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The Effectiveness of Problem Based Learning and Aptitude Treatment Interaction in Improving Mathematical Creative Thinking Skills on Curriculum 2013

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Abstract: The development of the revolution era 4.0 which increasingly rapidly demands the wider community to have the ability to think creatively mathematically. One effort to improve the ability to think creatively is through quality education. Quality education can be improved through to train thinking using the right learning model. This study aims to see which results are more effective in improving students' thinking skills between the two learning models applied. The two models are Problem Based Learning (PBL) and Aptitude Treatment Interaction (ATI) models. This research method uses quasi experimental method with a posttest only control test design not control group. This study uses two group subjects with two experimental classes. The analysis of the data used the hypothesis testing of the non-correlated 2-sample t-test. Based on the research results obtained Aptitude Treatment Interaction (ATI) models have a better effect on students' creative thinking abilities compared to Problem Based Learning (PBL) models.

Keywords: *Problem based learning, aptitude treatment interaction, creative mathematical thinking skills.*

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Introduction

The 21st century is closely related to the era of the industrial revolution 4.0 which requires people to have the ability to think more creatively and be able to accept rapid technological developments. Through education and learning, the ability to think creatively can be improved for the better. Therefore, education has an important role in influencing one's abilities. (Andiyana, Maya, & Hidayat, 2018; Arifin, 2017; Sanders, 2016; Sariningsih & Kadarisma, 2016). Improving the quality of education will affect one's thinking ability. But the creative thinking ability of Indonesian students is still said to be less advanced compared to the creative thinking ability of international students (Happy & Widjajanti, 2014; Santoso, Ratu, & Yunianta, 2014). To measure the mathematical creative thinking skills there are several indicators that must be met, such as original thinking, thinking in detail, thinking fluently, thinking flexibly(Huang et al., 2017; Sriwongchai, 2015; Tanujaya, 2016).This is provide by the comparative data of Indonesian students to international students in terms of the cognitive process domain in the 2018 International Student Assessment Program (PISA) released by the Organization for Economic Cooperation and Development (OECD).

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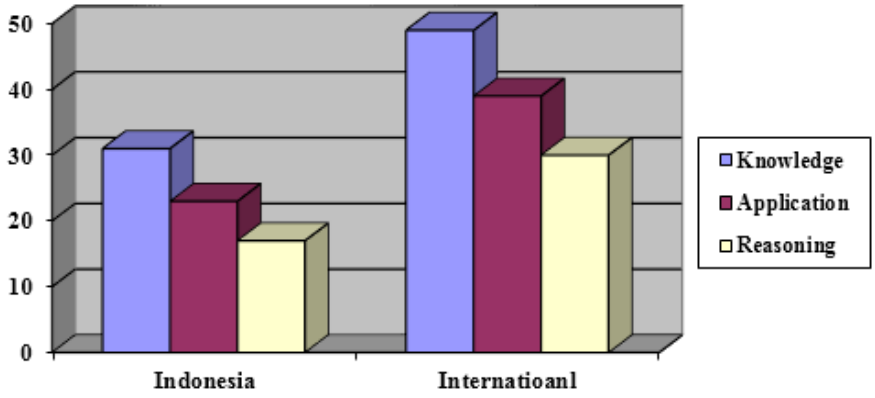

Figure 1.Percentage of correct answers of Indonesian students compared to international students on the problem of mathematical creative thinking abilities (Dwi,2019)

Based on Figure 1, it appears that the domain of Indonesian students' cognitive processes gets the lowest percentage in the aspect of reasoning. Indicators of reasoning aspects have the lowest value due to students' reasoning abilities according to Widdiharto, reflected through the ability to think critically (Diani, Herliantari, Irwandani, Saregar, & Umam, 2019), logically, systematically, creatively and have an objective nature (Diani, Irwandani, et al., 2019), honest (Kasayanond, Umam, & Jermsittiparsert, 2019), discipline in solving problems (Habibi et al., 2019), both mathematically and with other solutions. Mathematical creative thinking can be improved through the use of appropriate learning models (Ario 2016; Diniyah, Akbar, Akbar, Nurjaman, & Bernard, 2018; Fuadi, Johar, & Munzir, 2016; Wibowo 2017). Several previous studies have examined the effect of learning models on students' thinking abilities (Ramadhani, Umam, Abdurrahman, & Syazali, 2019). There are Problem Based Learning models with Open-ended approach, problem-based learning (Maskur, Syazali, & Utami, 2019), ethnomatemics-based scientific approach, PBL is a learning model that uses real world problems as a context for students to learn about creative thinking and problem solving skills, as well as to obtain essential knowledge and concepts from subjects. Problem Based Learning models that have an influence on students' mathematical creative thinking abilities (Andiyana, Maya, & Hidayat 2018b; Ulfa & Asriana, 2017; Happy & Widjajanti 2014; Sariningsih & Kadarisma 2016; UsmanMulbar 2015; Choridah 2013; Schettino 2016; Laurens et al. 2017; Suastika, 2017; Hidayat et al. 2019; Yew & Goh 2016).

Learning models that can improve mathematical creative thinking skills include Problem Based Learning models and Aptitude Treatment Interaction models. Several studies have examined the Aptitude Treatment Interaction model of students' thinking abilities (Sumarni et al., 2019). The examples of those related studies are Self-Efficacy towards mathematics through the Aptitude Treatment Interaction approach (Lestari et al., 2019), the effectiveness of the Aptitude Treatment Interaction model in improving learning styles and learning outcomes(Sagala, Umam, Thahir, Saregar, & Wardani, 2019), the development of mathematical learning tools with the Aptitude Treatment Interaction model, the application of the Aptitude Treatment Interaction to the material of space building (Lestari 2018; Fitri 2017; Preacher & Sterba 2019; Kusumawati 2016; Saregar et al. 2017; Nugroho, 2018). Mathematical creative thinking abilities of students have been extensively studied before, including creative thinking abilities that are influenced by the project based learning stem model (Prastowo et al., 2019), abilities that are influenced by Problem Based Learning models, the relationship of creative thinking and critical thinking of students, increasing the ability to think creatively with ethnomatematics-based on mathematical. (Anita 2017; Dhayanti, Johar, & Zubainur 2018; Tanujaya, Prahmana, & Mumu, 2017; Sariningsih & Herdiman 2017; Ismayani 2016; Nasution, 2017). Based on the previous article, this research update is looking at the effectiveness of both learning models, namely the Problem Based Learning model and the Aptitude Care Interaction model of students' creative thinking abilities applied in the 2013 curriculum. A more effective learning model will provide a significant increase in the mathematical creative thinking abilities.

Methodology

This study uses a Quasi Experiment Design method with t-Test data analysis. The research design uses two group subjects from the population including two experimental classes using the Problem Based Learning and Aptitude Treatment Interaction models. This method is implemented to see the effect of the treatment. This is consistent as stated by Sugiyono, that the experimental method can be said as a research method used to determine certain effects on others under controlled conditions (Sugiyono 2013). This study appoints two classes as a random sampling that will produce final data in the form of scores obtained through the final test at the end of learning (Rahmawati, Lestari, & Umam, 2019).Problem solving based learning can optimize student thinking through systematic team processes with group work (Rodriguez-ponce & Rodriguez-ponce, 2019), so students can drill, test and develop thinking skills continuously (Abidin 2014; Rusman 2013; Happy and Widjajanti 2014; Ulfa & Asriana, 2016; Santoso , Ratu, & Yunianta 2014; Tohir et al. 2018). Problem Based Learning model are in Figure 2.

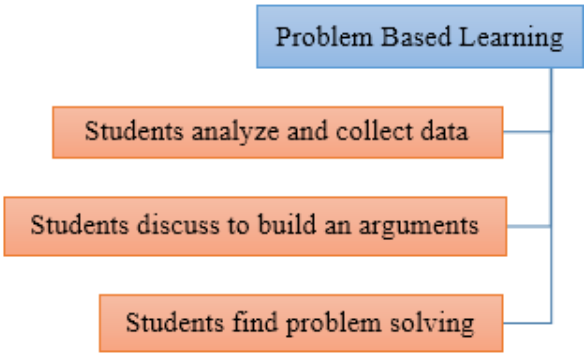

*Figure 2.*Problem Based Learning *Model*

Optimizing mathematical creative thinking abilities through Problem Based Learning *models can be achieved with the first steps, namely students analyzing and collecting data from problems given by the teacher, data collection can be done by bringing together the arguments of various students who have discussed the problem of students' thinking abilities, which then argument will refer to the solution of the problem* (Abello-romero, Mancilla, & Viancos, 2019). *The analysis phase will improve students' creative thinking abilities.* Aptitude Treatment Interaction model are demonstrated in Figure 3.

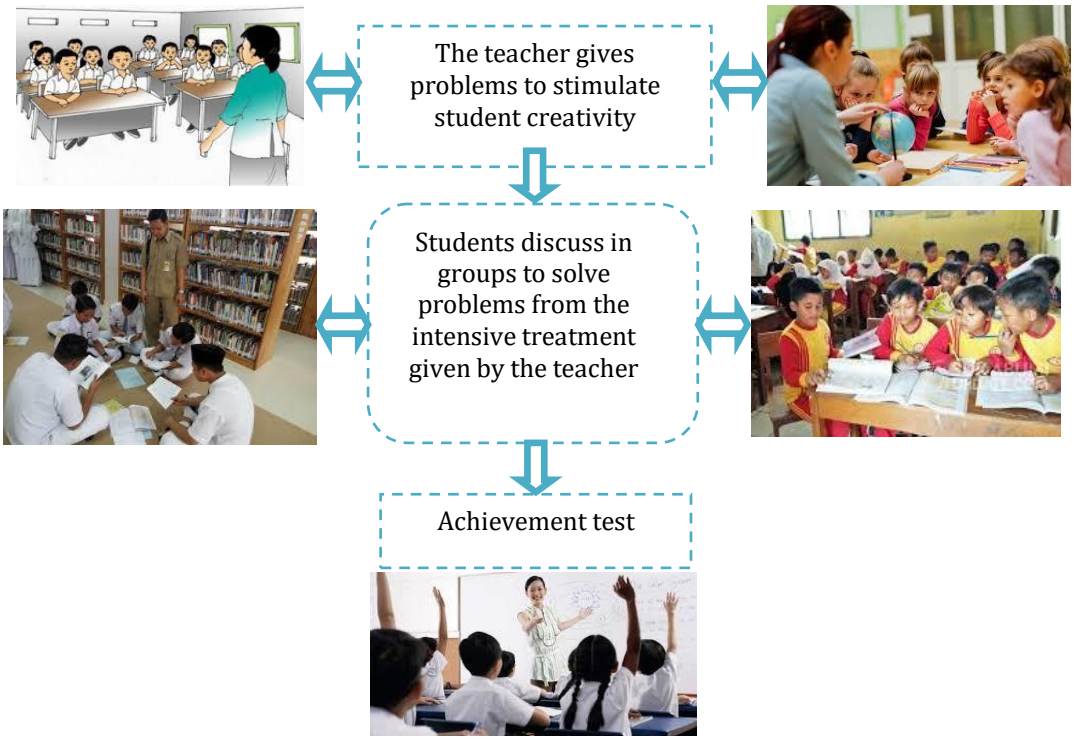

*Figure 3.*Aptitude Treatment Interaction Model

Aptitude Treatment Interaction model can be carried out with the initial treatment stage given by the teacher to stimulate students to think creatively (Felisardo, Llinas-audet, & Amestica-rivas, 2019). *After the initial treatment is given, the next step is the teacher divides students into groups, which then the teacher will give intensive treatment to each group* (Sriyakul et al., 2019). *Giving this treatment can improve students' creative thinking abilities. As an evaluation phase, an achievement test is administrated as a benchmark for achieving students' mathematical creative abilities. The research design used will be presented in Figure 4.*

The test conducted in this study is a test that is distributed after finishing learning (post-test) with essay questions. The post-test is consistent with the types of questions based on indicators of students' creative thinking abilities, and is distributed after the application of the Problem Based Learning model and the Aptitude Care Interaction model. Because the data analysis uses quantitative research, before the instrument is used, a validity test and a reliability test are performed to determine that the instrument used is valid. Then in testing the hypothesis that is using t-test 2 samples do not correlate with the normality test prerequisite test and homogeneity test.

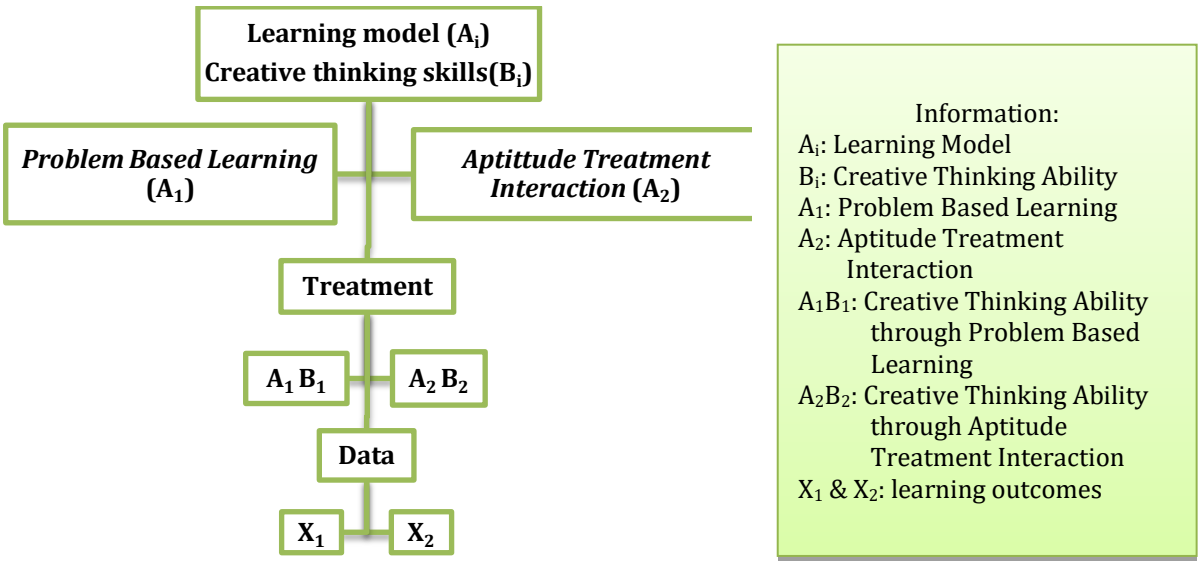

Figure 4.The research design

Findings / Results

The results and discussion of this study were obtained from several stages of the research test. The initial stage of testing is to test the feasibility of research instruments. The research instrument was a question test instrument to test students' abilities. Based on the research design, descriptive test results for the score data will be presented to measure the mathematical creative thinking ability in Table 1.

Table 1. Mathematical Creative Thinking Ability Score

Creative Thinking Ability	Mean	Median	Variance	St. Dev	Min	Max	Range
Aptitude Treatment Interaction	87.07	87.50	76.97	8.77	70.83	100.00	29.17
Problem Based Learning	77.18	75.00	47.14	6.86	64.30	89.30	25.00

Table 1 shows data on student learning outcomes from two learning models on the ability to think creatively. With centralization rules, it can be seen from the table that the ATI model is more influential in increasing students' creative thinking abilities, because the mean and median values of the ATI model are greater than the PBL model. Further analysis must be carried out to strengthen the results of the centralization rules (Networks, Channels, Participation, Moreno, & Trejo, 2019), namely statistical analysis of inference with the t-test 2 sample that does not correlate with the left side test. Before conducting the t test, it is first necessary to test the normality and homogeneity as a condition for testing the hypothesis. Normality test aims to determine whether the data obtained are normally distributed or not. The normality testing data are listed in Table 2 and homogeneity testing data are listed in Table 3.

Table 2. Normality Test on Students' Mathematical Creative Thinking Abilities

Learning Model	Kolmogorov-Smirnov[a]		Shapiro-Wilk	
	Statistic	Sig.	Statistic	Sig.
Problem Based Learning	0.141	0.119	0.947	0.125
Aptitude Treatment Interaction	0.131	0.187	0.932	0.050

Based on table 2, it can be seen that the application of the PBL and ATI models is normally distributed with a significant level of α = 0.05 so that it can be continued at the homogeneity of variance test stage, with the results in Table 3.

Table 3.Homogeneity Tests of Students' Mathematical Creative Thinking Abilities

Student learning outcomes			
Levene Statistic	df_1	df_2	Sig.
1.523	1	60	.222

Homogeneity test used by the writer is Levene test. The result of the calculation of homogeneity test with a significance level of 0.05 was obtained sig value of 0.222, because sig value of 0.222 > 0.05, then H_0 was accepted, thus the variance of both distributions is homogeneous.

Therefore, the data that were normally distributed and homogenous of variance ,sot-test of 2 non-correlated samples is carried out us presented in Table 4.

Table 4.Levenetest and T-test results of students' creative thinking abilities

	Levene Test *		t-test for Equality of Means				
	F	Sig.	t	Sig.(2-tailed)	Mean Difference	Std.Error Difference	95% Confidence Interval Difference
students' creative thinking abilities	1.523	.222	4.941	.000	9.8871	2.0010	5.8845 - 13.8897
			4.941	.000	9.8871	2.0010	5.8797 - 13.8945

*Levene's Test for Equality of Variances

Based on Table 4, it was obtained that in the t test the value of t_{count} was 4,941. As for drawing conclusions from the hypothesis based on the analysis of H_0 if $t_{count} \geq t_{table}$so will be accepted. Because 4,941 ≥ 2.04227, then H_0 is accepted, which means that the Aptitude Treatment Interaction model has a significant effect on students' creative thinking abilities compared to the Problem Based Learning model (Abdurrahman et al., 2019). This is in line with previous research that the learning model of Aptitude Treatment Interaction has an influence on increasing students' mathematical creative thinking abilities.

Discussion

Based on the rules of students' mathematical creative thinking ability through the PBL model the process begins by analyzing the questions given by the teacher and gathering facts from various sources. The facts gathered here are in the form of arguments from some students which are then discussed to find solutions to the problems given (Munoz-fritis, 2019). The level of mathematical creative thinking ability in PBL models is increased through the stage of analyzing a problem (Munifah et al., 2019a; Munifah, Romadhon, Ridhona, & Ramadhani 2019; Munifah et al., 2019c). On the other hand, in ATI model, the goal is achieved through the stage where the teacher provides initial treatment to students as an introduction that will trigger the emergence of students' creative thinking abilities (Syahrir et al., 2019). Furthermore in ATI model, students will be divided into various random groups which are then given treatment by the teacher. As an increasing students' mathematical creative thinking abilities in the ATI model it refers to the grouping stage of students who are followed up by the treatment given by the teacher (Pahrudin et al., 2019).

Judging from the differences in these steps, it can be seen that the ATI model at the grouping stage of students and the intensive treatment given to students has a high influence on improving students' mathematical creative thinking abilities (Syazali et al., 2019), since students can implement new ideas in a group and find various solutions from an issue. Besides there is room for an approach between the teacher and students by giving appropriate treatment to the aptitude of students as a result of learning mathematics in the classroom experiencing optimal improvement in results (Laurens et al. 2017; Suastika, 2017; Sitorus & Masrayati 2016; Tohir et al. 2018; Yew & Goh 2016; Lehmann, Goussios, & Seufert 2016; Pamungkas & Afriansyah 2017).

Based on the results of this study, it is proven that the ATI model is better than the PBL learning model in improving students' mathematical creative thinking abilities. PBL models can affect the ability of mathematical creative thinking by using an open-ended approach. Based on the average creative thinking ability of participant students who use the PBL model is bigger than the control class.

Conclusion

Based on the results of field trials conducted and referring to the research objectives, it can be concluded that students' creative thinking abilities get better improvement with the Aptitude Treatment Interaction (ATI) model compared to mathematical creative thinking abilities that use the Problem Based Learning (PBL) model.

Recommendation

Based on the above conclusions, the authors suggest that the use of learning models can collaborate an approach PBL model for optimal results. This research can be followed by further research by combining PBL models and ATI models with different approaches.

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