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Mechanical Wave Module Based on CTL to Improve Environmental Literacy of Students

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Abstract— The 21st century brings a change in education. In order to compete in the 21st century, every education graduate must have good competence. CTL is the best way to develop student competence in this century. This is because CTL is closer to students' daily lives so that this teaching can increase the environmental literacy of students. However, the application of CTL in schools was still low. The solution to this problem is to use the mechanical wave module based on CTL into Physics teaching in schools. The purpose of this research is to determine the effect of the mechanical wave module based CTL on the environmental literacy of grade XI students. This research is a quasi-experimental research with a before and after design for one sample group. The research instrument consisted of a test of learning outcomes for the knowledge aspect and performance assessment sheet for the environmental literacy of students. The data were analyzed by descriptive statistics, normality test, homogeneity test, and paired comparison test. From the results of data analysis, it can be stated that the use of the mechanical wave module based on CTL has given a positive effect on the knowledge and environmental literacy of grade XI students with a confidence level of 95%.

Keywords — Mechanical wave, Module, CTL, Environmental Literacy.

I. INTRODUCTION

The 21st century is a century marked by rapid information spread and technology developing widely. The 21st century is also called the era of globalization as a result of the development of science and technology. With this basis, every person is required to be able to master science and technology and adapt to their circumstances by having various skills in running their lives. Assessment and Teaching of 21st Century Skills (ATC21S) categorizes skills in the 21st century learning into ways of thinking, ways of working, tools for working and skills for living in the world [1]. The Partnership for 21st Century Skills (P21) has identified the competencies needed in the 21st century, namely critical thinking, creativity, collaboration, and communication. These four skills need to be created and developed in the 21st century learning. Therefore, human resources must have a high quality so that it is easier to absorb new information,

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have a reliable ability to adapt to be able to compete and keep pace with the changing times.

Quality human resources can be produced from quality education. This is because education can create graduates who have competencies in accordance with the times. To be able to face the challenges of the 21st century a teacher must have good strategy, skills, and creativity in teaching. The role of the teacher in the 21st century is more to guide students to find information on everything they do. In other words, teaching is more context-based, meaning the content of learning material must be linked to the real world.

Contextual teaching and learning (CTL) places more emphasis on the process of full student involvement to be able to find the material being learned and relate it to real-life situations so that it encourages students to be able to apply it in their lives [2]. This means that the material discussed at school is close to the daily lives of students and in the teaching process, students must be more active in building all of their competencies. In building these competencies students can collaborate and communicate with other students.

Starting from the results of a preliminary study in three Padang city schools, West Sumatera, Indonesia showed several conditions in learning Physics in the 21st century [3]. First, the application of CTL with REACT strategies was still low. Second, the integration of CTL and environmental literacy in physics textbooks was low. Third, there was no module to support the Physics teaching process. This is due to the low interest of students in increasing learning resources. One solution to overcome this problem is the application of CTL in the Physics teaching process in schools.

CTL has been carried out on Chemistry teaching with the results of CTL research having an effect on student achievement and attitudes [4]. In addition to other studies, CTL can increase the transfer of learning in students [5]. This illustrates that the application of CTL in the Physics teaching process in schools can also improve students' knowledge aspect and environmental literacy.

CTL has five characteristics that can be applied in the teaching process [6]. First, there is cooperation and sharing with friends and mutual support. Second, students are active and critical, learning with passion, fun, and not boring, and teachers are required to be creative. Third, integrated learning using various sources. Fourth, class walls and hallways are full of student work such as maps, drawings, diagrams. Fifth, reports to parents are not just report cards but are the work of students, practical reports.

In CTL, there is a learning strategy that can be used, namely REACT strategy [7]. This REACT strategy consists of five aspects namely connecting, experiencing, implementing, collaborating, and transferring.

CTL requires students to be close to their daily lives or environment. In accordance with the results of research [8] experience comes from interactions with the learning environment and the construction of knowledge in an individual occurs through interactions between individual knowledge schemes and their experiences with the environment. To be able to explain every phenomenon in life, students must have a good environmental literacy.

Literacy is one of the important foundations for success in school and life [9]. Literacy means ability in reading and writing [10]. The environment is everything that exists around humans and then lives together and influences each other for the development of human life. Environmental literacy is a conscious attitude to maintain the environment so that the balance is maintained [11]. Environmental literacy according to Elder in [12] is the ability of an individual to make decisions in daily life regarding a broad understanding of how individuals and communities utilize existing natural resources and do so sustainably. Environmental literacy is defined as knowledge about the environment as well as one's attitude to make effective decisions in a variety of environmental contexts [13]. The purpose of the environmental literacy as student characters are to prepare people who are environmentally conscious so that environmental problems can be overcome, grow and make students aware of the environment and can solve problems in the environment[14, 15].

In order to develop environmental literacy, environmental education must develop an understanding of life in the environment, the causal relationship between human attitudes and behavior towards the environment, and foster responsible behavior towards the environment [16]. The results of the study stated that the environmental literacy of students is still stated low because of several factors, one of which the intention to know is and study environmental problems [17]. Thus, it can be concluded that environmental literacy is the ability of individuals to understand and interpret to make decisions in an environmental context. The concept of environmental literacy was developed from the concept of scientific literacy. In the world of education, environmental literacy can be formulated in students' soft skills and hard skills.

Environmental literacy ability can be measured through four components. The first component is environmental

knowledge. The indicator is the basics of the environment. The second component is the attitudes towards the environment. The indicators are the environment, sensitivity to environmental conditions, and feelings of environmental conditions. The third component is the cognitive skills of the environment. The indicators are the identification of environmental problems, environmental analysis, and planning for environmental literacy. The fourth component is behavior towards the environment. The indicator is the responsibility for protecting the environment [11].

CTL strategies and indicators of environmental literacy are integrated into a learning material in the form of the module. The use of learning material is needed to support the teaching process and make learning more directed. A module is a complete unit that stands alone and consists of a series of learning activities arranged to assist students in achieving a number of goals that are specifically and clearly formulated [18]. The development of the module can answer or solve problems or difficulties in learning. Modules can facilitate students more interested in learning and can improve learning outcomes. In addition, the module can help schools realize quality learning.

Modules have several characteristics. First, self-instructional, students are able to learn themselves, not dependent on other parties. Second, self-contained, all learning material from one competency unit studied is contained in one whole module. Third, stand-alone, the module developed does not depend on other media or does not have to be used together with other media. Fourth, adaptive, modules should have a high adaptive power to the development of science and technology. Fifth, user friendly, the module should also meet the familiar rules of being friendly with the wearer. Sixth, consistency, consistent in the use of fonts, spaces, and layout [19].

The module based on CTL is a module that contains a series of activities that emphasize the process of direct student involvement and make students aware of events that occur around. This module has several advantages including. First, by using this module students are able to explain natural phenomena in everyday life. Second, students become critical and care for the environment. Third, help students learn independently. Fourth, students can think of solutions to solve real problems in everyday life. Based on the results of the study [20] the use of CTL modules can improve students' critical thinking skills. The purpose of this research is to determine the effect of the mechanical wave module based on CTL on environmental literacy of students.

II. METHODS

The method of this research is quasi-experimental research. Experiment design can be grouped into before and after design for one sample group. In this design, knowledge and environmental literacy of students were assessed before and after using a mechanical wave module based on CTL.

The subject of the research was the students of grade XI in SMA Negeri 7 Padang. The sample of this research was a class of grade XI students. The number of students involved in research activities was 36 students. These students used this mechanical wave module in Physics teaching.

The instruments for collecting data in this research can be grouped into two parts. The first instrument was a written test to assess the knowledge aspect. The second instrument was the performance assessment sheets to assess the environ mental literacy of students including knowledge, attitudes, cognitive skills and behavior toward the environment.

The research data were analyzed using descriptive statistical analysis, normality test, homogeneity test, and paired comparison test. Descriptive statistical analysis was used to provide information about the knowledge aspect and environmental literacy of students. Statistical analysis parameters include mean, median, standard deviation, variance, minimum value, and maximum value. A normality test was used to determine normally distributed data groups. The homogeneity test was used to determine the variance of two distributions having the same value or different value. The paired comparison test was used to determine a difference in the average value of abilities after and before treatment.

III. RESULT AND DISCUSSION

The first result of the research is related to knowledge aspect of students. A pretest was given to students before using the module. After using the module in the teaching process for three meetings a posttest was given to students. The number of students who took part in the pretest and posttest was 36 students. Descriptive statistical parameter values, normality test, homogeneity test, and paired comparison test can be seen in Table 1.

Table 1. Data Analysis of the Knowledge Aspect

Statistical Parameters	Knowledge Value		Reference Value
	Before	After	
Mean	69.00	79.33	
Median	72.00	84.00	
Standard deviation	12.77	13.30	
Variance	163.09	176.91	

Minimum	36.00	40.00	
Maximum	92.00	92.00	
P-value of the normality test	0.12	0.17	0.15
P-value of the F test	1.08		1.76
Z value of the Wilcoxon test	-5.00		1.96

From the data in Table 1, it can be explained that the value of knowledge after using the module is higher than before using the module. There is an increase in the minimum value for the test before using the module and after using the module. This shows that an increase of the knowledge value of students before and after using mechanical wave module based on CTL.

The normality test value of 36 students before using the module is smaller than the reference value, while the normality test value after is greater than the reference value with a significant level used 0.05. This states that the data before the treatment are normally distributed, but after the treatment aren't normally distributed. The F test is performed to group the data before and after treatment to determine the homogeneity of the data. Based on the homogeneity test, the F value is smaller than the F table. This means that the data before and after treatment have the same variance.

The effect of the mechanical wave module based on CTL towards the knowledge aspect of students is determined investigated from the comparison of results before and after treatment. The Wilcoxon test is performed because the data after treatment aren't normally distributed.

The results of the Wilcoxon test analysis obtained the value of Z_{cal} = -5.00 while the value of Z_{table} = 1.96 with a significant level of 0.05. The calculated value is outside the area of acceptance of the null hypothesis. Based on these results it can be stated that there is a significant difference between before and after using the mechanical wave module toward the knowledge aspect of students. The existence of this difference explains that the use of the mechanical wave module based on CTL has given a significant effect on the knowledge aspect of students.

The second result of the research is connected to the environmental literacy of students. Environmental literacy consists of four indicators, namely: 1) environmental knowledge (EK), 2) environmental attitudes (EA), 3) environmental skills (ES), and 4) environmental behavior (EB). The average value of the environmental literacy of students can be seen in Figure 1.

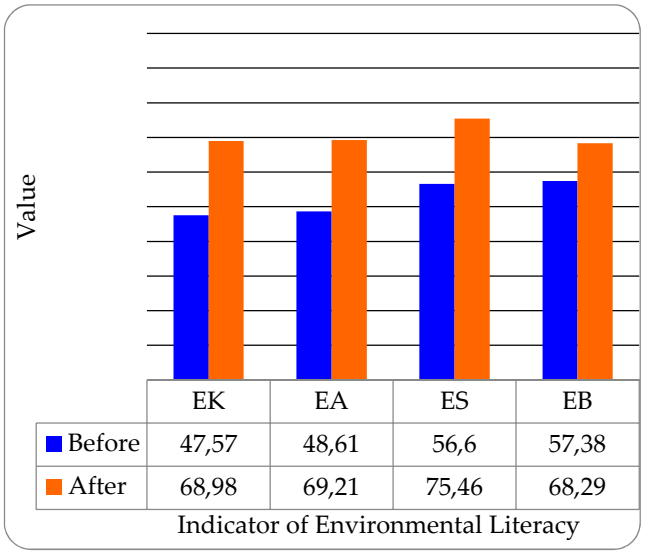

Fig 1. Average Value of Environmental Literacy Indicator

From the data in Fig 1, it can be stated that the average value of the four environmental literacy indicators of the environment after using the module is higher than before they used it. This average value indicates that the mechanical wave module can improve the environmental literacy of students.

The environmental knowledge of students was assessed before and after using the mechanical wave module based on CTL. Descriptive statistical parameter values, normality test, homogeneity test, and paired comparison test can be seen in Table 2.

Table 2. Data Analysis of Environmental Knowledge

Statistical Parameters	Calculated Value		Reference Value
	Before	After	
Mean	47.57	68.98	
Median	50.00	66.67	
Standard deviation	8.36	10.47	
Variance	69.82	109.55	
Minimum	37.50	50.00	
Maximum	62.50	83.33	
P-value of the normality test	0.25	0.14	0.15
P-value of the F test	1.57		1.76
Z value of the Wilcoxon test	-5.14		1.96

From data in Table 2, it can be described that increasing the environmental knowledge of students before and after using the mechanical wave module based on CTL, which is seen from the mean value obtained. The result of the normality test indicates that the data of environmental knowledge before using the module aren't normally

distributed, while the data after using the module are normally distributed. Based on the homogeneity test, it is known that data of environmental knowledge of students have homogeneous variance.

The Wilcoxon test is performed because the data before using the module aren't normally distributed. The Z value of the Wilcoxon test is -5.14. The calculated value is outside the area of acceptance of the null hypothesis. Based on these results it can be stated that there is a significant difference between before and after the use of the mechanical wave module based on CTL toward the environmental knowledge of students. The existence of this difference explains that the use of the mechanical wave module based on CTL has given a significant effect on the environmental knowledge of students.

The environmental attitudes of students were assessed twice before using the mechanical wave module. After using the module also assessed the environmental attitudes of students for three meetings. Descriptive statistical parameter values, normality test, homogeneity test, and paired comparison test can be displayed in Table 3.

Table 3. Data Analysis of Environmental Attitudes

Statistical Parameters	Calculated Value		Reference Value
	Before	After	
Mean	48.61	69.21	
Median	50.00	66.67	
Standard deviation	9.34	7.92	
Variance	87.30	62.78	
Minimum	25.00	58.33	
Maximum	62.50	83.33	
P-value of the normality test	0.30	0.21	0.15
P-value of the F test	1.39		1.76
Z value of the Wilcoxon test	-5.23		1.96

The mean value of environmental attitudes of students in Table 3 before and after using the mechanical wave module has increased from 48.61 to 69.21. The data of the environmental attitudes of students before and after using the module aren't normally distributed. On the other hand, the data before and after treatment have homogeneous variance.

The effect of the mechanical wave module on the environmental attitudes of students is determined by a Wilcoxon test. The Z value of the Wilcoxon test is -5.23. The calculated value is outside the acceptance area of the null hypothesis. The result of this test indicates that there is a significant difference between before and after using the mechanical wave module based on CTL towards the environmental attitudes of students. Therefore, the use of the mechanical wave module based on CTL has given a significant effect on the environmental attitudes of students.

The cognitive skills of students was assessed twice before using the mechanical wave module based on CTL. After using the module also assessed the environmental cognitive skills for three meetings. Descriptive statistical parameter values, normality test, homogeneity test, and paired comparison test can be seen in Table 4.

Table 4. Data Analysis of Environmental Cognitive Skills

Statistical Parameters	Calculated Value		Reference Value
	Before	After	
Mean	56.60	75.46	
Median	50.00	75.00	
Standard deviation	9.20	7.70	
Variance	84.70	59.30	
Minimum	50.00	58.33	
Maximum	75.00	91.67	
P-value of the normality test	0.37	0.27	0.15
P-value of the F test	1.43		1.76
Z value of the Wilcoxon test	-5.23		1.96

Table 4 shows that the mean value of the environmental cognitive skills before and after using the mechanical wave module can be increased. The result of the normality test indicates that the data of the environmental cognitive skills before and after using the module aren't normally distributed. On the other hand, the result of the homogeneity test gives information that the data of the environmental cognitive skills have the same variance.

Based on the results of the normality and homogeneity test, a Wilcoxon test was conducted. The calculated value of Z is outside the acceptance area of the null hypothesis. It is mean that there is a significant difference in the environmental cognitive skills of students between before and after the use of the mechanical wave module based on CTL. The existence of this difference explains that the mechanical wave module based on CTL has a significant effect on the environmental cognitive skills of students.

The environmental behavior of students was assessed before and after using the mechanical wave module. The value of the descriptive statistical parameter, normality test, homogeneity test, and Wilcoxon test can be seen in Table 5.

Table 5. Data Analysis of the Environmental Behavior

Statistical Parameters	Calculated Value		Reference Value
	Before	After	
Mean	57.38	68.29	
Median	57.82	66.67	
Standard deviation	8.05	7.92	
Variance	64.82	62.78	
Minimum	50.00	50.00	
Maximum	75.00	83.33	
P-value of the normality test	0.29	0.16	0.15
P-value of the F test	1.03		1.76
Z value of the Wilcoxon test	-5.12		1.96

Based on the data in table 5, it can be described that the mean value of the environmental behavior of students before and after using the mechanical wave module can be improved. The data of the environmental behavior of 36 students before and after using the module aren't normally distributed. Meanwhile, the result of the F test, it is known that the data before and after treatment have a homogeneous variance.

The data analyzed by Wilcoxon test because the data aren't normally distributed. The value of the Wilcoxon test is -5.12. The calculated value is outside the acceptance area of the null hypothesis. Thus, it can be stated that there is a significant difference in the environmental behavior of students between before and after the use of the mechanical wave module based on CTL. This difference indicates that the use of the mechanical wave module based on CTL has given a significant effect on the environmental behavior of students.

The results of this research are supported by several other studies. The effects of learning can be indicated by the significant effects of the use of integrated learning materials on CTL in several aspects such as student achievement and attitudes [4], transfer of learning to students [5], students' science process skills [21], knowledge and digital literacy students [22], knowledge, attitudes, and competencies of students' literacy skills [23]. This means that the results of this research are relevant to the results of other studies.

IV. Conclusion

Based on the results of data analysis, it can be concluded that the use of the mechanical wave module based on CTL has a positive effect on t²he knowledge aspect and environmental literacy of grade XI students. This result indicates that the use of mechanical wave module based on CTL can improve the knowledge aspect and environmental literacy of students.

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