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EFFECT OF PROBLEM-BASED LEARNING AND INITIAL ABILITY ON AUTOMOTIVE ENGINEERING LEARNING OUTCOMES

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Abstract. *The purpose of this study was to enhance the life skills of students of Light Vehicle Engine Maintenance at vocational high school level, in which the problem-based learning is necessary to enhance their machinery learning. The problem-based learning can promote students' self-study skills and better problem solving skills. It therefore can provide greater engagement in learning. One of the ways to promote learning is to consider students' initial ability. The present research aimed at examining the differences in the effect of Problem Based Learning and students' initial abilities on their achievement in Light Vehicle Engine Maintenance learning. This study was a quasi-experimental study with 2 x 2 or 22 factorial designs. A total of 127 eleventh-grade vocational high school students of Light Vehicle Engine Maintenance participated in the study. The data were collected by tests and non-tests. They were then analyzed by 2-way ANOVA. The results showed that the students' learning outcomes was improved when the teacher applied the Problem Based Learning model without having to look at the students' initial abilities. This is due to the fact that the learning model and the initial abilities did not have a significant interactional effect on learning outcomes students' learning outcomes.*

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A. INTRODUCTION

The learning model has a considerable contribution in teaching and learning activities. The ability to capture lessons by students can be influenced by the selection of the appropriate learning model. Accordingly, the set learning objectives will be attained. There are various types of learning models that can be used as alternatives for teachers to make classroom learning activities effective and optimal. One of them is by using the problem-based learning model. Students are placed as teaching subjects who actively construct their knowledge and skills, according to their capacity and level of thinking, while being invited to collaborate to solve real problems in society (Nichols, 2015). According to Eggen & Kauchak (2012), the problem-based learning can encourage understanding the material in depth and develop students' critical thinking skills. When students provide evidence for conclusions obtained, this is actually the essence of critical thinking. In addition, the problem-

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based learning can effectively improve problem-solving skills. This is because problem-based learning has the distinctive characteristics as follows: (1) the lesson focuses on problem solving; (2) responsibility for solving problems is on the students' hands; and (3) the teacher supports the process when students work or solve problems.

In addition to choosing the appropriate learning model in the teaching and learning process, to understand new things someone needs capital in the form of abilities that have been attached to it and that are related to new things to be learned which are called initial abilities. The initial ability (entry behavior) is basically the state of knowledge and skills that must be possessed first by students before he learns new abilities or skills. Filgona and Sababa (2017) suggest that learning will work well, starting from what students already know, both the knowledge and behavior of the preconditions for the next teaching material. A person's initial abilities have an influence on the learning outcomes. That is, students who have high initial abilities, will have a tendency to achieve high learning outcomes. Based on the description above, then by selecting the suitable learning model and by paying attention to the initial abilities of students, it is expected that the student achievement can be improved more effectively.

There have been numerous studies on the use of the problem-based learning to enhance the students' learning success in any kind of subjects, in particular in their problem-solving skills. Some of them were Nurdyansyah et.al. (2017), Hasrida (2017), Lestari (2017), Hevriansyah & Megawanti (2016), Purwaningrum (2016), Rahmat (2016), and Yew and Goh (2016). The studies investigated the effectiveness of the problem-based learning models. The studies employed various research methods including quantitative, qualitative, literature studies, and research and developments. The results revealed that the problem-based learning models mostly and significantly impacted the students' learning at all their schooling levels. However, there have been a few studies investigated the effectiveness of the problem-based learning models at the vocational school settings.

The present study therefore investigated therefore the effect of using the problem-based learning model and the students' initial abilities upon their achievements in Light Vehicle Engine Maintenance learning. It was intended to discover the differences in the students' achievements in Light Vehicle Engine

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Maintenance learning that was used the problem-based learning model and the conventional learning model.

B. RESULT AND DISCUSSION

This quasi-experimental study employed a nonequivalent pre-test and post-test control-group design. The subjects belonging to the experimental study were divided into the experimental group and the control group, but the classification of groups could not be done by random techniques. The groups were randomly assigned (Degeng & Sutomo, 1998; Creswell, 2009). The research sample can be presented as in Table 2.1.

Table 2.1. Samoles of Thr Study

Names of Schools	Classes	Groups	Number of Students
SMKN 1 Jetis	XI-TKR1	Experimental	32
	XI-TKR2	Control	31
SMKN 1 Pungging	XI-TKR1	Experimental	32
	XI-TKR2	Control	32
Total			127

The teaching and learning process is carried out in 8 meetings, with an allocation of 8 x 45 minutes per meeting. There were two kinds of data collection techniques. They were tests and non-tests. There were two types of tests used in this study, namely subjective tests that included descriptions tasks and practical tests. Subjective test instruments form a description to measure the variables of student learning outcomes in the cognitive realm (knowledge), while the practice test/performance test to measure the variables of student learning outcomes in the psychomotor domain (skills). The non-test data were obtained from the X-TKR class students learning report book. The determination of the initial high and low abilities category was on the basis of the value (on average) of the productive subjects of the X-TKR class. If the scores obtained by students were less than normal, the students were categorized as having low initial abilities, and vice versa, if the scores obtained by the students were more than normal, then the students fell into having high initial abilities category.

Then the data were processed and analyzed in both descriptive and inferential statistics. In this study, the data normality test used the Kolmogorov Smirnov test tool. The criterion is that if the probability value or significance lev-

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el of the calculation was greater than the significance level of the study (i.e 0.05), it can be said that the data from the existing samples are normally distributed (Santoso, 2014). Meanwhile, one of the test tools that can be used to test the homogeneity of variance is Lavene test (Santoso, 2014). The criteria if the mean probability value (mean) or the level of significance of the calculation is greater than the significance level of the study (i.e 0.05), it can be said that the data came originaaly from populations that had the same variance (homogeneous). To do both tests, namely: data normality test and homogeneity of variance, the IBM SPSS Statistics 20 for Windows application program assistance was applied.

After all the parametric assumptions are met, the next step is testing the research hypothesis. To test whether there is a difference between the application of the learning models (problem-based vs. expository learning) and the initial ability (high vs. low) on student learning outcomes, the two-way factorial 2x2 ANOVA was used. The hypothesis testing of the study was carried out with the help of the IBM SPSS Statistics 20 for Windows computer application program (Santoso, 2014).

The null hypothesis testing was carried out at the level of significance of the study of 5% or 0.05. Decision making on the acceptance or rejection of the null hypothesis (Ho), was done by comparing the probability value (sig.) of F count with the significance level of the study (0.05). If the calculated value had a probability or significance level of less than 0.05, then the null hypothesis (H0) was rejected. Contradictorily, if the value of Fcount has a probability or significance level of more than 0.05, where is the null hypothesis (H0) accepted. Before conducting the research hypothesis testing, the following steps were taken.

The research subjects based on the model of learning and level of initial ability is shown in Table 2.2 below.

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Table 2.2 Research Subjects Based on Learning Models and Student Initial Ability

		Learning Models		Total
		Problem-Based	**Exspository**	
Students' Initial Abiities	**Mean**	75.54	75.05	
	Low (<Mean)	32	36	68
	High (>Mean)	32	27	59
Total		64	63	127

The results of the Light Vehicle Engine Maintenance learning outcomes in posttest, both in each treatment group (problem-based learning model and expository learning), as well as overall are presented in Table 2.3.

Table 2.3 Descriptive Statistics of Post tests of Light Vehicle Engine Maintenance learning

Learning Models	**Initial Abilities**	**Number of Samples (N)**	**Means of Post tests on learning outcomes**	**Standard Deviation**
Problem= based	Low	32	72,37	6.32
	High	32	75,33	6.49
	Total	*64*	*73.85*	*6.53*
Expository	Low	36	63.60	6.39
	High	27	67.66	8.11
	Total	*74*	*65.34*	*7.40*
Total	Low	68	67.73	7.69
	High	59	71.82	8.18
	Total	*127*	*69.63*	*8.15*

The results of the normality test of learning outcomes test with the Kolmogorov Smirnov statistical test are shown in Table 2.4.

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Table 2.4 Results of the normality test of learning outcomes test with the Kolmogorov Smirnov statistical

Learning outcomess (Dependent Variable)	**Kolmogorov-Smirnov**		
	Statistic	**df**	**Sig.**
Experimental group	0.072	64	0.200
Control group	0.075	63	0.200

Based on the contents of Table 3.1 above, it can be seen that the probability value (significance) of the calculation, both the learning outcomes variables of the experimental group and the control group = 0.200> 0.05 (significance of the study). It can be concluded that the post-test data on student achievement in the two research groups were normally distributed. The next assumption test that must be fulfilled in the statistical analysis with two-way ANOVA 2 x 2 is the test of variance homogeneity. The test results of the variance homogeneity between groups in the learning outcomes variables are presented in Table 2.5.

Table 2.5 Results of the variance homogeneity between groups Lavene Test

Independent Variables	**F**	**df1**	**df2**	**Sig.**
Learning outcomes	0.943	1	125	0.333

Based on the contents of Table 4.1 it can be shown that the probability value (significance) calculation of the learning outcomes variable with Lavene test was 0.333. The probability value (sig.) of the calculation is> 0.05. So it can be concluded that the variance between groups (groups) in the learning outcomes variable was homogeneous.

After all the assumption tests that needed to be carried out were fulfilled, the next step was testing the research hypothesis with two-way ANOVA 2 x 2. The hypothesis testing of the research was done with the help of IBM SPSS Statistics 20 for Windows computer application program.

The two-way used to test three research hypotheses (alternative hypotheses), namely:

Ha1 = There is a significant difference in Light Vehicle Engine Maintenance learning outcomesoutcomes between groups of students who use problem-based learning models and groups of students who use expository learning

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model in class XI-TKR.

Ha2 = There are significant differences in Light Vehicle Engine Maintenance learning learning outcomesoutomes between groups of students who have high initial abilities and groups of students who have low initial abilities in the XI-TKR class.

Ha3 = There is a significant interaction effect between the learning model and the initial ability to Light Vehicle Engine Maintenance learning outcomes in class XI-TKR.

Each research hypothesis (alternative hypothesis) above can be transformed into a null hypothesis (H0) as follows.

Ho1 = There is no significant difference in Light Vehicle Engine Maintenance learning outcomes between groups of students using the problem-based learning model with groups of students using the expository learning model in the XI-TKR class.

Ho2 = There is no significant difference in Light Vehicle Engine Maintenance learning outcomes between groups of students with high initial abilities and groups of students who have low initial abilities in the XI-TKR class.

Ho3 = There is no significant interaction effect between the learning model and initial ability on Light Vehicle Engine Maintenance learning outcomes in class XI-TKR

The results of hypothesis testing with two ways of ANOVA 2 x 2 factorial in Table 2.6.

Table 2.6 Results of Main Effect and Interaction between Variables (Tests of Between-Subjects Effects)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2693.403[a]	3	897.801	19.430	0.000
Intercept	611239.299	1	611239.299	13228.194	0.000
Learning_Model	2122.350	1	2122.350	45.931	0.000
Initial_Abilities	387.652	1	387.652	8.389	0.004
Learning_Model * Initial_Abilities	9.293	1	9.293	0.201	0.655
Error	5683.499	123	46.207		
Total	624100.370	127			
Corrected Total	8376.902	126			
R Squared = 0.322 (Adjusted R Squared = 0.305)					

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Effect of the Implementation of Learning Models on the Light Vehicle Automotive Maintenance Learning Outcomes.

The results are obtained after the two groups are given each treatment. In total, the group of students treated with problem-based learning models obtained a mean score of 73.85, higher than the group of students treated with the expository learning model, which was 65.34. Based on the first hypothesis test results (Ho1) it can be shown that the value of Fcount = 45,931 and sig. calculation = 0.000 <0.05 (significance level of research). It can be concluded that Ho1 is rejected, and Ha1 is accepted. So that it can be interpreted that there is a significant difference in Light Vehicle Automotive Maintenance learning outcomes between groups of students treated with a problem-based learning model and groups of students treated with expository learning models. The significant difference in Light Vehicle Automotive Maintenance learning outcomes between the two treatment groups showed that Light Vehicle Automotive Maintenance learning outcomes was influenced by the learning model applied. These findings indicate that the application of problem-based learning models has a better influence on the acquisition of Light Vehicle Automotive Maintenance learning outcomess than on the application of expository learning models. In other words, it can be interpreted that the application of a problem-based learning model is more effective in obtaining Light Vehicle Automotive Maintenance learning outcomes than the application of an expository learning model.

This finding is consistent with the results of research conducted previously by Darsana et al. (2013); Moestafa (2013); Prastyo (2014), and Mujiono (2015) concerning the effect of Problem-Based Learning on Learning Outcomes of Grade 10 students in Vocational Engineering concluded that there were significant differences in the earning outcomes among the students treated by using the problem based learning model with the students who utilized the conventional learning. The student learning outcomes taught by using a problem-based learning model were higher than the learning outcomes of the students who were taught using conventional learning.

Effect of Initial Ability on Light Vehicle Automotive Maintenance Learning Outcomes.

The results of descriptive statistical analysis show that the group of students who possessed high initial abilities obtained an average value of learning out-

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comes of 71.82, while the group of students having low initial abilities obtained an average value of learning outcomes of 67.73. These results indicate that the group of students who had high initial abilities obtained better grades in the learning outcomes than the group of students with low initial abilities.

On the basis of the results of the second hypothesis test it is shown that Fcount = 8.389 and the significance of the calculation = 0.004 <0.05, so it can be concluded that Ho2 was rejected and Ha2 was accepted. This can be interpreted that there was a significant difference in the learning outcomes between the students who had high initial abilities and the students who had low initial abilities. The difference in the learning outcomes that was significant in both groups of students with different initial ability levels indicates that the students' ability level affected the acquisition of the student learning outcomes. The acquisition of better learning outcomes in the students with high initial ability levels in accordance with Santyasa (2005) which suggests that initial abilities affected directly and indirectly in the learning process. The findings of this study are in accordance with previous studies conducted by Astuti (2013); Hevriansyah & Megawanti (2016); Purwaningrum (2016); Rahmat (2016); Hasrida (2017); and Lestari (2017).

Effect of Interaction of Learning Model and Initial Ability on Learning outcomes of Light Vehicle Automotive Maintenance.

Kerlinger (1986) defines interaction as the collaboration of two independent variables or more deeply influences a dependent variable; whereas the meaning of interaction influence is the combined effect of two or more independent variables on the dependent variable.

From the results of the third hypothesis test it can be shown that there was no significant interaction effect between the learning model and the students' ability on Learning outcomes of Light Vehicle Automotive Maintenance in the XI-TKR class of the vocational high schools. This is indicated by the results of analysis with two-way ANOVA. The value of Fcount = 2.247 and the significance level of calculation = 0.655> significance level of the study, which is 0.05. This means that Ho3 was accepted.

The absence of interaction effects between the two independent variables, namely the learning model and the students' initial abilities indicate that each of the independent variables had a strong influence on the dependent variable, namely learning outcomes of Light Vehi-

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cle Automotive Maintenance separately and independently (individually). This statement is in accordance with the results of the first and second hypothesis tests discussed in the previous two subchapters. The absence of a significant interaction effect between the learning model and the initial ability of students towards the learning outcomes is in accordance with several previous research findings. The results of Purwaningrum's study (2016); Rahmat (2016); and also Hasrida (2017) shows that there is no significant interaction effect between the learning model and the initial ability to obtain the students' learning outcomes.

C. CONCLUSION

Based on the general description, the results of hypothesis testing, and discussion of the results of the study, it can be concluded as follows.

1. There is a significant difference in the learning outcomes of Light Vehicle Engine Maintenance between groups of students who use the problem-based learning model with a group of students who use the expository learning model in the XI TKR class. The mean value of Light Vehicle Engine Maintenance learning outcomes groups of students treated with a problem-based learning model was 73.85, higher than the group of students treated with the expository learning model, which was 65.34. This can be interpreted that independently, the learning model had significant effect on Light Vehicle Engine Maintenance learning outcomes.
2. There is a significant difference in the Light Vehicle Engine Maintenance learning outcomes between the groups of students with high initial abilities and groups of students who have low initial abilities in the XR TKR class. The mean value of Light Vehicle Engine Maintenance learning outcomes groups of students with a high initial ability level is 71.82, higher than the group of students with high initial ability levels, namely 67.73. This indicates that the level of students' initial abilities significantly influence Light Vehicle Automotive Maintenance learning outcomes.
3. There is no significant interaction effect between the learning model and initial abilities on the Light Vehicle Engine Maintenance learning outcomes in the TKR XI class. This is indicated by the results of analysis with two-way anova technique, obtained F = 0.201 and significance (p) = 0.655 (greater than the research significance level, 0.05).

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Some suggestions are provided on the basis of the results above. First, teachers are advised to use a model of problem-based learning in learning, especially learning on certain material or subject matter, according to the characteristics of problem-based learning. the characteristics of problem-based learning are: (1) the learning process is student centered, (2) the learning process takes place in small groups, (3) the teacher acts as a facilitator, (4) the problems presented in the learning setting are organized in a particular form and focus and are learning stimulus, (5) new information is obtained through independent learning, and (6) problem is a vehicle for developing problem solving skills. Based on these characteristics, the teacher must be able to choose the right material or subject to be taught with a problem-based learning model. In addition, when carrying out learning with a problem-based learning model, teachers do need to pay attention to students' initial abilities. This is because the learning model and initial abilities do not have a significant interaction effect on the Light Vehicle Engine Maintenance learning outcomes.

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