Effects of mechanical wave learning material by integrating CTL strategy on environmental literacy of grade XI students

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Effects of mechanical wave learning material by integrating CTL strategy on environmental literacy of grade XI students

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Abstract. Learning in the 21st century should be connected to real world contexts. CTL strategy is one way to develop student skills. This is because learning process with a CTL strategy presents learning material that is related to the environment around students, in this way it can foster and improve students environmental literacy. In learning process, CTL strategy and environmental literacy can be integrated into learning material. However, the conditions found in the application of CTL strategy and environmental literacy in schools were still lacking. The solution to this problem is to use mechanical wave learning material integrated with CTL strategy for the environmental literacy of grade XI students. This research was a quasi-experimental research with a before and after design for related sample groups. The research instrument consisted of a knowledge aspect learning outcome test and student environmental literacy assessment sheets. The research data were analyzed using descriptive statistics and the two means comparison test for related groups. The result of the data analysis is the use of mechanical wave learning material integrated with CTL strategy has a positive effect on the knowledge aspect and environmental literacy of grade XI students.

1. Introduction

The educational challenges of the 21st century require students to possess a wide range of skills. The four skills are required by education graduates to get success in the 21st century, namely: ways of thinking, ways of working, tools for work, and skills for life [1] [2]. Besides that, literacy of students can be developed in education to improve and expand their abilities in the form of knowledge and concepts that can support their lives [3].

At the high school level, physics is one of the compulsory subjects. Physics is a branch of natural science that is fundamental for students to be able to understand natural phenomena that occur around them. In practice, physics subjects can be carried out by the teacher by relating to the real-world context that occurs in the environment around students. This can encourage the implementation of meaningful learning and involve students actively in the learning process.

The real conditions that occur in the field weren't in accordance with the expected ideal conditions. This can be seen from the preliminary studies that have been conducted. First, the application of CTL was still lacking. Second, the application of environmental literacy in physics learning was still lacking. Third, the textbooks used in the learning process in schools weren't connect to the environment around students. One solution to overcome the problem was to integrate a CTL strategy into physics learning material to improve the environmental literacy of students. The main

characteristic of the solution is the integration of the CTL strategy into physics learning material to improve the environmental literacy.

The contextual teaching and learning or CTL can be interpreted as a concept to help teacher connect learning material to real-world contexts [4]. CTL encourages students to be actively involved in finding and studying learning material, connecting learning material with real-world contexts, and applying it in their daily lives [5, 6, 7]. This means the material discussed in the classroom is close to their daily life so that active learning is created to build all the competencies possessed by students.

CTL can affect students achievement and attitudes [8]. In addition, CTL can improve the transfer of learning to students [9]. CTL approach has seven characteristics. First, learning is applied in a real world context, meaning that the learning material is related to the real world. Second, learning provides good opportunities for students to do meaningful tasks. Third, learning must provide meaningful experiences to students by observing and investigating an event. Fourth, learning is created through group work to facilitate students working in a small group. Fifth, learning facilitates students to study together, work together, and understand deep learning material through collaboration. Sixth, learning must be able to encourage student activity, creativity, and productivity in the learning process. Seventh, learning needs to create a pleasant atmosphere in constructing knowledge [6].

The essence of CTL is meaning, meaning, and meaning [10]. CTL consists of seven components, namely, namely: constructivism, finding, asking, the learning community modeling, reflection, and authentic assessment [11]. The application of CTL encourages students to be actively involved in constructing knowledge, asking questions, investigating an event, working in groups, and reflecting on their understanding. Asking, investigating, and reflecting are the three components of CTL which are believed to be able to develop the critical thinking skills of students. Through these three components, students are expected to be able to take advantage of existing models, then construct their own (constructivist) understanding of what they are learning [10].

CTL requires students to be close to their surroundings. Experience is obtained from interaction with the learning environment and knowledge construction in individuals [12]. From the experience gained from interacting with the environment, a skill called environmental literacy will emerge. Environmental literacy is a skill to develop sensitivity, awareness, understanding, critical thinking, and solve problems related to environmental problems and environmental ethics [13]. There are four formulations in environmental literacy. First, knowledge as a basic understanding of building awareness and environmental preservation. Second, skills as the ability to communicate, solve problems and seek information related to the environment. Third, attitude as a form of appreciation, openness, and tolerance with matters relating to the environment. Fourth, behavior is an action against the environment [14].

In learning physics, a CTL strategy and environmental literacy can be realized through the help of various media and learning resources. The CTL strategy is known as connecting, experiencing, applying, collaborating, and transferring. One of the learning resources that can realize the CTL approach and environmental literacy is learning material. In the learning process, learning material play an important role [15, 16]. First, learning material can make learning more interesting, realistic, practical, and meaningful [17, 18]. Second, it can improve learning outcomes, save time, increase students interest, and facilitate students memory [19]. Third, to develop self-confidence, self-actualization, and motivation of students [17, 20]. Also, the role of learning material can develop the three competencies of students, namely knowledge competencies, skills competencies, and attitude competencies, and can increase values in the learning process [21].

Physics learning material integrated with the CTL strategy is a learning material that link the material with real-world contexts and contain formulations or components of environmental literacy. This environmental literacy component provides students with understanding, abilities, attitudes, and actions towards the environment. This learning material has several advantages. First, it can make teachers and students aware of the environment. Second, the learning material is connected to a real-world context. Third, students can apply the material learned in everyday life. Fourth, it can make students easier in understanding the learning material. Fifth, make students active in learning. So that

the objective was to investigate the effect of using mechanical wave learning material by integrating CTL strategy on environmental literacy of grade XI students.

2. Method

This type of research was a quasi-experimental research. This research method can't fully control the external variables that affect the implementation of the experiment [22]. The research design can be included in the sample group before and after treatment. This means that the learning outcomes of one sample group after being given treatment were compared to before treatment. Limited field testing has been carried out in grade XI SMA Negeri 2 Padang with a total of 28 students. The effect of using mechanical wave learning material by integrating CTL strategy on environmental literacy was seen from the comparison after and before treatment.

The first assessment instrument on the aspect of knowledge before and after using mechanical wave learning material by integrating CTL strategy on environmental literacy uses a written test in the form of multiple-choice questions. Second, the instrument for assessing the aspects of students' environmental literacy uses an environmental literacy assessment sheet. In this case, environmental literacy includes knowledge, attitudes, skills, and behavior towards the environment.

The data in this research were analyzed by five kinds of statistics. The descriptive statistics was used to describe an object being studied through sample or population data as it is and is generally accepted [23]. The normality test was used to prove if the population under study is normally distributed. The homogeneity test was carried out to determine whether the population under study is the same variant. If the research data was normally distributed and in the same variant, the appropriate test to use was the correlated t-test. In this case, the correlated samples t test is a parametric statistical method. The correlated t-test was used to determine differences in knowledge aspect and the environmental literacy of students after and before using the mechanical wave learning material by integrating CTL strategy on environmental literacy. On the other hand, if the processed data doesn't meet the assumptions of using the parametric statistical method, it can use the Wilcoxon signed-rank test [24]. The purpose of the Wilcoxon signed-rank test to determine differences in students' abilities between after and before using mechanical wave learning material by integrating CTL strategy on environmental literacy for non parametric statistics.

3. Result and Discussion

The results of this research were to see the effect of mechanical wave learning material by integrating CTL strategy on environmental literacy on aspects of knowledge aspect and environmental literacy of students. The components of environmental literacy discussed in this research consist of four components, namely: knowledge, attitudes, skills, and behaviour towards the environment. The competency data of students knowledge and environmental literacy were compared between the data before and after the use of mechanical wave learning material by integrating CTL strategy on environmental literacy. Data regarding the ability aspect of student knowledge were analyzed using descriptive statistics and paired groups t test. The results of the data analysis on knowledge aspect of students can be seen in Table 1.

Table 1. Data analysis of knowledge aspect

Statistical Parameters	Knowledge Value		Reference Value
	Before	After	
Mean	65.29	80.57	
Median	70.00	80.00	
Modus	70.00	90,00	
Standard deviation	10.95	7.15	
Variance	119.99	51.07	
Minimum	45.00	70.00	
Maximum	83.00	90.00	

Statistical Parameters	Knowledge Value		Reference Value
	Before	After	
P-value of the normality test	0.0978	0.1372	0.1674
P-value of the F test	2.350		1.898
t-test of paired groups	-12,24		1.70

In the knowledge competency, it can be explained that the average value of after knowledge is higher than the knowledge before using the mechanical wave learning material by integrating CTL strategy on environmental literacy. After the normality test was carried out, it was found that the before and after knowledge data groups had a normal distribution. Meanwhile, from the homogeneity test using the F test, the calculated F value is greater than the F table. This means that the data on the value of knowledge before and after do not have the same variance. So, with these results to analyze the data using the correlated samples t test. The self-correlated t-test was used to analyze the difference between the two paired data. The t value for knowledge is -4.18. Meanwhile, in determining the t table, first, determine the degrees of freedom. The value of the degrees of freedom is obtained from the number of students minus 1. Degrees of freedom (dk) = 27 and the significant level used is 0.05, then the t table value is 1.70. Based on the acquisition of the t value which is negative, which is -4.18, then what is used in the t table calculation is the left side test. So that the t table yield becomes -1.70. Based on the t value that is in the null hypothesis area. The results of this hypothesis test indicate that there is a significant difference between the knowledge competencies of students before and after using the mechanical wave learning material by integrating CTL strategy on environmental literacy. Thus the use of mechanical wave learning material by integrating CTL strategy on environmental literacy is effective for improving the knowledge aspect of grade XI students.

Furthermore, the effect of using mechanical wave learning material by integrating CTL strategy on environmental literacy is seen from the aspect of environmental literacy. The components assessed are knowledge, attitudes, skills, and behavior towards the environment. The knowledge towards the environment data were analyzed to determine the value of the central tendency size and the size of the data distribution and the comparison of the two means of the paired groups. The results of the knowledge towards the environment data analysis can be seen in Table 2.

Table 2. Data analysis of knowledge towards the environment

Statistical Parameters	Knowledge Toward The Environment Value		Reference Value
	Before	After	
Mean	56.70	69.20	
Median	50.00	75.00	
Mode	50.00	75.00	
Standard deviation	7.97	8.66	
Variance	63.45	75.02	
Minimum	50.00	50.00	
Maximum	75.00	75.00	
P-value of the normality test	0.3354	0.2515	0.1674
P-value of the F test	0.182		1.898
Wilcoxon signed-rank test	-4.18		1.96

Based on Table 2, it can be described that the average value of knowledge towards the environment after being higher than before using the mechanical wave learning material by integrating CTL strategy on environmental literacy. After the normality test was carried out, it was found that the knowledge towards the environment data group before and after was not normally distributed. Meanwhile, from the homogeneity test using the F test, the calculated F value is smaller than the F table. This means, the data on knowledge towards the environment before and after has the same

variance. So, with these results to analyze the data using the Wilcoxon signed-rank test. The calculated Z value for the 28 students was -4.18 and the Z table value was 1.96. The calculated Z value is outside the area of acceptance of the null hypothesis. The results of this hypothesis test indicate that there is a significant difference between the knowledge towards the environment after using the learning material. Thus the use of mechanical wave learning material by integrating CTL strategy on environmental literacy has the effect of increasing knowledge towards environment of grade XI students at a 95% confidence level.

The effect of using mechanical wave learning material by integrating CTL strategy on environmental literacy is then attitude towards the environment. Data regarding students attitudes towards the environment were analyzed using descriptive statistics and Wilcoxon signed-rank test. The results of data analysis on students attitudes towards the environment can be seen in Table 3.

Table 3. Data analysis of attitudes toward the environment

Statistical Parameters	Attitudes Toward The Environment Value		Reference Value
	Before	After	
Mean	57.59	67.41	
Median	62.50	62.50	
Modus	62.50	62.50 dan 75.00	
Standard deviation	6.22	7.86	
Variance	38.65	61.80	
Minimum	50.00	50.00	
Maximum	62.50	75.00	
P-value of the normality test	0.2817	0.2696	0.1674
P-value of the F test	1.599		1.898
Wilcoxon paired comparison test	-3.79		1.96

Based on Table 3, it can be seen that the average value of attitudes towards the environment after being higher than before using the mechanical wave learning material by integrating CTL strategy on environmental literacy. After the normality test was carried out, it was found that the attitudes towards the environment data before and after was not normally distributed. Meanwhile, from the homogeneity test using the F test, the calculated F value is smaller than the F table. This means, data on attitudes towards the environment before and after have the same variance. So, with these results to analyze the data used the Wilcoxon signed-rank test. The calculated Z value for 28 students was –3.79 and the Z value for the table was 1.96. The calculated Z value is outside the area of acceptance of the null hypothesis. The results of this hypothesis test indicate that there is a significant difference between the attitudes towards the environment of students after using the learning material. Thus the use of mechanical wave learning material by integrating CTL strategy on environmental literacy affects improving attitudes towards the environment of grade XI students at the 95% confidence level.

Furthermore, the effect of using mechanical wave learning material by integrating CTL strategy on environmental literacy is seen from skills towards the environment. Data regarding the skills of students environment were analyzed using descriptive statistics and Wilcoxon signed-rank test. The results of data analysis on the skills towards the environment can be seen in Table 4.

Table 4. Data analysis skills towards the environment

Statistical Parameters	Skills Towards The Environment Value		Reference Value
	Before	After	
Mean	58.93	75.89	
Median	62.50	75.00	
Modus	50.00 dan 62.50	75.00	
Standard deviation	8.91	6.74	

Statistical Parameters	Skills Towards The Environment Value		Reference Value
	Before	After	
Variance	79.37	45.47	
Minimum	50.00	62.50	
Maximum	75.00	87.50	
P-value of the normality test	0.2705	0.3740	0.1674
P-value of the F test	1.746		1.898
Wilcoxon signed-rank test	-4.21		1.96

Based on Table 4, it can be stated that the average value of skills towards the environment after being higher than before using the mechanical wave learning material by integrating CTL strategy on environmental literacy. After the normality test was carried out, it was found that the skill towards the environmental data group before and after was not normally distributed. Meanwhile, from the homogeneity test using the F test, the calculated F value is smaller than the F table. This means, the skills toward the environment data before and after have the same variance. So, with these results to analyze the data used the Wilcoxon signed-rank test. The calculated Z value for the 28 students was –4.21 and the Z value for the table was 1.96. The calculated Z value is outside the area of acceptance of the null hypothesis. The results of this hypothesis test indicate that there is a significant difference between the skills towards the environment after using the learning material. Thus the use of the mechanical wave learning material by integrating CTL strategy on environmental literacy affects improving skills towards the environmental for grade XI students.

The effect of using mechanical wave learning material by integrating CTL strategy on environmental literacy is seen from behavior towards the environment. Data regarding student behavior towards the environment were analyzed using descriptive statistics and Wilcoxon signed-rank test. The results of the analysis of behavior data on students environments can be seen in Table 5.

Table 5. Analysis of behaviour towards the environment

Statistical Parameters	Behavior Towards The Environment Values		Reference Value
	Before	After	
Mean	58,48	72,77	
Median	62,50	75,00	
Modus	62,50	75,00	
Standard deviation	8,37	8,37	
Variance	70,06	70,06	
Minimum	50,00	50,00	
Maximum	75,00	100,00	
P-value of the normality test	0,2731	0,3592	0,1674
P-value of the F test	1,000		1,898
Wilcoxon signed-rank test	-3,92		1,96

Based on Table 5, it can be argued that the average value of behaviour towards the environment after being higher than before using the mechanical wave learning material by integrating CTL strategy on environmental literacy. After the normality test was carried out, it was found that the behaviour towards the environment data group before and after was not normally distributed. Meanwhile, from the homogeneity test using the F test, the calculated F value is smaller than the F table. This means, behavioural towards the environment data before and after have the same variance. So, with these results to analyze the data using the Wilcoxon signed-rank test. The calculated Z value for 28 students was –3,921 and the Z value for the table was 1.96. The calculated Z value is outside the area of acceptance of the null hypothesis. The results of this hypothesis test indicate that there is a significant difference between the behaviour towards the students the environment after using the

learning material. Thus the use of mechanical wave learning material by integrating CTL strategy on environmental literacy has an effect on improving behaviour towards the environment of grade XI students at the 95% confidence level.

From the results of other studies, the effect of learning can indicate a significant effect of the use of learning material by integrating CTL strategy seen in several aspects such as it can improve students' environmental literacy [25], student achievement and attitudes [26], transfer of learning to students [27], science process skills students [28], knowledge, attitudes, and competences of students' literacy skills [29]. This means that the results of this research are relevant to the results of other studies.

4. Conclusion

The result of the data analysis indicates that the use of mechanical wave learning material has a significant effect on the knowledge aspect and environmental literacy of grade X students. Environmental literacy includes knowledge, attitudes, cognitive skills, and student behavior towards the environment around them. Therefore, the use of mechanical wave learning material by integrating CTL strategy on environmental literacy can improve the knowledge aspect and environmental literacy of grade XI students.

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