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Webbed Type of Integrated Science Learning on the Theme of Environmental Pollution to Improve Students' Scientific Literacy

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Abstract: This study aims to get information on how to integrate the science learning type of Webbed with the theme of environmental pollution to improve students' scientific literacy. The subject of study was seventh-grade students in middle school. The research method used in this study is a quasi-experimental method with a Nonequivalent Control Group Design. The data were analyzed by calculating the normalized gain average score to determine the increase in scientific literacy. The average result of N-Gain in students' scientific literacy as a whole obtained in the experiment class is 0.66 while the control class is 0.43, both are in the medium category with a difference of 0.23. The hypothesis test result in the **t**-test is known as the significance level of 0.000 which means that Ho is rejected, and Ha is accepted. Based on the result of this t-test, it is known that students' scientific literacy abilities are not the same. This means that there were differences in the increase in scientific literacy in integrated webbed versus conventional science learning types without integration. The result of the study shows that webbed-type integrated learning can improve students' scientific literacy on aspects of content, process, and attitude.

Keywords: Webbed learning model, Environmental pollution, Scientific Literacy.

INTRODUCTION

The development of natural science and technology affects various aspects of life, including political economy, culture, and education. Good science education is a means to produce quality human resources in development in the era of globalization. The objectives of science learning are applicative abilities, development of thinking skills, learning abilities, curiosity, and development of caring and responsible attitudes towards the environment (Yuningsih, et al., 2020). There are 4 aspects in measuring scientific literacy that interact with each other at PISA 2015 namely Context, Science Process Competence, Knowledge, and Attitude (OECD, 2017). Scientific literacy ability is defined as the ability to distinguish scientific facts from various information, recognize, and analyze the use of scientific inquiry methods as well as the ability to organize, analyze, and interpret quantitative data and scientific information (Gormally et al., 2012). Scientific literacy is dependent on the steps of the scientific method so science is a process combined with authentic experience (Klucevsek, 2017). Scientific literacy is referred to as understanding science and its application in individual and civic experience to allow students to appreciate science as a human and intellectual achievement; use the scientific method and apply science to social, economic, political, and personal domains (Bybee in Valladares, 2021) Furthermore, scientific literacy is the application of reading, writing, and literacy skills in science classes. When students have mastered the basics of scientific literacy, they are able to take information from existing texts, organize concepts and connect different ideas, and communicate their new scientific ideas with others (Wright et al., 2016), and is the ability to understand science with a more holistic approach (Lederman et al., 2013).

Although scientific literacy is not explicitly stated in the 2013 curriculum, from the content of core competencies and basic competencies it can be concluded that one of the goals of science education in junior high schools is to build students to have scientific literacy (become science literates), which includes the dimensions of scientific literacy process, application content, science application context and attitudes. The low pretest scores of students are below the minimum completeness criteria on environmental pollution material and lack of interest in reading, so it is necessary to encourage teachers to motivate students to read subject matter before teaching and learning activities take place, it is rare to find self-awareness efforts to develop themselves because they are too dependent on teachers to get the source of knowledge. Even in the field observations and the results of previous studies, it turns out that there is still a lot of teacher-centered classroom learning using the lecture method and little discussion involving students without being accompanied by an exploration of student literacy in science. The science learning process should be carried out with a scientific approach according to its essence and direct observation. Ordinary learning does not encourage students to gain experience and learning process skills. Another thing that is obstacle is the assessment of science learning which is only based on written tests without paying attention to process skills. In addition, students are only tested on memorization skills which causes the weak application of mastery of science concepts in everyday life. Mastery of academic content and skills should not be separated from one another.

Improving scientific literacy can be achieved through an integrated, innovative science learning process that accommodates student learning needs, one of which is an integrated learning model. Integrated learning is one approach that is oriented towards learning practices that are following the developmental needs of students and based on real-world problems (Lederman in Tamassia and Frans, 2014). In addition, integrated learning can help students see how concepts are linked to understanding phenomena from a more holistic perspective (Martinello & Cook in Kim and Bolger, 2017). Based on the 2013 Curriculum, which has been used in almost all schools in Indonesia, science learning must be implemented in an integrated manner, both in the content of Physics, Chemistry, Biology, and others as well as with context and skills and attitudes. Therefore, teachers are required to be more professional in mastering science material in an integrated manner and can develop teaching materials and learning media that can be used for learning. In addition, learning must be carried out interestingly and not boring, and can increase student interest in learning. In fact, learning is still not integrated, this is because many teachers may feel unprepared to teach in an interdisciplinary curriculum because the targeted scope is different from their educational background (Gresnigt et al., 2014). In addition, there is still a lack of necessary learning resources so the impact of learning outcomes is still not accommodating the achievement of scientific literacy.

The application of scientific literacy in science learning in schools must be carried out through scientific activities that include three important components, namely science as a process, science as a product and attitude development. Therefore, learning activities in schools must support students' scientific literacy such as laboratory work, making scientific papers, problem-solving, scientific discussions, and so on. Scientific literacy is an important thing to master because of its wide application and can be applied in almost all fields. Therefore, the questions in this research are: How to increase scientific literacy in content, process, and attitude aspects after the implementation of Webbed-type integrated learning on the theme of environmental pollution for students and how are students' responses to Webbed-type integrated science learning?

Webbed-type integrated science learning is integrated learning with characteristics departing from the thematic approach as a liaison for the integration of subject matter and learning activities. In this connection, the theme can bind learning activities both in certain subjects and across subjects (Fogarty, 2009). Webbed integrated science learning is relevant to be used in this study by carrying the theme of environmental pollution with sub-themes of water pollution, soil pollution, and air pollution because understanding the concept will be intact, and contextual with interesting themes because it is close to everyday life. The integrated webbed type can strengthen students' understanding of lessons and is easy to apply for novice teachers who are not accustomed to integrating lessons (Trianto, 2010). The theme of environmental pollution is very suitable to be used as integrated learning content because the theme contains Biology, Chemistry, and Physics materials so that students can see the integration and can relate to the material that has been previously studied. Based on research from Zakiyah et al. (2013), integrated learning can also build critical thinking skills by looking at concepts, topics, and ideas broadly that are connected with certain themes so that they are able to solve problems faced by thinking broadly and deeply with different points of view.

Pollution material is an environmental problem that does not only occur in the surrounding environment but is already a world problem that students should know about. Based on the observations of teachers at schools, it turns out that the level of student awareness of pollutants that pollute the environment, especially in the school environment is still low. They tend to have to be instructed by teachers, lack of awareness and initiative from students themselves to maintain environmental cleanliness. In fact, in learning about environmental problems, only theories or aspects of knowledge are presented, although some are based on problems that occur but few are combined with aspects of skills. The problem of environmental pollution was chosen because it is an actual and contextual theme that is closely related to daily life so it is hoped that after students have increased their knowledge and skills concepts, students can realize the importance of a clean and healthy environment and can apply it in life, at least preventing pollution in their own environment (Yuningsih et al., 2018). Because when knowledge-based environmental care attitudes and behaviors have been fostered, awareness will be formed in maintaining the environment in a sustainable manner (Mullenbach & Green, 2018; Nazarenko & Kolesnik, 2018). Previously there were not many studies on webbed-type integrated learning, including Puspita et al. (2020) that show webbed-type can improve students' reading comprehension of reading in several subjects. The purpose of this study was to obtain information on how webbed-type integrated learning with the theme of environmental pollution to improve students' scientific literacy.

METHOD

The research method used in this study is quasi-experimental. The research design used is a Nonequivalent Control Group Design (Sugiyono, 2015). The population in this study were all seventh-grade students in junior high school using a sample of one experimental class and one control class. The difference between the two classes is the treatment in the learning process, the experimental class uses webbed type integrated science learning while the control class does not use integration. At the end of the lesson, students' scientific attitude questionnaires were given in both classes to measure scientific attitudes and students' responses to science learning were given without using cohesiveness. Both classes were given pretest and posttest.

The instrument used is multiple choice questions consisting of 32 questions with 4 answer choices that have been tested for aspects of validity, reliability, and level of difficulty to assess students' scientific literacy skills in content and process achievements, a Likert scale questionnaire of 30 which contains positive statements and negative statements to capture the scientific literacy attitude scale by analyzing students' responses to science issues with environmental themes taken after the learning took place.

Analysis of quantitative data in determining the increase in scientific literacy in content aspects and process aspects that occur before and after learning is calculated by the g factor formula (N-Gain) according to Meltzer, namely the posttest score minus the pretest score then the results are divided from the ideal score (maximum score) which is reduced by the pretest score pretest (Meltzer, D. E. in Utomo et al., 2020). The N-Gain interpretation according to Hake (1999) is presented in Table 1:

Table 1. Classification of Interpretation of N-*gain*

Mean Gain Value	Interpretation
0.7	High
0.3 < g < 0.7	Medium
g < 0.3	Low

The research data were then tested statistically by performing a normality test to find out whether they came from a class that was normally distributed or not, a homogeneity test of variance from the experimental class and control class, as well as an independent t-test if the data were normally distributed and homogeneous, all of which were processed using the SPSS 22 program.

Qualitative data analysis was conducted to collect data from observations and questionnaires on students' scientific literacy attitudes. Observational data were obtained when students participated in learning activities, both in discussions, experiments and literacy. Each statement in the data obtained through a questionnaire is processed quantitatively using a percentage calculation (%) with the following formula; The percentage value is the frequency of answers (f) divided by the number of students (n) and then multiplied by 100%. The results of the percentage are then interpreted with the following criteria.

Table 2. Questionnaire value

Criteria (%)	Interpretation
0 - 20	very weak
21 - 40	weak
41 - 60	sufficient
61 - 80	strong
81 - 100	very strong

Source: Ridwan in Dharma (2015)

RESULTS AND DISCUSSION

Data on the results of integrated science learning webbed types include mastery of scientific literacy, attitudes, and observations during learning activities as well as students’ responses to learning with the following results.

Improving students' scientific literacy in the experimental class with the control class

The results of student learning activities as a whole can be seen in Table 3.

Table 3. Overall student learning outcomes

Mastery of Science Literacy Student	Experiment Class			Control Class		
	Pre-test	Post-test	N-gain	Pre-test	Post-test	N-gain
Maximum score	72	97	0.94	69	84	0.69
Minimum score	41	69	0.17	25	56	0.08
Average value	**57.32**	**85.74**	**0.66**	**57.32**	**76.37**	**0.43**
Average value (%)	57.32	85.74	65.69	57.32	76.37	43.26
Ideal value	100	100	100	100	100	100

Based on Table 3 above, it can be seen that the average level of mastery of the pretest results in the experimental class and the control class both have the same average value, namely with a value less than the minimum completeness criteria of students, which is 70. After the webbed-type integrated science learning is carried out in the experimental class and separated learning or not combining basic competence material in the control class, there was an increase in the average post-test results in the value of mastery of science literacy in the experimental class and the control class. The increase in students' scientific literacy skills can also be seen from the average value of N-gain, both of which are in the medium category but in the experimental class, the value is higher with a difference of 0.23 (22.43%), which indicates that webbed-type integrated science learning can improve student scientific literacy. For more details see Figure 1.

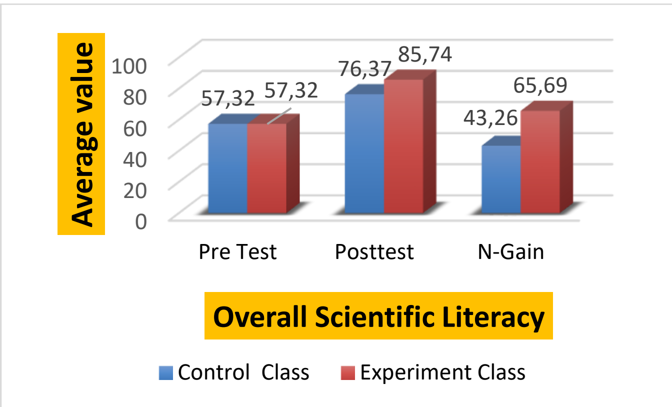

Figure 1. Bar chart Average score of Pretest, Posttest, and N-Gain results

The increase in students' scientific literacy in the experimental class was caused by learning about environmental pollution in the experimental class, starting with the sub-themes, save water, save the earth, acid rain, and soil, and life, then relating them to concepts that are following basic competencies. The theme of

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environmental pollution that is conveyed is contextual which is close to everyday life, thereby generating greater interest and motivation to learn in students which causes mastery of concepts to be further increased. The slight difference in N-Gain between the control class and the experimental class was because, in the control class, the timing of giving acid and base material was close to the contamination material, making it easier for students to remember and absorb the theory. This is also because the control class carries out laboratory work activities so that aspects of the process and their knowledge also increase.

Achievement of Knowledge Content Aspect Ability in Experiment Class and Control Class

The content aspects analyzed in this study are water pollution, air pollution, soil pollution, elements, acids and bases, physicochemical properties, changes in substances (heat), ecosystems and human health impacts. Mastery of content aspect in the experimental class and control class is shown in Table 4 below.

Table 4. Mastery of the Content Aspect of the Experimental and Control Classes

No	Content Aspect	Experiment Class			Control Class		
		Pre-test	Post-test	N-gain	Pre-test	Post-test	N-gain
1.	Water Pollution	61.98	93.75	0.65	64.58	83.85	0.43
2.	Air Pollution	65.63	93.75	0.34	65.63	73.44	0.30
3.	Soil Pollution	56.25	92.19	0.73	45.31	81.25	0.63
4.	Elements - Compounds	59.38	76.56	0.29	51.38	69.53	0.23
5.	Acid-base	35.16	60.94	0.34	51.56	70.31	0.23
6.	Chemical Physical Properties	51.04	83.33	0.45	60.42	69.79	0.14
7.	Ecosystem	53.13	79.69	0.50	55.47	81.25	0.33
8.	Human Health Impact	59.38	83.59	0.33	57.03	75.00	0.24
9.	Changes in the state of matter	62.50	96.88	0.38	59.38	75.00	0.31
	Average Score	**56.04**	**84.52**	**0.45**	**56.75**	**75.49**	**0.32**

Based on Table 4, in general, there is an increase in the value of N-Gain in all aspects of content, although N-Gain in the experimental and control classes are both in the medium category, but the experimental class has a significant difference of 0.13 (13%) higher than the control class. This is following research by Liu and Wang (2010) that thematic learning with webbed is very effective for students to learn concepts and can develop related concepts in the framework. This learning is also suitable for students with different abilities. Aspects of soil pollution content get N-Gain with a high category in the experimental class while the control class gets N-Gain with a medium category. The high content of soil pollution is because learning is carried out in the field (outside the classroom) which is directly dealing with the experiences and lives of students so that it is easier for students to absorb and find information. This is following research conducted by Ayotte-Beaudet et al. (2019) that learning carried out outdoors in an environment close to the school creates contextualization, students feel directly involved with the problem so that it can arouse students' scientific interest in exploring knowledge.

If the soil pollution content is compared with the water pollution content, both classes are in the moderate category, but there is a significant difference in the water pollution content of 0.22 (22%) while the soil pollution is 0.10 (10%) which means an increase in literacy ability greater science on water pollution content in the experimental class than on soil pollution content. This is due to the teaching method used on water pollution content by using experimental and discussion methods that explore the ability to find a problem, knowledge, attitudes, and skills of students. This is following the objectives of the experimental method, namely to encourage appropriate observations and explanations, make situations more real, stimulate and maintain attention and understandable reasoning, improve students' problem understanding skills and find solutions, as well as develop critical thinking and develop skills to interact with each other, cooperate in finding facts and reaching new information (Dillon in Ibrahim et al., 2014). In addition, practicum activities on water pollution content were carried out in the laboratory using LKS, students looked enthusiastic because previous practicum activities were rarely carried out in the laboratory room, creating a new atmosphere and experience for them. It is also conveyed by Hodson (2014) that laboratory work of various types can be used to provide opportunities for students to test their new understanding in the real world, students can understand phenomena and events that can be explained differently and more deeply to understand concepts by using the scientific method.

The low N-Gain category is the content of elements and compounds, both of which get a low predicate with a very small difference of 6%. It shows that the items in the compound-element content are of high complexity, so a higher level of material deepening is needed in both classes, and because the elemental and compound content is content that has just been studied for class VII and has not been included in the knowledge in elementary school so that require more time in learning the material. While the content of Physical and Chemical Properties in the control class gets a very low N-Gain compared to other content which shows their lack of mastery of knowledge which is too rote, and less ability to relate theory to laboratory work activities. This weakness also needs to be corrected in strengthening the concept. The development for each content for more details can be seen in Figure 2 below.

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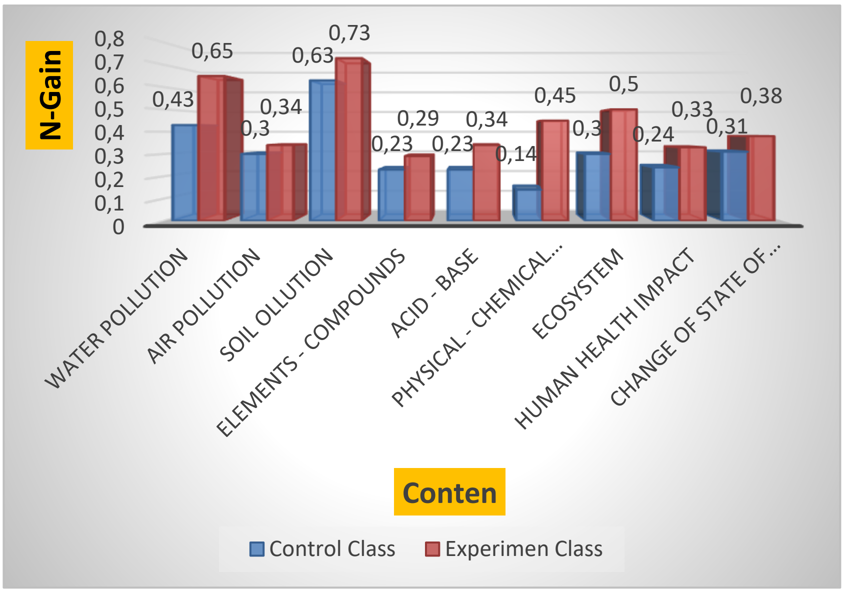

Figure 2. Bar chart of the average N-Gain of Science Content Aspects of Students in the Control Class and Experiment Class

Achievement of Process Aspects of Competence/Competence in Experiment Class and Control Class

Students' scientific literacy skills in the process or competency aspects consist of 3 indicators, namely, explain phenomena scientifically, evaluate and design scientific investigations, and interpret data and evidence scientifically. The data on the capability aspects of the project are presented in Table 5.

Table 5. Data on students' scientific literacy skills in process aspects

No	Aspect Indicator Process	Experiment class			Control Class		
		Pre-test	Post test	N-gain	Pre-test	Post test	N-gain
1.	Explain phenomenon by scientific	59.96	86.72	0.64	58.40	78.91	0.47
2.	Evaluate and design scientific investigation	62.50	92.71	0.64	66.67	85.42	0.47
3.	Interpret data and evidence scientific	52.88	80.95	0.55	54.09	71.15	0.22
	Average score	**58.45**	**86.79**	**0.61**	**59.37**	**78.49**	**0.39**

Based on Table 5, it is known that all aspects of the process have increased both in the experimental and clear control classes with the average N-Gain both in the medium category. But there is a higher significant difference in the experimental class with a difference of 0.22 (22%). If it is seen from the results of observations of student learning activities that are quite good, it turns out to be less significant with the results of N-Gain that more in-depth efforts are still needed to improve aspects of the process. The biggest process improvement is evaluating and designing scientific investigations in the experimental class with an N-Gain difference of 0.17 (17%) compared to the control class. Meanwhile, in the process of interpreting the data and scientific evidence, it turned out that both classes got a lower post-test average score, but the difference between the two classes was 0.33 (33%) which means that there is a significant difference between the experimental class and the control class. This shows that science process skills, including the ability to find resources, define, and understand the content, are basic professional skills (Turiman et al., 2012). The increase in literacy for the process/competence aspect can be seen more clearly in Figure 3.

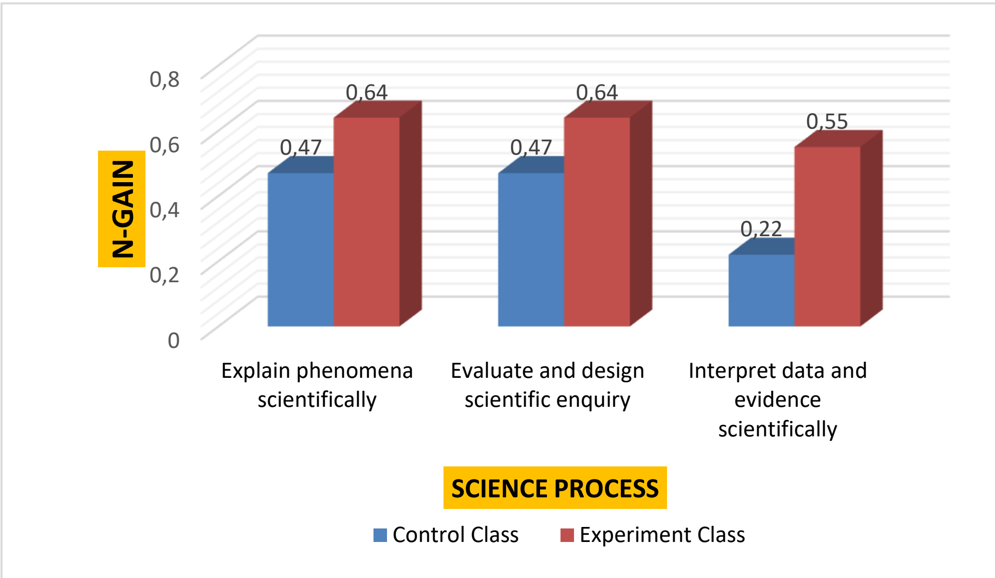

Figure 3. Bar chart aspects of students' scientific literacy process

The reduction in posttest results in the process of interpreting scientific data and evidence is generally in the question items in the form of graphs and tables from examples of experimental results, where this requires mastery of mathematics and reasoning power in connecting one data to another. Meanwhile, if seen from the results of observations of laboratory work activities they look skilled and active in discussions, discrepancies between these activities can occur because in interpreting the data it takes physical factors for skills and mental or psychological factors both cognitive and in students such as lack of learning and lack of habits of reading textbooks or other teaching resources to practice more actively in connecting the results of data based on experiments with theories and facts.

Based on table 5, it is known that the N-Gain from the process aspect gets the same results, so a T-test is carried out on the N-Gain results to determine the difference between the control class and the experimental class as shown in the table below.

Table 6. T-Test Results in Independent Sample of N-Gain in the Scientific Literacy Process

No.	Process Aspect Indicators	T-Test
1.	Explain phenomena scientifically	0.035
2.	Evaluate and design scientific investigations	0.042
3.	Interpret data and evidence scientifically	0.005

Based on the results of the T-test independent sample test from N-Gain in the process aspect, the results of the T-test were all still below the value of 0.05, which means that there is a significant difference between the experimental class that does webbed-type integrated science learning and the control class without integration.

Achievement of Attitude Aspect Ability in Experiment Class and Control Class

Ability in the aspect of scientific literacy attitude consists of 3 indicators, namely interest in science, respect for the scientific approach to environmental research, and awareness. Data collection for the attitude aspect was carried out after the completion of learning activities in both the experimental class and the control class. Results achievement of the attitude aspect is listed in Table 7 below.

Table 7. Data on scientific literacy ability aspects of attitude

Indicator Aspect Attitude	Class Average Experiment (%)	Class Average Control (%)
1. Interest in science	88.80	77.34
2. Valuing scientific approaches to inquiry	89.06	71.68
3. Environmental awareness	90.59	73.13
Average Score (%)	**89.49**	**74.05**

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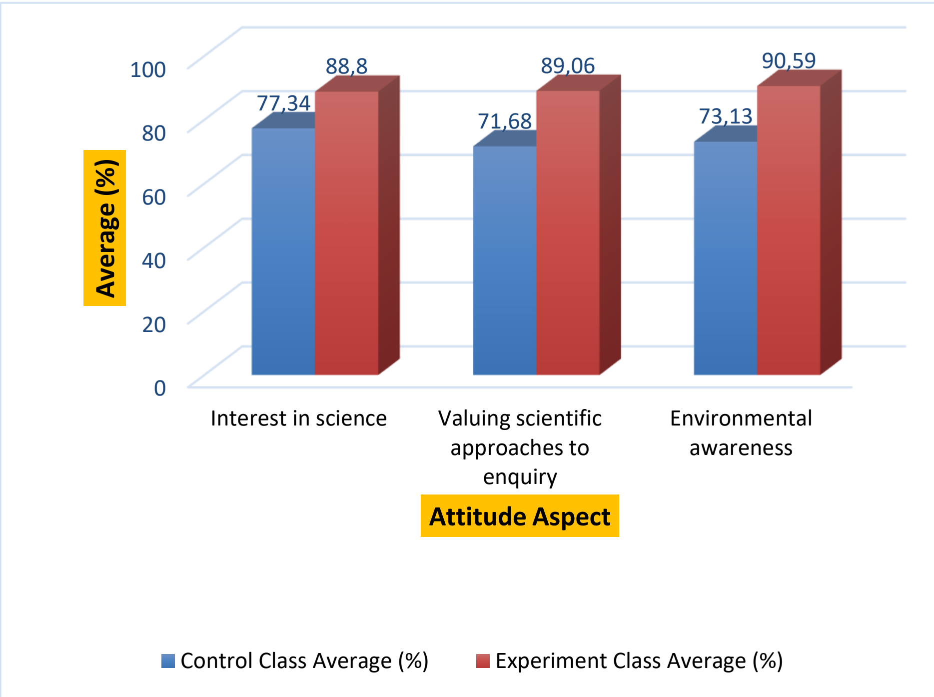
Based on these data, it is known that the highest overall average value of the attitude aspect is in the experimental class with a very strong category, while the control class is lower in the strong category. This happens because the learning is carried out using experimental methods which were previously rarely done so it provides new experiences for students. The number of discussions between teachers and students or among students' friends causes the class to come alive so that learning is more meaningful. This proves that webbed-type integrated science learning can improve scientific literacy attitudes. The highest increase in attitude was found in the environmental awareness indicator in the experimental class while the control class got a lower score. This indicates that students' awareness of the environment is significant after webbed-type integrated science learning because of direct observations in the field. In addition, environmental education imparts knowledge and experience to individuals by changing individual beliefs, attitudes, and behavior (Frantz & Mayer, 2014; Yeşilyurt et al., 2020). More details can be seen in Figure 4 below.



Student Response Questionnaire Results

Based on the results of the questionnaire responses of students to integrated science learning webbed type with the environmental pollution theme shows that most students are enthusiastic and motivated to learn with spirit as in Table 8.

Table 8. Questionnaire of student responses to webbed-type integrated learning

No.	Statement Indicator	Response			
		Yes	Percentage (%)	No	Percentage (%)
1.	Webbed-type integrated science learning makes it easier for me to comprehend and understand environmental pollution material	27	84.38	5	15.63
2.	Learning activities with laboratory work through integrated science learning webbed type gives a new experience and makes me very happy	32	100	0	0
3.	Learning activities with webbed-type integrated science learning make it easier for me to understand other materials related to environmental pollution as a whole	26	81.25	6	18.75
4	Webbed-type integrated science learning on the theme of environmental pollution is very close to everyday life	32	100	0	0
5.	Webbed-type integrated science learning encourages me to collaborate with friends in discussions and laboratory work activities	30	93.75	2	6.25

Based on Table 8 above, it shows that all experimental class students stated that webbed-type integrated learning is fun and can provide new experiences and themes that are very close to everyday life, which are classified as very strong criteria. For the statement of ease in understanding the theme of environmental pollution, it is still in the strong category. Generally, students' responses to the implementation of webbed type integrated science learning on environmental pollution material are very good. Most of the students support the webbed type of integrated science learning because it is fun, makes them more motivated to study environmental pollution that is close to their daily lives, and raises their curiosity attitude. The responses of other science study teachers who observed the webbed-type integrated science learning process were also good, so they wanted to also practice integrated science learning and were more enthusiastic to look for other themes that could be combined with related material content.

Testing Requirements Analysis

One of the characteristics of quantitative research is that statistical data tests are carried out, one of which aims to analyze research data that directs researchers to answer the problem formulation and test the proposed research hypothesis. This statistical test was obtained with the help of the SPSS version 22 program with the recapitulation results in Table 9 below this.

Table 9. Summary of statistical test results on students' scientific literacy skillss

No.	Tested	Test Type	Results	Conclusion
1.	Normality	Kolmogorof-Smirnov	0,200 Experiment 0,200 (Control)	Normal data Normal data
2	Homogeneity	Levene'test	0,001	Heterogeneous data (unequal variance
3	The results of the experimental and control class posttest	Independent sample test	0,000	The results are not the same there is a difference = Ha accepted

In addition to the various advantages in the application of webbed-type integrated science learning, there are several weaknesses found in this study, namely, Basic Competencies related to the main theme are not in one semester and some are even in different grade levels, making it a little difficult to assess each knowledge content or end-of-semester assessment; The amount of material related to the theme of environmental pollution causes it to take a long time more because it requires greater deepening so that less time will affect the level of mastery of students' scientific literacy. It takes creativity and skills as well as mastery of the concept of teacher material in integrated science learning so that learning can be more fun.

The results of this study also support several previously reported studies such as Chumdari et al. (2018) that concluded that the thematic integrated learning (webbed) from the experimental group could improve the character of students, furthermore, Novianti and Fitriani (2016) proved that there was an increase in process skills through integrated science learning with the webbed type and the shared type where the N Gain in the Webbed type was slightly higher compared to the Shared type. Suryaneza and Permanasari (2016) found that the experimental class with the webbed type integrated science learning treatment showed a significant increase in scientific literacy in the content and process aspects with the high category compared to the control class with the medium category.

CONCLUSION

Based on the description above, it can be concluded that webbed-type integrated science learning can improve aspects of the content, process, and attitude of students' overall scientific literacy with N-Gain achievement in the medium category. Based on the T-test, it was found that there was a significant difference between the experimental class using webbed-type integrated science learning and the control class without integration, which means there was an increase using webbed-type integrated science learning. The application of webbed-type integrated science learning with the theme of environmental pollution can improve students' scientific literacy in the content aspect with the acquisition of an N-Gain value in the medium category on soil pollution content in the experimental class, while in the process aspect, the largest increase is in the competence of evaluating and designing scientific investigations. In the aspect of scientific literacy attitude, the average achievement in the experimental class is very strong. The students' response to webbed-type integrated science learning on environmental pollution materials is generally very good, it can increase learning motivation, as well as foster new experiences. Webbed-type integrated science learning can improve scientific literacy because it is student-centered by prioritizing the scientific process.

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