

Problem Based Learning Model using Exe-Learning for Mechanical Waves

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Abstract. Mechanical Wave is considered as an abstract materials in physics, thereby requires support from learning media for contextual problems presentation. The present research applies the exe-learning in the model of problem based learning. Such eXe shall encourages to troubleshooted, analyzed and finding the solution for authentic problem as well as scientific attitude that expected to emerge as a result of their learning process. The research method used was a quasi- experiment design with nonequivalent control group. The results showed that using problem based learning model-assisted exe-learning able to improve student's learning outcomes as well as promoting the scientific attitude of medium and higher level. Therefore, this research may serve as an alternative for learning physics thus becoming more effective and efficient.

Keywords: Problem Based Learning Model, Exe-Learning, Mechanical Waves

1 Introduction

Mechanical Waves is one of the abstract concepts of physics [1] which is considered difficult by students in term of cognitive aspects [2], which lead to poor comprehension of such concept by the student [3]. The problems experienced by the students i.e. difficulty in understanding the basic concept of mechanical waves. For example, students are frequently having misconception about the direction and the wave speed [4]. The equation to determine the waves speed is as follows:

$$v = \lambda \cdot f.$$

Where f is the wave frequency and λ is the wavelength [5]. To determine the refraction index, n is a relative index of two medium inter alia as shown in the following equation:

$$n = \frac{|U_i|}{|U_t|}$$

Where $|U_i|$ is the initial speed in medium 1, and U_t is the final speed (2 medium). This shows that n is the refraction index of the two mediums (bending) of the coming wave [6]. Interference is a fusion of coherent two waves. To determine the wave interference using the formula of the Pythagorean theorem:

$$\Delta D = d \sin \theta$$

Where ΔD is the distance between two sources coherent with the site where the interference pattern is observed, d is the distance between two coherent sources and θ is the angle. Compare wave diffraction by a slit width of wavelength [7].

As mentioned previously regarding poor conceptual comprehension rooting from less suitable model and learning method applied for the intended topic [8]. The student's misconception is that the wave transfers the material while in fact the wave only transfers energy [4]. One of the learning models able to minimize misconception of the mechanical wave is a model of problem based learning (PBL) [9] [10]. PBL model is a learning model which involves the contextual issues, generating students with the ability to apply the skills of problem solving in real life, and provide an opportunity to engage students in an exploration of problem solving [11]. PBL model may improve communication between students from interaction with the rest of the Group [12], enhance cooperation in group activities, student understanding of the concepts, engage in working independently, and participate in the discussion [13]. Discussions with classmates to build communication between mates in problem solving [14], by applying the knowledge [15].

Problem based learning model is composed of five stages of learning consisting; students focus on the issue, organized the students learning, individual and group investigations, developing and presenting the work, analyzing and evaluating the process of problem solving [16]. The model of problem based learning encourages students to be able to interpret, collect new information, identify solutions and methods, solve problems, collaborate, discuss, and compare the idea to produce a conclusion [17] [18], as well developing a scientific attitude in physics [19]. In addition to improve the learning outcomes, the psychomotoric also improve [20]. The scientific attitude is the attitude toward science of how the students feel and think about science [21]. Scientific attitude is related to student learning outcomes. Kaptan and Korkmaz have conducted research on the influence of PBL effect on the scientific attitude of students [22].

PBL model encourage students to understand concepts through discussion, students collaboration, social interaction supported by computer device [23]. Computer devices is one of the tools to support the student's learning process [24], and try to understand some concepts that are abstract [25]. Learning media used is the eXe learning media [23]. It's easy to use without extensive programming language [26].

Based on the above explanation, the study objective is to apply PBL model by using the eXe-Learning in learning the characteristics of mechanical wave, and to determine its effect to the learning outcomes and scientific attitude of the students. The attitude observed is attitude after learning, by observing the academic ability of students. Academic ability is the individual ability that allows them to give a proper response on stimulus received [27], processing information and improving the ability to complete tasks [28].

2 Methodology

The population in this study is the entire students of XI MAN 3 Tangerang. The sample in the study is grade XI IPA 2 as a experimental group and Class of XI IPA 3 as the control group. Academic ability of the students is grouped into 3 groups including students who possess higher academic ability as much as 7 students, There are 20 students who have middle academic ability, and 8 students who have poor capability either in experimental or

control group. Experimental group were taught with the model of problem based learning assisted exe-learning, while the control group is taught using the conventional model.

The research method used was quasi experiment method with the nonequivalent control group design research design [29][30]. Sampling techniques is the purposive sampling techniques [31] [32].

Da sampling in this studwas conducted using the test and non-test. Testing method was utilized to measure learning outcomes in the form of pre-test and post-test. The instruments utilized are leartning outcomes test and scientific attitude quotioner. Test results obtained subsequently analyzed using a test N-Gain equation 1 [33].

$$N - Gain = \frac{posttest - pretest}{100 - pretest} \quad (1)$$

Determination of N-Gain value criteria is $0 < G < 0,3$ low Category, $0,3 \leq G < 0,7$ medium Category, dan $0,7 < G$ High Category [34]. Prerequisite test utilized the test of normality (Kolmogorov-Smornov test) and homogeneity test (test Levene). Test hypotheses utilized the parametric tests was Test T with significance level 5% ($\alpha = 0.05$).

The scientific attitude data were calculated using formula as follows: [35]

$$Percentage = \frac{score}{maximum\ score} \times 100\%$$

Determination of scientific attitude criteria is very good (86%-100%), good (76%-85%), sufficient (60%-75%), poor (55%-59%) and very poor ($\leq 54\%$) [36].

3 Result and discussion

3.1 Learning Outcomes

Before treatment, we firstly conducted the pre-test to define the experiment and controls. Pre-test result was analyzed with Normality test of Kolmogorov-Shapiro Wilk as summarized in Table I below:

Tabel 1. Pre-test normality test

Academic Ability Group	Experiment Group		Control Group	
	Signification	Description	Signification	Description
Low	0.200	Normal	0.200	Normal
Middle	0.117	Normal	0.023	Not Normal
High	0.030	Not Normal	0.200	Normal

Table I shows the results of normality test in pre-test. In, experimental group of poor and middle academic ability the data are normal, while the higher academic ability group has abnormal data. The academic control group which has normal data: poor and high academic ability.

Post-test results in analysis with test Kolmogorov-Shapiro Wilk normality on table II:

Tabel 2. Posttest normality test

Academic Ability Group	Experiment Group		Control Group	
	Signification	Description	Signification	Description
Low	0.200	Normal	0.200	Normal
Middle	0.026	Not Normal	0.200	Normal
High	0.200	Normal	0.200	Normal

Table II shows the results of the post-test normality test in the experimental group and the control group. In the normality data, experimental group has normal data for low and high academic skill. Meanwhile all the data in control group is normal. the pre-test and post-test data were subsequently tested for their homogeneity to determine whether data is homogenous or heterogeneous. Homogeneity was tested using the Levene test using SPSS 21 and the result is summarized in the following Table III:

Tabel 3. Pre-test and post-test homogeneity test

Academic Ability Group	Experiment Group and Control Group			
	Pretest		Posttest	
	Signification	Description	Signification	Description
Low	0.114	Homogen	0.420	Homogen
Middle	0.547	Homogen	0.563	Homogen
High	0.155	Homogen	0.119	Homogen

Table III shows the results homogeneity test upon pre-test and post-test. It is shown that the experiment group and the control group obtained a homogeneous data in every level of academic ability of students. Pre-test and post-test data are re-tested with hypothesis test to determine the effects of the treatments. Hypothesis test results is summarized in the table IV below:

Tabel 4. Pre-test and post-test hypothesis test

KKA	Pretest		Posttest	
	Signification	Description	Signification	Description
Low	0.468	H ₁ rejected	0.189	H ₁ rejected
Middle	0.494	H ₁ rejected	0.000	H ₁ accepted
High	0.115	H ₁ rejected	0.008	H ₁ accepted

Table IV above shows that the use of the model of problem- based learning assisted exe learning may improve learning outcomes of students on academic ability groups, and higher academic ability. Students who learn to use the problem-based learning model is expected to connect the personal understanding of any of the information with previous experience, self-reliant and able to make decision on subject of learning to cultivate the motivation [37]. Exe learning media creates more flexible learning structure, easy, and can be updated. Exe learning media may have an effect on students' cognitive ability and the ability of the creative thinking

[28]. Model of problem-based learning assisted exe-learning may improve student learning outcomes [38]. This is in accordance with the results of N-Gain of the learning outcomes. The results of the value N-Gain student learning results is shown in table V below:

Tabel 5. N-gain student learning outcomes

Academic Ability Group	Experiment		Control	
	N-Gain	Category	N-Gain	Category
Low	0.55	Middle	0.43	Middle
Middle	0.65	Middle	0.52	Middle
High	0.73	High	0.54	Middle

Table V above indicates that the experimental group has a value of N-Gains higher than that of control group, in both of the student's academic ability group, poor, middle academic ability, as well as a group of high academic ability. Problem-based learning may improve student learning outcomes [37]. Problem-based learning is developed to assist students to improve the student's thinking ability, problem-solving ability, and intellectual skills; connecting experience acquired through various situations, real or simulated situations; and become an independent learner [23].

Tabel 5. Scientific attitude of students

No	Scientific attitude of Students	Low Academic Ability		Middle Academic Ability		High Academic Ability	
		%	Conclusion	%	Conclusion	%	Conclusion
1	Inquisitive	77.68	Good	85.31	Good	89.28	Very Good
2	respect to data	81.25	Good	85	Good	86.61	Very Good
3	critical thinking	80.36	Good	83.33	Good	89.28	Very Good
4	attitude of discoveries and creativity	80.36	Good	80	Good	85.71	Good
5	open thinking and cooperation	84.53	Good	83.54	Good	83.93	Good
6	Persistence	83.33	Good	80.83	Good	86.31	Very Good
7	sensitive to the surrounding environment	84.82	Good	82.19	Good	83.93	Good
Avarage		81.76	Good	82.89	Good	86.44	Very Good

4 Conclusion

The use of models of problem-based learning assisted exe-learning may enhance the learning outcome of students in the groups of middle and high academic ability related to comprehension of the concept and characteristics of wave mechanics, as well as improving the student's scientific attitude

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