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# Effect of problem based learning with didactical engineering on student mathematical disposition

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**Abstract.** The purpose of this study is to comprehensively describe the effect of problem based learning (PBL) with didactical engineering (DE) on students' mathematical dispositions. The research method used was quasi-experimental, with the research design of Posttest-Only Design with Nonequivalent Groups. The population in this study were all eight grade students in one of the State Junior High Schools in Subang Regency and the samples involved were 43 students spread in two classes, namely the experimental class and the control class. The instruments used in this study were mathematical disposition scale questionnaires and guidelines for observing teacher and student activities. Data analysis was carried out quantitatively and the statistical test used was the t test, Mann-Whitney test, two-way ANOVA. Based on the results of data analysis it can be concluded that learning factors influence the mathematical disposition of students but based on the PMA category does not affect the mathematical disposition, and there is no interaction between the learning model and the PMA category.

## 1. Introduction

Mathematics is a universal science that underlies the development of various branches of science. Mathematics is also one of the branches of science that is always used in all aspects of life, it is one reason for students to master mathematics. Meanwhile, the goals of mathematics learning in the mathematics curriculum include: students can solve problems and have an attitude of respecting the usefulness of mathematics in life, curiosity, attention, and interest in learning mathematics, as well as attitudes resilient and confident in solving problems [1]. NCTM [2] named the objectives in the affective aspects above with the term mathematical disposition. Similarly Katz [3], argues that mathematical disposition contains confidence, diligence, interest, and flexible thinking in exploring various alternative problem solving strategies.

Students' mathematical disposition will be seen when students solve mathematical questions whether the student is working with confidence, responsibility, diligent, abstinence, feeling challenged, having the will to look for other ways, and reflecting on the way of thinking that has been done. Students who try to work seriously and have the willingness to find ways to solve problems show that students have perseverance in learning mathematics, meaning that students have a positive attitude or disposition towards mathematics. Through strong dispositions and intelligent behavior, they will be able to deal with a variety of life and life problems ranging from simple levels to very complex ones independently with full confidence [4]. Furthermore mathematical disposition must be increased because it is the most important factor in determining student learning success [5].

As part of the learning objectives of mathematics, mathematical disposition is a necessity and is very important to be developed for students who study mathematics, because mathematical



dispositions are also closely related in the learning process which is about how students ask, answer questions, communicate mathematical ideas, work in groups, and in solving problems. Later, students do not necessarily make use of all the mathematical material they learn. However, it is certain that they need a positive disposition to deal with problematic situations in their lives. Thus, mathematics learning must be meaningful, meaning that students see that mathematics is important for themselves later because it can help them solve problems they face [4].

At this time, students' mathematical dispositions have not been fully achieved, this is because learning tends to be teacher-centered and provides less opportunities for students to develop mathematical thinking skills. Whereas the importance of developing thinking skills and learning that should be student-centered has been poured in the 2013 curriculum. Therefore to facilitate the mathematical disposition of students developing learning situations that need to be designed appropriately and more meaningfully, learning that gives students the opportunity to build their own knowledge. In line with the opinion of Leder argues that students must be encouraged to actively learn to construct mathematics by arranging their own knowledge through the knowledge, understanding, experience, and initial abilities of each [6].

The learning model that is in accordance with the curriculum 2013 and can foster mathematical disposition is a problem based learning model accompanied by didactical engineering. The problem based learning model gives students the opportunity to use their own strategies, construct their own knowledge, solve (real) problems to find a mathematical proof by holding a reorganization because of a new understanding, then in the time process, students develop new knowledge through activities that help students "expanding his knowledge" and at the end of the learning objectives students can "use knowledge in a meaningful way" [7]. Problem based learning (PBL) in this study is a learning model that uses context, situation, questions, or problems as triggers for student learning in building knowledge and mathematical abilities including mathematical disposition of students towards mathematics.

While didactical engineering is a series of didactic design steps aimed at improving the teaching process and the development of learning materials [8]. According [9] said that didactical engineering as a systematic study of designing, developing and evaluating educational interventions (such as programs, strategies, and learning materials, products and systems) as a solution to solving complex problems in educational practice, which also aims to advance knowledge of these interventions and their process of dissemination and development. Furthermore Suryadi [10] said that didactic design basically consists of three stages, namely: 1) didactic situation planning analysis before learning, 2) analysis of didactic metapples to support learning, and 3) retrospective analysis of data generated between planning before learning with the results of an analysis of non-academic methods.

Based on the description above, the implementation of the PBL model with DE developed in this study is a learning design with a student-centered learning approach, while the teacher (researcher) is only a facilitator. The learning syntax through PBL models with accompanying ED are as follows: 1) Introduction: performing apperception by relating related material (before), conveying learning objectives, giving initial problems, dividing students into study groups. 2) Core Activities: the teacher gives a problem, encourages students to discuss by identifying problems (students observe, choose strategies and methods of problem solving), solve problems (in groups students solve problems given), develop and present the results of work in front of the class by giving the reason for each problem raised. 3) Closing: making conclusions about the concept or material that has been taught.

The problems in this study are formulated in the form of questions as follows: does the learning model influence the students' mathematical dispositions? Does the prior mathematic ability influence the students' mathematical disposition? Is there an interaction between the learning model and the PMA category towards students' mathematical dispositions? Likewise the purpose of this study is to describe the effect of PBL learning models along with DE on students' mathematical dispositions and whether there is an interaction effect between learning models in terms of the PMA categories of students towards mathematical dispositions. The results of this study are expected to be used by future researchers who want to do more detailed research about the application of PBL models with ED to students' mathematical dispositions or other affective abilities.

## 2. Method

The research method used was quasi-experimental research and used Posttest-Only Design with Nonequivalent Group [11] as follows.

NR X O<sub>1</sub>

NR O<sub>2</sub>

Descriptions : NR = Nonrandom

X = PBL with DE

O<sub>1</sub> = O<sub>2</sub> = Questionnaire on the Mathematical Disposition Scale

The population in this study were all students of eighth grade in one of the Junior High Schools in Subang Regency, while the samples involved were 43 students spread across two classes, namely the experimental class and the control class. The experimental class uses the PBL model with DE and the control class using conventional learning models. The instrument used is a questionnaire on the mathematical disposition scale and guidelines for observing teacher and student activities. Furthermore, statistical tests are used, namely the t-test, Mann-Whitney, and two-way ANOVA, by first testing the data normality and data homogeneity before using the statistical test.

## 3. Result and Discussion

### 3.1. Effect of Learning Models on Mathematical Disposition

Data analysis of attitudes towards the mathematical disposition questionnaire was obtained from the results of filling in the mathematical disposition questionnaire. Before processing the mathematical disposition questionnaire in the form of an ordinal scale, it is converted to interval scale using the Method of Successive Interval (MSI). The results of recapitulation of data on mathematical Disposition of experimental class and control class students after obtaining treatment were PBL models with DE and conventional learning models (CL), which consisted of mean, standard deviation, number of students, normality test, and two different test averages indicated in the following Table 1.

**Table 1.** Recapitulation of Student Mathematical Disposition Test Results based on Learning Models

Learning	N	Score		Normality (Shapiro-Wilk)	Homogeneity	t test
		Mean	SD			
PBL with DE	21	83.05	4.873	0.819	0.191	0.001
CL	22	78.41	3.54	0.289		

Table 1 show the information is obtained that the average score for the experimental class is greater, which is equal to 83.05 compared to the control class which is equal to 79.41. However, to see the test of the difference in the two averages must be tested statistically significantly, beforehand it is necessary to test the normality beforehand and the calculation results show p-value more than the significance level  $\alpha = 0.05$  for the experimental class and control class which means the data are normally distributed. Then the two variance test obtained the Sig. equal to 0.191 more than the significance level  $\alpha = 0.05$ , which means that the data has the same or homogeneous variance.

After the normality test and homogeneity test were carried out, to see the difference in the two averages, the t test was carried out. Obtained p-value results less than the significance level  $\alpha = 0.05$ , which means there are differences in mathematical dispositions of students who get PBL models accompanied by ED with students who get the CL model. in other words, the learning model affects students' mathematical dispositions. Especially the PBL model with DE has a greater influence on students' mathematical dispositions compared to the CL model.

### 3.2. Effect of PMA Category on Mathematical Disposition

Prior Mathematical Ability (PMA) is classified into three, namely high, medium, and low. The results of the recapitulation regarding PMA data are shown in the following Table 2.

**Table 2.** Recapitulation of Mathematical Disposition Data Test Results Based on PMA

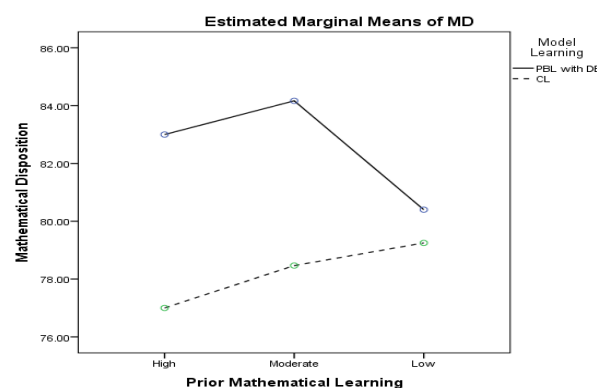
Learning	PMA Categories	N	Score based PMA		Normality	Homogeneity	Mean difference test
			Mean	SD			
PBL with DE	High	4	83.00	1.414	Normal	Homogeneous	0.367
	Moderate	12	84.17	5.813	Normal		
	Low	5	80.40	3.435	Normal		
CL	High	3	77	1.732	Not Normally		0.361
	Moderate	15	78.47	4.103	Normal		
	Low	4	79.25	2.217	Normal		

Table 2 show appears that for the normality test in the experimental class the PMA category is high, medium and low obtained by Sig. more than the significance level  $\alpha = 0.05$ , which means the data are normally distributed, whereas for the high PMA category control class, the Sig value is obtained. less than the significance level  $\alpha = 0.05$ , which means the data are not normally distributed while for the moderate and low PMA category the Sig. more than the significance level  $\alpha = 0.05$  which means the data is normally distributed. For the experimental class the homogeneity test was carried out with homogeneous results, followed by the t test obtained by the Sig. amounting to 0.367 more than the significance level  $\alpha = 0.05$ , which means there are no mathematical disposition differences for each PMA category. In other words, the high, moderate, and low PMA categories did not influence students' mathematical dispositions.

For the control class, because one of the data is not normally distributed, the data variance homogeneity test of mathematical disposition based on the PMA category is not carried out. But the next statistical test uses the Kruskal Wallis non parametric statistical test obtained by the results of Asymp. Sig. equal to 0.361 less than the significance level  $\alpha = 0.05$ , which means there are no differences in mathematical dispositions for each PMA category. This shows that there is no influence of students prior mathematical ability on students' mathematical dispositions.

### 3.3. Interaction between Learning Models and PMA Categories of Mathematical Dispositions

The analysis used to determine whether there is an interaction between the learning model and PMA on mathematical dispositions, namely using a one-way ANOVA test with the Sig. 0.371 more than the significance level  $\alpha = 0.05$ , which means there is no interaction between the learning model and PMA towards mathematical dispositions. For more details, it will be shown in the diagram in Figure 1 below.



**Figure 1.** Interaction between Model and PMA Categories on Mathematical Disposition

Figure 1 show that the mean line graph for the PBL model with DE shows that the experimental class students with the high PMA category are higher than the students with the moderate or low PMA category, and likewise for moderate PMA category on the low PMA category. In addition, it can be seen from the average line graph of students who received the PBL model with ED greater for each PMA category (high, medium, low) compared to students who received the CL model. The average of the two line graphs shows that students in both learning models have a significant influence on students' mathematical literacy abilities.

Although the two line graphs do not intersect, which means that there is no significant interaction effect on students' mathematical literacy abilities based on the learning model and the PMA category of students, but shows that both the learning model and the three PMA categories of students have a significant influence on students' mathematical literacy.

#### 4. Conclusion

Based on the formulation of the problem and the results of the data analysis presented above, it can be concluded as follows: 1) the learning model influences students' mathematical dispositions, especially for the PBL model with ED better than students who get the CL model; 2) there is no influence of mathematical initial abilities (high, medium, and low) on students' mathematical dispositions; and 3) at both classes there is no interaction between the learning model and the PMA category on students' mathematical dispositions. Thus, the implementation of the PBL model with DE is deemed necessary, because there are many advantages if it is used as an alternative mathematical learning model in improving affective aspects, namely the students' mathematical disposition of junior high school.

#### Conclusion

Based on the formulation of the problem and the results of the data analysis presented above, it can be concluded as follows: 1) the learning model influences students' mathematical dispositions, especially for the PBL model with ED better than students who get the CL model; 2) there is no influence of mathematical initial abilities (high, medium, and low) on students' mathematical dispositions; and 3) at both classes there is no interaction between the learning model and the PMA category on students' mathematical dispositions. Thus, the implementation of the PBL model with DE is deemed necessary, because there are many advantages if it is used as an alternative mathematical learning model in improving affective aspects, namely the students' mathematical disposition of junior high school.

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