The effectiveness of inquiry lesson-based digestive system materials for training students' science literacy ability

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Abstract

Learning biology needs to seek the formation of students who have scientific literacy skills. This ability is closely related to understanding science in everyday life. This study aims to analyze the increase in scientific literacy skills by implementing inquiry lesson-based worksheets on the material of the human digestive system. The research method used was quasi-experimental with a non-randomized control group pre-test and post-test research design. Participants are two classes XI MIPA. The sampling technique is cluster random sampling. That is, two classes XI MIPA were randomly selected. Classes XI MIPA 5 and XI MIPA 6, each consisting of 32 students, where one was the control class and the other was the experimental class. Data were obtained using 10 PISA frameworks scientific literacy questions in the form of valid and reliable multiple choice questions. The results showed a significant difference, as evidenced by the results of hypothesis testing with Sig. (2-tailed) = 0.000 < 0.05, then H0 rejected and Ha accepted. There is a difference in t-count experimental class and t-count where is the control class t-count the experimental class is greater than t-count the control class is 53.82 > 21.997 so that the scientific literacy abilities of students from the two classes have significant differences.

Abstrak

Pembelajaran biologi perlu mengupayakan terbentuknya peserta didik yang memiliki kemampuan literasi sains. Kemampuan ini erat hubungannya dengan pemahaman sains di dalam kehidupan sehari-hari. Penelitian ini bertujuan untuk menganalisis peningkatan kemampuan literasi sains melalui implementasi LKPD berbasis *Inquiry Lesson* pada materi sistem pencernaan manusia. Metode penelitian yang digunakan yaitu *quasi eksperimental* dengan desain penelitian *Pre-test and Post-test Non-randomized Control Group*. Partisipan merupakan dua kelas XI MIPA. Teknik penarikan sampel menggunakan *cluster random sampling*, yaitu dipilih secara acak dua kelas XI MIPA. Kelas XI MIPA 5 dan XI MIPA 6 yang masing-masing terdiri dari 32 peserta didik, dimana salah satu sebagai kelas kontrol dan yang lain sebagai kelas eksperimen. Data diperoleh dengan menggunakan soal literasi sains berframework PISA berjumlah 10 dengan bentuk soal pilihan ganda yang telah valid dan reliabel. Hasil penelitian menunjukkan perbedaan yang signifikan dibuktikan melalui hasil uji hipotesis dengan Sig. (2 tailed) = 0,000 < 0,05, maka H0 ditolak dan Ha diterima. Terdapat perbedaan pada t-hitung kelas eksperimen dan t-hitung kelas kontrol dimana t-hitung kelas eksperimen lebih besar dari t-hitung kelas kontrol yaitu 53,82 > 21,997, sehingga kemampuan literasi sains peserta didik dari kedua kelas tersebut memiliki perbedaan yang signifikan.

A. Introduction

Science education is currently directed at increasing the competencies students need to develop themselves for further learning and living in a society in various situations. Students need to be equipped with 21st-century skills to ensure competitiveness in the globalization era. The abilities that are important for students to master in the 21st century today are scientific literacy and numeracy literacy (Fuadi et al., 2020). Scientific literacy is not the ability to understand the universe but a person's ability to use scientific knowledge and its processes to make decisions and use them. Students need to master scientific literacy so they know how to understand the environment, economy, health,

Through scientific literacy, students can use their scientific knowledge to deal with problems related to science problems in everyday life (Rusilowati, 2019). Students who can understand scientific facts and the relationship between science, technology, and society can apply their knowledge to solve real-life problems and are called scientifically literate people (Wulandari & Raharjo, 2018). Given the importance of scientific literacy, educators must improve their ability to determine the right learning strategy. The learning approach used as a standard learning process is scientific learning with the inquiry method, which includes observing, asking, processing, presenting, concluding, and creating. From the findings above, several problems can be identified that make students from various levels of education still unable to master scientific literacy to the fullest such as a learning process that is not open-minded in seeking knowledge and overcoming problems that occur around them (Mijaya et al., 2019). Low scientific literacy is also caused by students' lack of readiness to take part in learning (Kuswanto et al., 2021).

Inquiry learning in scientific literacy emphasizes achieving a scientific attitude in students from the learning outcomes (Daniah, 2020). The learning to increase scientific literacy for students involves developing attitudes, expanding ideas, and science process skills with scientific inquiry activities (Semilarski & Laius, 2021). Appropriate learning approaches or models can increase scientific literacy in science learning (Payu et al., 2023). The inquiry model is considered the center or core of science learning, allowing students to use science to find answers to problems that occur (Daniah, 2020). The learning process will trigger inquiry skills by directly involving students, one of which is the ability to find solutions to problem-solving (Avikasari et al.,

2018). The inquiry lesson is a student-centered learning model, providing opportunities for students to develop learning activities and train students scientific thinking skills (Andika & Yudiana, 2022). Learning models that can be used in scientific training literacy are inquiry lesson learning which aims to measure students' scientific literacy skills in the form of personal abilities in understanding the learning objectives to be achieved, thinking processes, and interpreting data (Fadilah et al., 2020). The inquiry lesson stage is a transitional stage from interactive demonstration to inquiry lab, where teacher involvement is still needed in learning. At this stage, students carry out guided inquiry activities,

Based on preliminary studies and interviews, one of the teachers stated that he had not used the Student Worksheet (LKPD), which was integrated with the stages of the learning model to guide students' activities when learning the human digestive system. When studying, he always gives questions related to everyday life so that students are trained to analyze information in the surrounding environment with explored concepts. However, students' ability is still challenging to analyze data and answer questions given by the teacher. In addition, the ability to analyze the information possessed by students is still low. One of the Biology class XI materials studied is the digestive system.

Students are expected to be able to analyze problems or contextual information about the digestive system and relate it to phenomena or symptoms associated with the digestive system during the learning process. Therefore, learning the digestive system requires worksheets that can practice the learning process. The LKPD used generally contains a summary of some material and discussion questions but few activities that can encourage students to reconstruct their knowledge. LKPD criteria are influenced by its construction and content load information that is essential to train the ability to understand phenomena scientifically as a form of learning strategy for student inquiry in the classroom (Ayu, 2020).

Based on research conducted by Dewi et al. (2020) states that LKPD is effective in increasing scientific literacy skills with an average N-gain value of 0.7 in the high category, research by Novita et al. (2021) got an N-gain of 0.8 in the high category, and also Phabchai et al. (2018) get an N-gain of 0.36 in the medium category. These studies are one of the efforts to improve students' scientific literacy in environmental pollution. Before conducting research, it is necessary to study the

literature on relevant previous studies so that future research has an overview of the research problem and is able to relate it to current needs to push students' scientific literacy abilities.

The LKPD based on inquiry lessons is LKPD which contain the inquiry stage to facilitate students' scientific literacy skills, one of which is to analyze phenomena scientifically. Research conducted by Wulandari & Raharjo (2018) shows that the achievement of learning indicators on protist material after using inquiry-based worksheets with a scientific literacy framework is 82.81% in the complete category.

The effort to support the implementation of each stage of the inquiry lesson requires an appropriate learning media. Of the various types of media, LKPD is included in printed learning media that teachers can use in learning. LKPD can be used as a learning medium to improve learning outcomes and students' critical thinking skills (Fadilah et al., 2020). Inquiry learning can train students' scientific literacy skills by applying contextual learning in LKPD so that students' understanding will be closely related to everyday life (Rini et al., 2021). The inquiry lesson stage is used as the basis for compiling activities in LKPD that are used in identifying problems and building problem-solving skills so his knowledge can be reconstructed more thoroughly (Wiwi et al., 2022).

The inquiry-based LKPD on plant material he developed effectively improved student learning outcomes (Izzatunnisa et al., 2019). At the inquiry lesson level, the teacher shows the scientific process indirectly to students to understand how to formulate an experiment, plan an investigation, identify control variables, and make hypotheses. Students are directed to scientific activities with direct guidance from the teacher (Wenning, 2010). Inquiry lesson-based LKPD specifically developed on the Digestive System material is expected to help students increase scientific literacy through independent learning in finding concepts using inquiry lesson-based LKPD.

Apart from learning models, learning resources can also be used to support student learning activities in class, such as using LKPD as a guide for student learning activities and goals (Semilarski & Laius, 2021). The purpose of using teaching materials is to help and facilitate students in learning through various forms and increase interest in learning activities (Prastowo, 2012). LKPD based on inquiry lessons is expected to support student involvement in learning activities. So inquiry-based learning is expected to be able to bridge thinking skills and science attitudes as students' scientific literacy (Rewalino et al., 2020).

LKPD based on inquiry lessons is LKPD which contain the inquiry stage to facilitate students' scientific literacy skills, one of which is to analyze phenomena scientifically. Research conducted by Wulandari & Raharjo (2018) shows that the achievement of learning indicators on protist material after using inquiry-based worksheets with a scientific literacy framework is 82.81% in the complete category.

Based on the descriptions above, against the background of low scientific literacy skills, one effort can be made to apply the inquiry model with the inquiry lesson type. LKPD guides the learning stages based on inquiry lessons. The results of inquiry research aimed at developing scientific literacy skills have not yet integrated their learning activities with LKPD, so based on the findings above, LKPD based on inquiry lessons to train scientific literacy skills needs to be applied theoretically and empirically to the digestive system material.

B. Material and Method

The research method used was a quasi-experimental design of the Pre-test and Post-test Non-randomized Control Group. The sample in this study was cluster random sampling which randomly selected two XI MIPA classes to take data samples, with the specifications for the Experiment class being XI MIPA class and the control class being XI MIPA 6 class. The research design is presented in Table 1.

Table 1 Pre-test and Post-test Non-randomized Control Group

Group	Pre-test	Independent Variable	Post-test
E	Y1	X	Y2
C	Y1	O	Y2

Information:
Y1 = Pre-test
Y2 = Post-test
X = Experimental Class applied by LKPD based on Inquiry Lesson
O = Control Class applied by LKPD is not based on Inquiry Lesson

The researcher collected data on students' scientific literacy through a Pre-test by giving treatment in the form of learning the human digestive system with inquiry lesson-based worksheet media, then collecting Post-test data after the learning was finished. LKPD is developed by following the steps for preparing LKPD, namely analyzing essential competencies, compiling a map of needs, determining titles, and writing/composing LKPD. Before the instrument is used in the study, the LKPD feasibility test is

carried out by expert judgment or validation. The instrument used in this study was a scientific literacy test instrument, in the Pre-test and Post-test using an objective test of multiple choice of 10 questions. Scientific literacy questions are made based on scientific literacy knowledge competencies in the 2015 PISA framework developed by the OECD (2016) using the context of problems regarding the body's energy needs and balance, nutritional content in food, the structure of organ functions and disorders or diseases of the human digestive system. Before being used in research, test instruments have been tested to meet valid and reliable criteria.

C. Results and Discussion

The test was carried out twice, namely before the treatment (pre-test) and after the treatment (post-test), regarding the increase in scientific literacy skills from each indicator in the control group. The increase in scientific literacy skills in the control class is also presented based on the minimum and maximum scores in the Pre-test and Post-test in Table 2.

Table 2 Control Class Science Literacy Ability

Information	Min value	Max value	Average
Pre-test	50	66	58,62
Post-test	73	85	80

Based on Table 2, it can be seen that the literacy of students in the control class was not applied to the inquiry lesson-based LKPD. Based on the table, it can be seen that the average pre-test of students is 58.62 while the average post-test is 80. As for whether there is an increase in scientific literacy skills with a significant difference, it can be seen from the percentage of the average pre-test and post-test scores of the experimental class presented in Table 3**.**

Table 3 Experimental Class Science Literacy Ability

Information	Min value	Max value	Average
Pre-test	52	66	60,37
Post-test	81	94	88,21

After being given learning by using the module oriented to cyan literacy, the average score of the experiment class is more significant than the control class. From Table 3, it can be obtained that the Pre-test average is 60.37, and the post-test average is 88.21. In addition to the N-Gain test to see the increase in scientific literacy skills, the results from student tests, both Pre-test, and post-test, were analyzed using an assumption test. The normality test used in this study is the Liliefors test (L) with a significance level of $\alpha = 0.05$. Scientific literacy abilities were observed in both the control and class classes. Scientific literacy abilities were observed in both the control and class classes. The experiment as a whole increased, but the increase in the class experiment was much more significant than in the control class because the experiment class is a class that is given treatment using a module oriented towards scientific literacy. The results of the calculation of the control class Pre-test normality test are presented in Table 4.

Table 4 shows that L^2count $<$ L^2table is accepted in the experimental and control classes Ho. This means that with a significance level (α) of 5%, the class comes from a normally distributed population. Based on the normality test above, it can be proven that the data is normally distributed. This statistical analysis is used to assess data distribution in a group or variable to meet the assumptions required by other statistical analyses, such as homogeneity tests and hypothesis testing.

A homogeneity test is carried out to ensure that the groups being compared have a homogeneous variance. The homogeneity of variance was tested for the two groups of Pre-test and post-test data using Fisher's test. The general homogeneity test results on the Pre-test and post-test data can be seen in Table 5.

Table 5 shows that the Pre-test and post-test data obtained a significance value of > 0.05, so Ha is accepted. With a significance level (α) of 5%, the Pre-test and post-test data in the experimental and control classes for each ability measured both have a homogeneous variance. The population being estimated must be homogeneous so that the measurement results are valid and accurate.

Based on the results of the normality and homogeneity tests of the pre-test and post-test data for the control class and the experimental class for the two dependent variables, it was found that the data were normally distributed and homogeneous so that the hypothesis testing could be continued. Hypothesis testing was carried out using the Paired T-Test, assuming that both variances were homogeneous (equal variance assumed) and had a significance level of 0.05.

This test aims to determine whether the two population means are identical (have the same variance) or not from the several samples observed. The results of the t-hypothesis test of students' scientific literacy abilities can be seen in Table 6.

Table 4 Normality Test Results

Analysis Data (experiments)	Pre-test	Post-test
L^2count	0.0566	0.0982
Significance level	5%	
L^2table	0.1562	
Conclusion	L^2count < L^2table	
	Data is normally distributed	
Data Analysis (control)	**Pre-test**	**Post-test**
L^2count	0.0726	0.0520
Significance level	5%	
L^2table	0.1562	
Conclusion	L^2count < L^2table	
	Data is normally distributed	

Table 5 Pre-test and Post-test Science Literacy Data Homogeneity Test Results

Levene Statistics	df1	df2	Sig.	
Science Literacy Results	1,571	33	124	.200
	1,251	33	124	.294
	1,251	33	115,613	.295
	1,588	33	124	.196

Table 6 Hypothesis Test of Students' Science Literacy Ability

t-table	2-tailed	t-count	Test criteria	Conclusion
Control **(1,998)**	0.000	21,977	t-count > t-table then H0 is rejected (Ha is accepted)	t-count > t-table
Experiment		53,582		t-count > t-table

Table 6 shows a significant difference between the pre-test and post-test to see t-table, and it is based on the degrees of freedom (dk), which is N-1, namely 32-1 = 31. The value of dk = 31 at the 5% significance level is obtained t-table that, is 1.998. Based on the results of the analysis of the Paired Sample T-test above, the data received is t-count greater than t-table that is 53,582 and Sig. (2-tailed) = 0.000 < 0.05, then H0 rejected, and Ha accepted.

Based on the analysis results of the Paired Sample T-test above, the data obtained is t-count greater than t-table that is 21,977 > 1,998 and Sig. (2-tailed) = 0.000 < 0.05, then H0 rejected, and Ha accepted. There is a difference between t-count the experimental class and t-count control class. The experimental class t-count is greater than the control class is 53.82 > 21.997, so it can be concluded that the experimental class using inquiry lesson-based worksheets has higher scientific literacy skills than learning in the control class and is effective in training students' scientific literacy abilities. The stages also influence students' scientific literacy abilities in the inquiry lesson, which can create a structured student flow of thought because, at each step, it starts from student questions as hypotheses, tests hypotheses, analyzes, concludes, and applies concepts. At the application stage, students are trained to be sensitive to scientific problems that occur in disorders of the human digestive system as well as solutions or efforts to solve problems.

The teacher presents various problems related to the concepts obtained at the verification and generalization stages as a process of interpretation ability until students can draw conclusions (Wenning, 2010). Therefore, based on the results of a comparison of students' average scientific literacy ability, it can be seen that the average ability of the experimental class shows significant results from the control class in the learning process. The achievement of scientific literacy skills in each activity in the LKPD during the learning process at each meeting is reviewed through the mean scores obtained by students in the experimental class presented in Figure 1.

Changes in the achievement of scientific literacy skills based on the learning process using inquiry lesson-based LKPD in the experimental class and the class above are influenced by the Inquiry lesson learning process. This process can be observed from the results of paired t-tests which show that there are fundamental differences in scientific literacy as a result of learning through the application of Inquiry Lesson-based LKPD, which is also proven through the results count the

experimental class is more significant than count the control class is 53.82 > 21.97.30 and a significance value < 0.05.
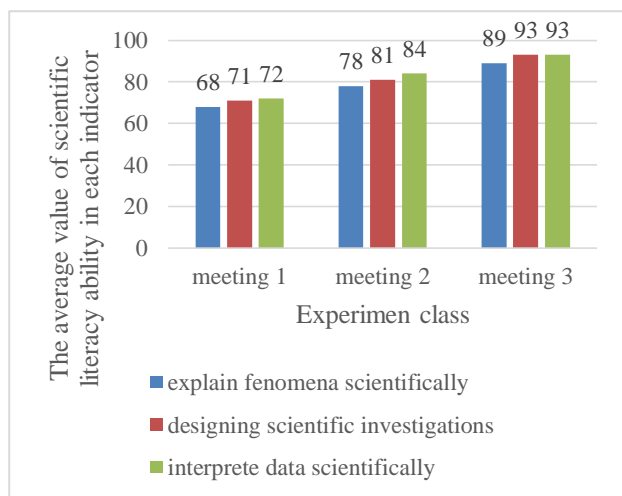

Figure 1
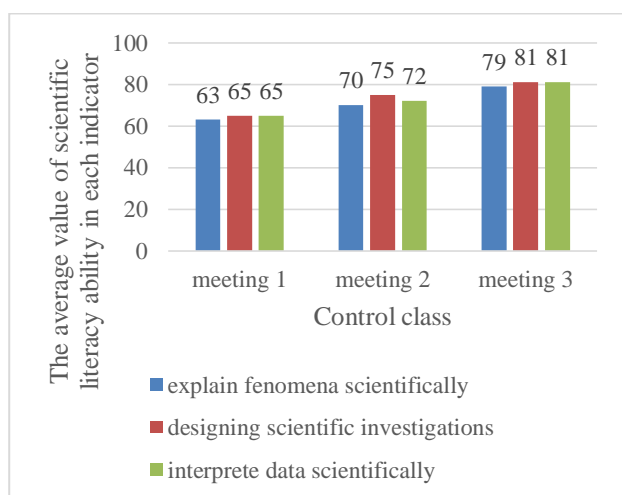Average achievement of scientific literacy ability of experimental class students

Figure 2
Average achievement of control class students' scientific literacy ability

The resulting increase in the experimental class was due to the influence of the inquiry learning process, which not only required students to know the concept, but students were also able to discover and apply concepts in everyday life. The learning process at each meeting is reviewed through the average value obtained by students in the control class presented in Figure 2.

Based on Figure 2, there is data showing that the achievement of each indicator of scientific literacy ability in the control class has also increased but not significantly. Improving scientific literacy skills in the control class that uses moderate criteria, it is assumed that students still

have difficulty thinking or expressing relationships between concepts and seen in the process, many students are still less responsive to the scientific phenomena given because it is influenced by the ability to ask questions in class very dependent on its ability to identify problems that are still low.

Differences in scientific literacy abilities obtained individually or in control class groups and experimental classes are assumed because, through inquiry lesson-based worksheets, participants are trained to find information from phenomena and problems given by the teacher. Therefore the involvement of students in the discovery process can increase their knowledge and minimize learning by rote, so it is hoped that they can train their inquiry abilities (Widowati et al., 2018). Learning whichapply a student-centered learning approach that will allow students to have the opportunity and facilitation to build their knowledge to gain a deeper understanding (Srikandi et al., 2021).

In line with the research of Semilarski & Laius (2021), the implementation of inquiry lesson-based worksheets can support student involvement in learning activities. So inquiry-based learning is expected to bridge thinking skills and science attitudes as students' scientific literacy (Rewalino et al., 2020). LKPD based on inquiry lessons is LKPD which contain the inquiry stage to facilitate students' scientific literacy skills, one of which is to analyze phenomena scientifically. Research conducted by Wulandari & Raharjo (2018) shows that the achievement of learning indicators on protist material after using inquiry-based worksheets with a scientific literacy framework is 82.81% in the complete category.

Other research regarding by Wiwi et al. (2020) explains that students' inquiry abilities can be developed with the inquiry learning model, inquiry lesson learning which can provide opportunities for students to investigate, find or find accurate sources to be able to answer their curiosity. Yohamintin & Huliatunisa (2023) in research on the implementation of inquiry learning, it is stated that the inquiry model is also a learning model which has an essential role in building student activities in education that will produce skills in basic science such as inquiry skills. Then research by Zahroh et al., 2021), LKPD based on guided inquiry is also widely used in several science lessons.

Based on the descriptions above, learning by applying LKPD, which is oriented towards scientific literacy, is one of the efforts that can be made to use the inquiry model with the inquiry lesson type. LKPD guides the learning stages based on inquiry

lessons. The results of inquiry research aimed at developing scientific literacy skills have not integrated their learning activities with LKPD, so based on the findings above, LKPD based on inquiry lessons to develop scientific literacy skills needs to be applied theoretically and empirically to biology material for class XI high school.

D. Conclusion

Based on the results of the research and discussion, it can be concluded that the use of inquiry lesson-based student worksheets in learning in the experimental class had a significant positive impact on increasing scientific literacy. Scientific literacy skills experienced a higher increase in the experimental class through the application of inquiry lessons and an increase with moderate criteria in the control class. The inquiry lesson learning model provides more optimal conceptual understanding than control class learning. This is because education is more effective in triggering students to construct their knowledge, so it is very suitable as an alternative to learning science, especially in achieving scientific literacy.

E. Acknowledgement

F. References

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