learning model by implementing the PISA indicators in the learning indicators as well as the research instruments and the treatment is applied equally to the four sample groups. The learning indicators that will be measured in this study also refer to indicators of science process skills with the data collection instruments used in this study in the form of test questions (Nuayi, 2020).

This study uses the average, standard deviation, and variance as statistical tests for quantitative data dispersal, and is obtained based on the results of calculating the value of each sample group. The following calculation of avarage can be seen in Table 2.

Table 2. Results of Avarage

Class	Pretest	Posttest
Experiment	34.33	87.23
Replication 1	37.01	85.37
Replication 2	36.71	82.76
Replication 3	37.68	82.41

Based on the results of the average pretest score, it shows that students' initial scientific literacy ability by implementing the PISA framework is still very low. As stated by Adriani et al. (2018) even though the form of the questions was simple, student responses showed that understanding of basic scientific concepts was still weak, and the ability to apply and interpret data decreased. With alternative answers, students can answer confidently. This may be caused by the weak ability of students to express the contents of certain discourses and interpret data in the form of images, graphics and other forms of presentation. In addition, there are limitations to students' ability to express thoughts in writing, students' reasoning is still very weak, and students are not used to combining and then expressing information in text form answer the question in a new form of expression. Meanwhile, according to Dewi et al. (2018) the average posttest value that exceeds the pretest value in the experimental class and replication class shows that students have the ability to make connections between science, technology, and the environment.

Based on data analysis for the four sample groups through statistical testing, data normality was obtained for class XI MIPA 1 as the experimental class with a normal distribution because the value x^2_{count} is smaller than the price x^2_{table}. Likewise, for the three replication classes XI MIPA 4, XI MIPA 5 and XI MIPA 3 each has a x^2_{count} price lower than the x^2_{table} price, then the distribution of data statistical values can be declared normal distribution. So it can be concluded that all data statistical values of normality for the pretest and posttest of the experimental class and replication have normal

criteria. The following are the average results of the Chi Square Test, which can be seen in Table 3.

Table 3. Average Results of the Chi Square Test

Class	x^2_{count}		x^2_{table}
	Pretest	Posttest	
Experiment	34.06	29.7	48.6
Replication 1	5.35	33.8	47.4
Replication 2	16.51	18.7	43.7
Replication 3	32.5	32.5	46.1

Table 4. Average of t Test Value

Class	t Test Value	
	t_{count}	t_{table}
Experiment	15.69	1.691
Replication 1	10.24	1.692
Replication 2	9.45	1.697
Replication 3	9.36	1.694

The problems that are often faced by researchers are often related to drawing conclusions based on data regarding a scientific system. Each issue should involve using experimental data and drawing conclusions based on official data. The data for each experiment or problem requires an estimate. Estimation can be formulated in the form of a statistical hypothesis (Sianturi, 2022).

In the results of testing the hypothesis, it is known that t_{count} is greater than the t_{table} value for all sample groups, both the experimental class and the replication class. This value is obtained by comparing the average sample for each class with the passing grade and also from the percentage of post-test scores obtained by students. The description of the analysis of this hypothesis can be concluded that $H_0$is accepted, where after receiving treatment, namely applying the Inquiry Based Learning model with the implementation of the PISA framework in the test can have an influence on students' scientific literacy skills in the rotational dynamics of a rigid bodies. So there is no difference in value between the experimental class and the replication class after being given the same treatment based on one learning device reference, it turns out that if given the same treatment it will give the same results although not identical. Whereas for students who only get grades according to or not far from the passing grade this is because some students pay less attention to learning and also the inactivity of students in groups.

In accordance with research on the effect of the Inquiry Based Learning model on scientific literacy skills conducted by Aulia (2019) stated that the scientific literacy abilities of the experimental class during the pretest and posttest showed differences in students' scientific literacy skills before and after the application of the Inquiry Based Learning model (IBL). The results of students' scientific literacy abilities after being given the IBL learning model were better than before, this was indicated by the performance scores of students' scientific literacy index in the control class and the experimental class increased from 33.95% to 82.35% (control class) and 32.40% to 89.86% (control class) experiment). This shows that the IBL has an effect on students' scientific literacy abilities.

Table 5. Average Value of Each Indicator

Class	Indicator 1	Indicator 2	Indicator 3
Experiment	0.81	0.72	0.90
Replication 1	0.64	0.70	0.89
Replication 2	0.51	0.48	0.80
Replication 3	0.63	0.58	0.78

The final test is the N-gain test. This analysis aims to categorize the magnitude of the increase in scientific literacy from each PISA indicator that is implemented in the research instrument. Then, according to Jelita et al. (2022) the N-gain test was carried out to see the difference between the pretest and posttest treatments of the experimental class. Referring to the N-gain index category according to Hake (1998) if $g > 0.70$ has high criteria, $0.30 < g < 0.70$ is medium criteria and for $g < 0.30$ is low criteria. The overall average result of the gain value for each PISA indicator for the experimental class and the replication class received high criteria, which means that by using the PISA indicator in the test there is a significant increase in scientific literacy skills. In research by Asyhari et al. (2015) explained that there is a common thread in the PISA indicator in increasing scientific literacy skills. The study found that the problems examined using test questions were problems students encountered in their daily lives. Through these problems, students acquire basic scientific literacy skills in the form of the ability to recognize scientific problems. The studied problem is solved through a series of information searches that help to find a solution to the problem of the phenomenon presented. The findings from information gathering activities can develop students' scientific literacy skills in the form of their ability to use scientific evidence. Through scientific evidence and findings, students can also develop their scientific literacy skills in explaining scientific phenomena. Students' ability to identify scientific issues, explain scientific phenomena, and interpret scientific data and evidence can be further developed through teacher-led class discussion activities, in which students give opinions orally and in writing about their group's findings in the form of working on worksheets.

Conclusion

Based on the research results, it can be concluded that learning that substitutes the PISA framework in learning indicators and research instruments, and also uses the Inquiry Based Learning model in teaching and learning activities, is a collaboration that is quite

harmonious in improving students' scientific literacy skills, as well as having a significant influence on development of student learning outcomes. This is evidenced by the technique of testing the hypothesis through the t statistical test, the value of t count is smaller than the t table, which means that the average value of the experimental class (XI MIPA 1) with replication class 1 (XI MIPA 4), replication class 2 (XI MIPA 3), and replication class 3 (XI MIPA 5) exceeds the passing grade at school, so when compared the three sample groups are declared consistent, and show that the same treatment will show the same results.

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