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Implementation of Interactive Learning Media on the Blood Circulatory System Towards Science Literacy

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Abstract: Scientific literacy is an important indicator in the implementation of science education, which must be integrated systematically at all levels of education. This study aims to investigate the differences in scientific literacy skills between classes taught using interactive learning media and those taught using conventional learning media, with a focus on the sub-topic of the circulatory system. Additionally, it aims to assess the changes in scientific literacy skills before and after the use of interactive learning media on the sub-topic of the circulatory system. The type of research employed was quasi-experimental, utilising a non-equivalent control group design with data collection techniques that included pretests and posttests of scientific literacy. These tests were used to evaluate the hypothesis through independent sample t-tests and paired sample t-tests. The study's results showed differences in scientific literacy abilities between classes taught using interactive learning media and those taught using conventional learning media in the sub-material of the circulatory system. The results of this study also indicated a difference in scientific literacy skills before and after the use of interactive learning media in the sub-material of the circulatory system. This study demonstrates that the use of interactive learning media that present content related to scientific phenomena can enhance students' scientific literacy skills. This research highlights the importance of utilising interactive learning media for teachers in enhancing students' scientific literacy.

Keywords: Bloodstream system; Interactive Learning Media; Scientific Literacy.

Introduction

PISA (Program for International Student Assessment) is a program launched to measure learning achievement every 3 years by the Organization for Economic Co-operation and Development (OECD) [1]. Indonesia has participated in PISA since 2000. Indonesia's overall science learning achievements show flat results [2]. PISA data from 2018 stated that Indonesia was among the 10 lowest countries out of 78 countries that participated in the PISA assessment [3].

The PISA results indicate that the level of scientific literacy of Indonesian students has not yet reached international standards according to the OECD measurement criteria. A number of factors that trigger the low scientific literacy skills of Indonesian students, related to PISA data, are misconceptions, selection of textbooks, less relevant learning, weak reading skills, and an unsupportive learning environment [3]. The minimal use of learning media in learning activities results in low levels of student activity and interest in the subject matter being taught [4]

Based on the researcher's observations at SMP Negeri 1 Kertak Hanyar, it is evident that students tend to be less active and appear less confident when answering questions from their teachers. In implementing learning, educators do not emphasize students' scientific literacy enough. Researchers also observed that most teachers were still not utilising technology effectively as a learning medium.

In connection with these problems, interactive, fun and exciting learning media based on information technology are needed that keep up with the pace of development in order to remain relevant, so that it can increase student participation during teaching and learning [5]. One of the learning media that can help educators in teaching and facilitating the learning process is interactive learning media. An example of interactive learning media that can be used is Articulate Storyline. Articulate Storyline can make interactive learning media more interesting, combined with menus, images, text, video, animation, audio, and quizzes in the form of scenes and slides [5].

Previous research has shown that the use of interactive learning media can improve students' scientific literacy. However, there is little research exploring the use of interactive learning media in the circulatory system sub-topic, particularly in the context of students' scientific literacy. This research is expected to improve students' understanding of the circulatory system sub-topic.

Based on the background that has been explained above, the formulation of the problem in this study is: 1) is there a difference in scientific literacy skills between classes taught using interactive learning media and classes taught using conventional learning media on the circulatory system sub-material? and 2) is there a difference in scientific literacy skills before and after the use of interactive learning media on the circulatory system material?

Research Method

The research design employed a quasi-experimental approach with a non-equivalent control group design. The research was conducted by administering pretests and posttests to both the control and experimental classes.

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Table 1. Research Design

Class	Pre-test	Treatment	Post-Test
Control	O_1	X_K	O_2
Experiment	O_1	X_E	O_2

Information:
O_1: Pretest data for the control class and the experimental class
O_2: Posttest data of the control class and the experimental class
X_K: Providing teaching through conventional media
X_E: Providing teaching through interactive learning media

The sample was taken using purposive sampling. Purposive sampling is a non-probability sampling technique where researchers select samples based on subjective considerations and research objectives. The sample in this study consisted of two control classes and two experimental classes, consisting of 55 students in grade VIII of SMP Negeri 1 Kertak Hanyar. The research data were collected in the form of pretests and posttests of scientific literacy. The research instruments included scientific literacy test questions, learning media, and teaching modules. The data analysis methods employed included validity and reliability testing, as well as normality and homogeneity testing, along with hypothesis analysis using independent sample t-tests and paired sample t-tests. This study also calculated the N-Gain score test.

The validity test in this study uses Aiken's V validity technique. The Aiken's V formula for calculating validity is:

$$V = \frac{\sum s}{n(c-1)}$$

The results of the Likert scale calculations were then converted into Aiken's V validity criteria, as in Table 2 below.

Table 2. Aiken's V Validity Criteria

Aiken's V Scale	Validity
$V \leq 0.4$	Less Valid
$0.4 < V \leq 0.8$	Valid
$V \geq 0.8$	Very Valid

The reliability test in this study was calculated based on the similarity of scores given by five validators using the Percentage of Agreement (PA) method, as described by Borich. The Percentage of Agreement (PA) can be formulated as follows:

Before analysis, researchers ensure that the data obtained meets the criteria for normal distribution. Data normality test using the IBM SPSS Statistics 21 tool on the One Sample Kolmogorov-Smirnov menu. The formulation of the normality test hypothesis is:
H_0 = Abnormal data
H_1 = Normal Data

The homogeneity test is used to identify similarities or differences between several population variants [6]. Data homogeneity test is assisted by IBM SPSS Statistics 21 software in the Levene's Test menu. The formulation of the homogeneity test hypothesis is:
H_0 = Data is not homogeneous
H_1 = Data homogeneous

An independent sample t-test analysis of post-test results is useful for determining the differences in scientific literacy skills between classes taught using interactive learning media and classes taught using conventional learning media, in the context of the sub-material of the circulatory system. This test is supported by IBM SPSS Statistics 21 software. The formulation of the Independent Sample T-Test hypothesis is listed below:

H_0 : There is no difference in scientific literacy skills between classes taught using interactive learning media and classes taught using conventional learning media in the context of the sub-material of the circulatory system.

H_1 : There is a difference in scientific literacy skills between classes taught using interactive learning media and classes taught using conventional learning media in the sub-material of the circulatory system.

The Paired Sample T-Test was used to determine the differences in scientific literacy skills before and after the use of interactive learning media on the circulatory system sub-topic. This test was conducted using the IBM SPSS Statistics 21 software. The hypothesis formulation of the Paired Sample T-Test was as follows:

H_0 : There is no difference in scientific literacy skills before and after using interactive learning media on the sub-material of the circulatory system.

H_1 : There is a difference in scientific literacy skills before and after using interactive learning media on the sub-material of the circulatory system.

The N-Gain test was used in the research to determine the increase in students' scientific literacy at the beginning and end of the learning process. The N-Gain test was also used to identify variations in scientific literacy between the control and experimental classes for each indicator. The normalized gain formula or equation (N-Gain).

$$(g) = \frac{\text{posttest score} - \text{pretest score}}{\text{maximum score} - \text{pretest score}}$$

Next, the results of the N-gain calculations obtained can be interpreted according to the following criteria.

Table 3. Gain Score Analysis Result Criteria

Value G	Category
$g \geq 0.7$	High
$0.3 \leq g < 0.7$	Medium
$g < 0.3$	Low

[7]

Results and Discussion

The validity test of interactive learning media in this study aims to assess the validity and suitability of interactive learning media, teaching modules, and test questions for promoting scientific literacy. This research instrument has been reviewed by 4 (four) validators who are lecturers of the Science Education Study Program at Lambung Mangkurat University and 1 (one) validator from a science teacher at SMP Negeri 1 Kertak Hanyar. The results of the calculation

of the validity of interactive learning media, teaching modules, and scientific literacy test questions are presented in Table 4.

The reliability test in this study was used to determine the trustworthiness or agreement between validators regarding the interactive learning media, teaching modules, and science literacy test questions. An instrument is considered reliable if the Percentage of Agreement obtained is ≥ 75%. The results of the reliability test are presented in Table 7.

Table 4. Results of the Validity of Interactive Learning Media

No.	Assessment Aspect Validator V Description	Validator					V	Information
		I	II	III	IV	V		
1.	Learning	45	47	40	39	47	0.84	Very Valid
2.	Language	25	25	20	19	25	0.89	Very Valid
3.	Audio Visual	59	57	48	47	60	0.87	Very Valid
4.	Application	25	23	20	20	25	0.88	Very Valid
Mean							0.86	Very Valid

Table 5. Results of the Validity of the Teaching Module

No.	Statement Items	Validator					V	Information
		I	II	III	IV	V		
1.	Completeness of Identity Components and General Information	50	49	38	39	50	0.88	Very Valid
2.	Completeness of Core Components	45	45	34	34	45	0.87	Very Valid
3.	Completeness of Attachment Components	15	11	12	12	15	0.83	Very Valid
4.	Completeness of Teaching Information	44	40	32	32	40	0.9	Very Valid
5.	Time Allocation	4	5	4	4	5	0.85	Very Valid
6.	Clarity of Prerequisite Knowledge	4	4	3	4	5	0.75	Valid
7.	Selection of Pancasila Student Profiles	5	5	4	4	5	0.9	Very Valid
8.	Selection of Learning Models and Approaches	4	5	4	4	5	0.85	Very Valid
9.	Clarity of Learning Objectives	10	10	6	8	10	0.85	Very Valid
10.	Selection of Meaningful Understanding	5	5	4	4	5	0.9	Very Valid
11.	Selection of Starting Questions	5	5	3	4	5	0.85	Very Valid
12.	Learning Activities	70	63	55	54	68	0.85	Very Valid
13.	Assessment	4	3	4	4	5	0.75	Valid
Mean							0.86	Very Valid

Table 6. Results of the Validity of the Science Literacy Test Questions

Question	Validator					Mean (V)	Information
	I	II	III	IV	V		
Question 1	5	3	4	4	3	0.7	Valid
Question 2	5	5	4	4	5	0.9	Very Valid
Question 3	5	5	4	4	5	0.9	Very Valid
Question 4	5	5	4	4	5	0.9	Very Valid
Question 5	5	4	4	4	3	0.75	Valid
Question 6	5	5	4	4	5	0.9	Very Valid
Question 7	5	5	4	3	5	0.85	Very Valid
Question 8	5	5	4	4	5	0.9	Very Valid
Question 9	5	5	4	4	5	0.9	Very Valid
Question 10	5	5	4	4	3	0.8	Very Valid
Mean						0.85	Very Valid

Table 7. Results of the Reliability Test of Interactive Learning Media

No.	Aspect	Mean		A-B	A+B	(1-(A-B) / (A+B))	R
		A	B				
1.	Learning	4.7	3.9	0.8	8.6	0.91	91%
2.	Language	5	3.9	1.2	8.8	0.86	86%
3.	Audio Visual	5	3.9	1.1	8.9	0.88	88%
4.	Application	5	4	1	9	0.89	89%
					Mean	0.88	88%

Table 8. Results of the Reliability Test of the Teaching Module

No.	Aspek	Mean		A-B	A+B	(1-(A-B) / (A+B))	R
		A	B				
1.	Completeness of Identity Components and General Information	5	3.8	1.2	8.8	0.86	86%
2.	Completeness of Core Components	5	3.8	1.2	8.8	0.86	86%
3.	Completeness of Attachment Components	5	3.7	1.3	8.7	0.85	85%
4.	Completeness of Teaching Information	5	4	1	9	0.89	89%
5.	Time Allocation	5	4	1	9	0.89	89%
6.	Clarity of Prerequisite Knowledge	5	3	2	8	0.75	75%
7.	Selection of Pancasila Student Profiles	5	4	1	9	0.89	89%
8.	Selection of Learning Models and Approaches	5	4	1	9	0.89	89%
9.	Clarity of Learning Objectives	5	3	2	8	0.75	75%
10.	Selection of Meaningful Understanding	5	4	1	9	0.89	89%
11.	Selection of Starting Questions	5	3	2	8	0.75	75%
12.	Learning Activities	5	3.8	1.2	8.8	0.86	86%
13.	Assessment	5	3	2	8	0.75	75%
Mean						0.84	84%

Table 9. Results of the Reliability Test of Science Literacy Test Questions

Question	Mean		A-B	A+B	(1-(A-B) / (A+B))	R
	A	B				
Question 1	5	3	2	8	0.75	75%
Question 2	5	4	1	9	0.89	89%
Question 3	5	4	1	9	0.89	89%
Question 4	5	4	1	9	0.89	89%
Question 5	5	3	2	8	0.75	75%
Question 6	5	4	1	9	0.89	89%
Question 7	5	3	2	8	0.75	75%
Question 8	5	4	1	9	0.89	89%
Question 9	5	4	1	9	0.89	89%
Question 10	5	3	2	8	0.75	75%
				Mean	0.83	83%

Table 10. Normality Test Results

One-Sample Kolmogorov-Smirnov Test				
	Class	Kolmogorov-Smirnov		
		Statistic	df	Sig.
Scientific Literacy Results	Control PreTest	.756	55	.618
	Control PostTest	.817	55	.517
	Experimental PreTest	.921	55	.370
	Experimental PostTest	.791	55	.293

Normality testing is the initial stage of the prerequisite test using the one-sample Kolmogorov-Smirnov Test. A distribution is considered normal if the significance value is >0.05; conversely, a significance value <0.05 indicates abnormal data. The results of the normality test calculations from the pretest and posttest results for the control and experimental classes are shown in Table 10.

After the normality test requirements were met, the prerequisite test was continued with a homogeneity test. The homogeneity test calculation indicated that the research findings were derived from homogeneous data. This was reflected in the significance ($p < 0.05$) of each test exceeding the Levene's Test of Equality score, with a p-value of 0.341 for the science literacy results. The calculated homogeneity test data from the pretest and posttest scores of the control and experimental classes are shown in Table 11.

After conducting the prerequisite test, a hypothesis test in the form of an independent sample t-test was conducted to determine the difference in scientific literacy skills between classes taught using interactive learning media and classes taught using conventional learning media on the sub-topic of the circulatory system. Descriptive statistical data assumptions of the independent sample t-test are listed in Table 12.

The findings of the independent sample t-test in Table 5 indicate a significance value (Sig. 2-tailed) of 0.004 < 0.05. These results indicate variations in scientific literacy skills in classes facilitated by interactive teaching media and classes that still use conventional learning media. The descriptive statistical results of the independent sample t-test are presented in Table 13.

Based on the average posttest data for the experimental and control classes, a difference in scientific literacy skills was observed between the two classes, as indicated by the 8.55-point difference in average scores. This implies that the control class's mean score is lower compared to the experimental class's mean score.

After conducting the independent sample t-test, a paired sample t-test was performed to determine the difference in scientific literacy skills before and after using interactive learning media on the sub-topic of the circulatory system. The results of the paired sample t-test comparing the pretest and post-test experimental classes are presented in Table 14 below.

The paired sample t-test data in Table 7 shows a significance (Sig. 2-tailed) of 0.000 < 0.05. Referring to the output, there is a difference in the level of scientific literacy before and after the use of interactive learning media on the circulatory system sub-topic. Descriptive statistics of the paired sample t-test are presented in Table 15.

Table 11. Homogeneity Test Result

Test of Homogeneity of Variance

		Levene Statistic	dfl	df2	Sig.
Scientific Literacy Result	Based on Mean	1.048	1	108	.308
	Based on Median	1.2755	1	108	.261
	Based on Median and with adjusted df	1.275	1	104.281	.261
	Based on the trimmed mean	1.035	1	108	.311

Table 12. Independent Sample T-Test Posttest Results

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Scientific Literacy Result	Equal variances assumed	1.048	.308	-2.940	108	.004	-8.545	2.906	-14.306	-2.785
	Equal variance not assumed			-2.940	104.005	.004	-8.545	2.906	-14.306	-2.782

Table 13. Descriptive Statistics Results of the Independent Sample T-Test

Group Statistics

	Kelas	N	Mean	Std. Deviation	Std. Error Mean
Scientific Literacy Results	Posttest_Control	55	71.45	13.665	1.843
	Posttest_Experimental	55	80.00	16.667	2.247

Table 14. Paired Sample T-Test Results for Pretest and Posttest of Experimental Class

Paired Samples Test

		Pair Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest Experimental – Posttest Experimental	-18.182	13.756	1.855	-21.901	-14.463	-9.802	54	.000

Table 15. Descriptive Statistics Results of the Paired Sample T-Test
Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest Experimental	61.82	55	16.340	2.203
	Posttest Experimental	80.00	55	16.667	2.247

Referring to the mean pre-test and post-test values of the experimental class, 61.82 and 80.00, respectively, it shows an increase in the difference in scientific literacy abilities between the initial and final stages of using interactive-based learning media in the sub-material of the circulatory system of 18.18.

The N-Gain Score test was used as a tool to assess the improvement in science literacy scores of students who received learning without interactive teaching media in the control class and the class that applied interactive learning. The N-Gain score test output is presented in Table 16.

Table 16. N-Gain Test Results

No.	Class	Average N-Gain Value	Information
1.	Control	0.26	Low
2.	Experiment	0.48	Medium

This study also calculated the increase in the n-gain test scores of the control and experimental classes for each indicator using Microsoft Excel. The calculation data are presented in Table 17 below.

Table 17. Indicator N-Gain Test Value

No.	Scientific Literacy Indicators	Class	
		Experiment	Control
1.	Identifying Valid Scientific Opinions	0.92	0.67
2.	Understanding Elements in Research Design	0.44	0.34
3.	Solving Problems Based on Scientific Phenomena	0.40	0.18
4.	Understanding and Interpreting Basic Statistics	0.44	0.22
5.	Making Inferences, Predictions, and Drawing Conclusions Based on Scientific Evidence	0.47	0.40

The study was conducted on students at SMP Negeri 1 Kertak Hanyar, with four sample classes: classes VIII A and VIII C as the experimental classes, and classes VIII B and VIII D as the control classes. The study's results showed that the experimental class demonstrated higher scientific literacy skills than the control class. Students in the experimental class were able to visualize material containing abstract concepts. This statement is supported by the opinion that interactive media helps visualize abstract concepts [8]. Students' scientific literacy skills improved due to the use of interactive teaching media, namely Articulate Storyline. These findings are in line with those who stated that the interactive learning media Articulate Storyline encourages increased scientific literacy [9]

The improvement in scientific literacy was analyzed using N-Gain, where the experimental class obtained a score of 0.48 (medium category) and the control class 0.26 (low category). The low N-Gain score in the control class was due to the use of conventional media, in contrast to the experimental class, which utilized interactive learning media to increase learning activities and reduce boredom through more engaging material stimuli. Interactive and varied media overcome boredom and stimulate student enthusiasm [10]. The results of scientific literacy statistics for each indicator are shown in the following image.

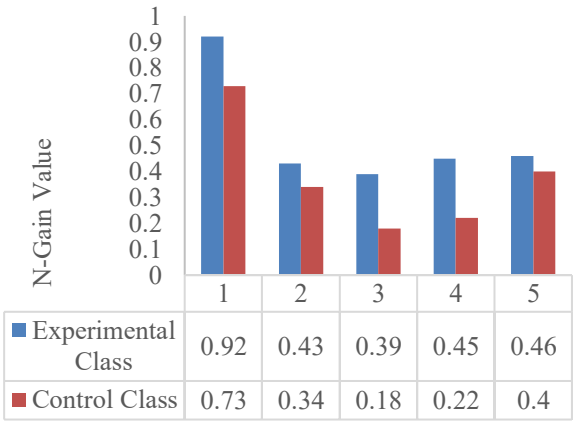

Figure 1. N-Gain Improvement of Experimental and Control Class Scores for Each Science Literacy Indicator

Information:
1: Identifying Valid Scientific Opinions
2: Understanding the Elements in Research Design
3: Solving Problems Based on Scientific Phenomena
4: Understanding and Interpreting Basic Statistics
5: Making Inferences, Predictions, and Drawing Conclusions Based on Scientific Evidence

The highest n-gain increase in the control and experimental classes' scores was found in the indicator of identifying valid scientific opinions, at 0.25, due to students' lack of training in identifying scientific concepts relevant to everyday life. The presence of interactive learning media that present scientific opinions through learning materials and videos can improve students' ability to identify valid scientific opinions. This finding is in line with the statement which confirms that interactive learning media helps students in processing scientific information from various sources [11]. Indicators identifying valid scientific opinions expressed in interactive learning media are shown in Figure 2.

The indicator for understanding and interpreting basic statistics showed the highest n-gain score difference, at 0.23, due to the use of interactive learning media containing articles related to contextual basic statistics. This interactive learning media helps improve scientific literacy by

emphasizing the importance of strengthening students' understanding and analysis of statistical data [12]. Indicators for understanding and interpreting basic statistics presented in interactive learning media are illustrated in Figure 3.

Figure 2. Indicators for Identifying Valid Scientific Opinions in Interactive Learning Media

Figure 3. Interaktif Understanding and Interpreting Basic Statistics in Interactive Learning Media

The indicator for solving problems based on scientific phenomena had an n-gain score difference of 0.12. Although still limited due to minimal practice in understanding material integrated with contextual phenomena, this interactive learning media helps improve scientific literacy by presenting articles on the scientific phenomenon of heart disease. This statement is supported by research results which reveal that Articulate Storyline helps improve scientific literacy by presenting content interactively and visualizing scientific phenomena [13]. Indicators for solving problems based on scientific phenomena presented in interactive learning media are shown in Figure 4.

Figure 4. Indicators for Solving Problems Based on Scientific Phenomena in Interactive Learning Media

The indicator for understanding elements in research design experienced an n-gain difference of 0.09, but this was not high because the learning media only included one simple practicum, making this interactive learning media less than optimal in enhancing students' understanding of research design elements. Practicums are crucial for science learning because they emphasize the importance of direct experience [15] and identify aspects of scientific data-based research [11]. The indicator for understanding elements in research design, as presented through interactive learning media, is illustrated in Figure 5.

Figure 5. Indicators for Understanding Elements in Research Design in Interactive Learning Media

The indicator for the ability to infer, predict, and draw conclusions based on scientific evidence experienced the lowest n-gain score difference of 0.06. The low n-gain difference in scientific literacy scores for this indicator was due to the learning media implemented, which did not emphasizing reading observation tables. Meanwhile, the learning media presented contained more articles on scientific evidence related to scientific phenomena. These indicators are outlined in the interactive learning media, as shown in Figure 6.

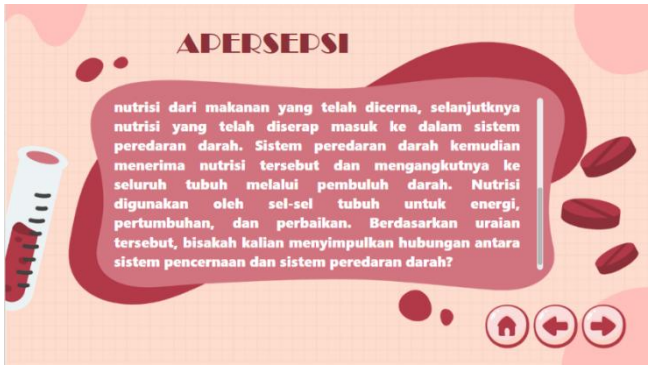

Figure 6. Indicators for Making Inferences, Predictions, and Drawing Conclusions Based on Scientific Evidence in Interactive Learning Media

Based on the results and discussion presented, it is known that there was an increase in scientific literacy skills before and after the use of learning media. This increase in scientific literacy in students was influenced by the use of interactive learning media that provided material on scientific phenomena. This media helped students understand questions that required scientific analysis [16-19]. The use of interactive learning media is an alternative solution for teachers in improving students' scientific literacy [20-22].

Conclusions

Based on the results and discussion, it was concluded that there was a difference in scientific literacy skills between classes taught using interactive learning media and classes taught using conventional learning media on the circulatory system sub-material. The study's results also showed a difference in scientific literacy skills before and after the use of interactive learning media on the circulatory system sub-material. This demonstrates that the use of interactive learning media is a viable alternative for teachers to enhance students' scientific literacy. Regarding further research, the researcher suggests that interactive learning media, when implemented to improve students' scientific literacy, include more simple, practical activities, reading, and observation tables, so that students' abilities can be optimally improved.

Author Contributions

Nina Febryanie: Conducting research, collecting and analyzing data, and writing article manuscripts.
Ellyna Hafizah and Maya Istyadji: Provide guidance, direction and critical review of article manuscripts as supervisors during the research process

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