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The influence of PJBL-Stem and PBL-based on the learning motivation of the students in the mathematical creative thinking skills

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Abstract: The study aims to (1) identify the influence of PjBL-STEM and PBL on the mathematical creative thinking skills; (2) the influence of high, moderate, and low learning motivation on the mathematical creative thinking skills; and (3) identify the interaction between PjBL-STEM & PBL and learning motivation on the mathematical creative thinking skills. The study itself is a Quasi-Experiment Research with Nonequivalent Control Group Design. The samples in the study are 66 Grade VIII students from 24th State Junior High School Batang Hari. These samples are drawn by using the total sampling technique in which the number of the samples is equal to the number of the population. Then, in gathering the data, the methods that have been implemented are observation, questionnaire, and written test. After the data have been gathered, the data are analyzed by using Two-Way ANOVA. Thus, the results of the study show that: (1) PjBL-STEM and PBL influence the mathematical creative thinking skills as having been shown by the significance value of 0.000, which is lower than 0.050 (0.000 < 0.050); (2) high, moderate, and low learning motivation influence the mathematical creative thinking skills as having been shown by the significance value 0.000, which is lower than 0.050 (0.000 < 0.050); and (3) there is an interaction between PjBL-STEM & PBL and learning motivation with the mathematical creative thinking skills as having been shown by the significance value 0.030, which is lower than 0.050 (0.030 < 0.050).

Keywords: PjBL-STEM, PBL, Learning Motivation, and Mathematical Creative Thinking Skills

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INTRODUCTION

The objective of the 2013 Curriculum is to improve the analytical competencies of the Indonesian learners in dealing with the demands of the 21st Century, which urge individuals to possess complex thinking skills; therefore, the learning process in the schools should be able to encourage the students to think analytically, competitively, productively, creatively, innovatively, and effectively (Asfiati, 2016). In learning Mathematics, students should be trained to think independently, cooperatively, and encouragingly to deal with routine problems, non-routine problems, and new problems (Syaiful et al., 2019). The life proficiency that can be internalized through the learning process of Mathematics, as having been laid out in the Minister of Education and Culture Regulation Number 58 on the Guidelines of Mathematics and the Minister of Education and Culture Regulation Number 21 on Content Standards, are namely: (1) the use of critical and reasoning skills in solving problems; (2) the effective communication of ideas; and (3) the internalization of attitudes and behaviours that go in accordance with the values and the learning process of Mathematics such as principle-obedient, consistent, highly respectful toward agreement, appreciative toward opinion differences, careful, tough, creative, and open (Mahmudi, 2016).

Departing from the above explanation, creative thinking skills is one of the objectives that the 2013 Curriculum would like to achieve and are also one of the objectives in the learning process of Mathematics. Within the learning process of Mathematics especially, creative thinking skills are

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highly necessary to solve difficult or non-routine mathematical test items. Through creative thinking skills, students should be able to understand, master, and solve the problems within the grasp of their hands through numerous problem solutions. This statement is in line with the argument of (Rawlinson, 2017, p. 4), who states that creative thinking demands imagination that leads to numerous answers or ideas. According to Siswono (2005), creative thinking skills refer to the student's capacity to understand problems and find solutions through various (divergent) strategies.

Based on the observation results in the 24th State Junior High School Batang Hari, several problems that students should deal with in learning Mathematics have been found. These problems are: (1) most of the students do not answer the questions that the teachers raise, and this finding implies that the students' fluency in delivering their ideas has still been low; (2) in solving the (mathematical) problems, the students only imitate what the teachers have taught without any effort to find other alternatives and this finding implies that the students' fluency in thinking of other alternatives of answers, which can be very various, has still been low; (3) the students tend to memorize or imitate what the teachers have delivered in solving the problems, and this explains why the students have difficulties in looking for alternatives answers especially when they deal with completely new items (in other words, this finding implies that the students have not been able to think about novelty); and (4) the students have not been able to provide detailed explanations and, therefore, it is apparent that they have not been able to elaborate the problem solution. These findings altogether show that the indicators of creative thinking skills, which comprise fluency, flexibility, originality, and elaboration, have still been low, and thus there should be efforts to develop the mathematical creative thinking skills among the students.

One of the efforts to develop creative thinking skills is to create a learning environment that engages the students in real-life experiences within their learning process (Yusnaeni et al., 2017). Implementing the learning process using learning models that can encourage students to learn independently is necessary for developing mathematical creative thinking skills. In relation to the statement, Project Based Learning (PjBL) refers to the learning project that directly engages the students in creating a project. This model provides a wide opportunity for the students to make decisions, undergo studies, and complete certain projects through concrete work performance (R. T. Sari & Angreni, 2018).

Then, the learning process that can equip the students with the creative thinking skills and a creative attitude in dealing with the competitive age is the one that benefits Science, Technology, Engineering, and Mathematics (STEM). STEM refers to the interdisciplinary approach that studies numerous academic concepts that are put side by side with the real world through the implementation of the principles of Science, Mathematics, Engineering, and Technology so that the students are demanded to be able to analyze and think creatively in processing data and solving problems within the context of their daily life (Wulandari, 2019). Through the STEM-based learning process, the students will understand concepts or knowledge (science) and implement the knowledge with the assistance of the technology in their possession in order to create or design (engineer) manners by means of analysis and based on mathematical data calculation in order to attain proper problem solution. According to Kaniawati et al. (2015), through the STEM approach, students can gain a different mindset, develop critical skills, and shape their reasoning logic so that their knowledge can be applied in all aspects of life. At the same time, the students will also become accustomed to problem-solving activities well. The STEM-based education will shape human resources that are able to think and reason critically, logically, and systematically. STEM-integrated learning has the potential to improve the learning quality and the motivation of the students (Gallant, 2011). On the contrary, according to Aurandt (Ceylan & Ozdilek, 2015), STEM education is effective for the learning process and the achievement of learning objectives.

Based on the previous explanation of the PjBL learning model and STEM approach, in PjBL-STEM, students will work in a concrete manner to complete certain projects, and they will implement their knowledge through the assistance of technology within their possession in order to create or design (engineer) a manner by performing mathematical data calculation-based as the effort for attaining the solution for their problems. According to Maria et al. (2019), the combination between the PjBL learning model and the STEM approach can optimize the learning process that supports the achievement of learning success in terms of concept mastery and mathematical creative thinking skills among the students.

In addition to the Project-Based Learning that has been integrated with STEM (PjBL-STEM), Problem Based Learning can also be one of the solutions for supporting the mathematical creative thinking skills among the students. According to Ersoy and Başer (2014), during the PBL process, the aspect that should be given attention is the development of the students' problem-solving skills and creative thinking skills. Similarly, Awang and Ramly (2008) state that PBL can assist students in developing their creative thinking skills, such as being cooperative and mastering interdisciplinary problem-solving initiatives, in which the students can learn both independently and collaboratively. In PBL as well, the students will learn about the content of the subject, and they will not only concentrate on the knowledge but also on the skills for solving the problems in a real-life situation. Thus, learning how to learn becomes important in addition to attaining knowledge from the content of the subjects. Therefore, the students should go further in looking for the solutions to a problem (Uden & Beaumont, 2006). The main objective of PBL is to improve the implementation of the students' knowledge, problem-solving skills, and independent learning skills by requiring the students to articulate, understand, and solve problems actively. PBL focuses on the problems in which the students start to learn by handling the simulation of authentic problems. In addition, PBL also centers on the students and requires them to direct their own learning process to define what they know and what they do not know about the given problems (Jonassen & Hung, 2015).

In addition to the PjBL-STEM learning model and the PBL learning model, learning motivation also has an influence on mathematical creative thinking skills. The students who have low motivation will show low learning interest, and thus, they will also have low mathematical creative thinking skills (Anditiasari et al., 2021). If the students' learning motivation can be improved, then the improvement will certainly positively influence their mathematical creative thinking skills. On the contrary, if the students' learning motivation is low, then the mathematical creative thinking skills of the students will certainly be low as well; not to mention, many factors influence the relationship between the learning motivation and the mathematical creative thinking skills (Harisuddin, 2019). Learning motivation is indeed one of the important factors in the achievement of the learning objective since without learning motivation, students will not attend the learning process in maximum performance. Therefore, the mathematical creative thinking skills should be given special attention by the students so that the students can benefit from their ideas in solving the mathematical problems through numerous manners that they have never used before.

As previously explained, one of the important factors that the students should have regarding creative thinking is learning motivation (Harisuddin, 2019). According to Darwanto (2019), in order to manifest the students' creativity, there should be internal encouragement within the students (intrinsic motivation) and external encouragement from the environment (external motivation). Similarly, Asrori (2019) states that motivation is necessary for the manifestation of an effective learning process in the classroom since motivation has a significant role in the learning process. Students with high learning motivation are generally able to achieve success within both the learning process and the learning output. According to Wentzel and Brophy (2014, p. 3), the concept of student motivation within the context of the classroom can be beneficial for explaining how far the students have internalized both their attention and their efforts in numerous activities. The student motivation can be reflected in the motive and objective that students would like to achieve, the source of subjective experience that has been relevant to their willingness to be engaged in the learning activities, and why they perform the learning activities.

Departing from the overall explanation, the current study aims at identifying: (1) the influence of the Project-Based Learning Model with the Science, Technology, Engineering, and Mathematics Approach (PjBL-STEM) and the Problem Based Learning (PBL) on the mathematical creative thinking skills; (2) the influence of high, moderate, and low learning motivation on the mathematical creative thinking skills; and (3) the interaction between the Project-Based Learning Modell with the Science, Technology, Engineering, and Mathematics Approach (PjBL-STEM) and the Problem Based Learning (PBL) on the learning motivation toward the mathematical creative thinking skills.

METHODS

The current study is quasi-experimental research conducted to identify the differences in the mathematical creative thinking skills between the students who attend the PjBL STEM-based and the

PBL-based learning proves and the conventional learning process with high, moderate and low learning motivation.

Design

The quasi-experimental research design that has been adopted in the study is the Non-Equivalent Control Group Design.

Population

The population in the study is all Grade VIII students of 24th Public Junior High School Batang Hari that comprise Grade VIII A, Grade VIII B, and Grade VIII C from the 2021/2022 Academic Year.

Sample

The sampling technique that has been used in the study is the total sampling technique in which the number of the samples is equal to the number of the population since the total number of the population is lower than 100 people. Therefore, the total number of the samples in the study is 66 people who are Grade VIII students from the 24th Public Junior High School Batang Hari.

Data Gathering Technique

The data gathering techniques that have been adopted in the study are observation, questionnaire, and written test.

Data Analysis Technique

The data analysis technique that has been used in the study is descriptive statistics. Then, the prerequisite test in the study is the Kolmogorov Smirnov Normality Test with assistance from SPSS Software. If the probability value of asymp. sig. ≥ 0.05, then the data have been normally distributed and, thereby, the homogeneity test should proceed by using the F-test with the assistance from the SPSS Software. In addition, if the probability value of asymp. sig. ≥ 0.05, then the data are considered homogenous. Furthermore, the hypothesis test is conducted using the Two-Way ANOVA Test using the SPSS Software. The single criterion for the Two-Way ANOVA Test is that Ho will be accepted if the probability value (sig.) is higher than the α, which implies that there is not any significant difference between the two groups that have been compared. Then, the subsequent test is conducted in order to identify the mean score differences between the two groups in comparison by using the Multiple Comparison Post Hoc Test, namely the Tukey HSD for Honest Significant Difference Test. The single criterion for the administration of the Tukey HSD test is that the test score will be significant if the probability value (sig) is lower than the α.

RESULTS AND DISCUSSIONS

Results

The scores of learning motivation of the students from the experimental group and the control group are provided in Table 1, Table 2, and Table 3.

Table 1. Categorization of Learning Motivation for the Students in the Control Group

Category	Classroom Interval	Grade VIII C	
		Frequency	Percentage
High	$X \geq 62.10$	6	28.57
Moderate	$57{,}05 \leq X < 62.10$	9	42.86
Low	$X < 57.05$	6	28.57
	Total	21	100.00

Source: Primary Data 2021

Based on the data in Table 1, it is found that the learning motivation of Grade VIII C students in the 24th Public Junior High School Batang Hari who have been exposed to the conventional learning process can be categorized as follows: (1) 6 students (28.57%) have high learning motivation; (2) 9 students (42.86%) have moderate learning motivation; and (3) 6 students (28.57%) have low learning motivation. Therefore, it can be concluded that the tendency of the learning motivation among the

Grade VIII C students of the 24th Public Junior High School Batang Hari who have been exposed to the conventional learning process is in the "Moderate" category (9 students or 42.86%).

Table 2. Categorization of Learning Motivation for the Students in the PjBL-STEM Group

Category	Classroom Interval	Grade VIII A	
		Frequency	Percentage
High	X ≥ 79.73	5	22.73
Moderate	68,36 ≤ X < 79.73	13	59.09
Low	X< 68.36	4	18.18
	Total	22	100.00

Source: Primary Data, 2021

Based on the data in Table 2, it is found that the learning motivation of Grade VIII A students in the 24th Public Junior High School Batang Hari who have been exposed to the PjBL-STEM learning process can be categorized as follows: (1) 5 students (22.73%) have high learning motivation; (2) 13 students (59.09%) have moderate learning motivation; and (3) 4 students (18.18%) have low learning motivation. Therefore, it can be concluded that the tendency of the learning motivation among the Grade VIII A students of the 24th Public Junior High School Batang Hari who have been exposed to the PjBL-STEM learning process is in the "Moderate" category (13 students or 59.09%).

Table 3. Categorization of Learning Motivation for the Students in the PBL Group

Category	Classroom Interval	Grade VIII B	
		Frequency	Percentage
High	X ≥ 78.50	7	30.43
Moderate	70,63 ≤ X < 78.50	11	47.83
Low	X< 70.63	5	21.74
	Total	23	100.00

Source: Primary Data, 2021

Based on the data in Table 3, it is found that the learning motivation of Grade VIII B students in the 24th Public Junior High School Batang Hari who have been exposed to the PBL learning process can be categorized as follows: (1) 7 students (30.43%) have high learning motivation; (2) 11 students (47.83%) have moderate learning motivation; and (3) 5 students (21.74%) have low learning motivation. Therefore, it can be concluded that the tendency of the learning motivation among the Grade VIII A students of the 24th Public Junior High School Batang Hari who have been exposed to the PjBL-STEM learning process is in the "Moderate" category (11 students or 47.83%). Then, the results of the prerequisite test for the normality test are provided in Table 4 and Table 5.

Based on the results in Table 4 and Table 5, it is apparent that the significance value of all groups from the normality test is higher than 0,05 (p > 0.05). Therefore, it can be concluded that the data in the current study have been normally distributed.

Table 4. Results of Normality Test for the Pretest Items

One-Sample Kolmogorov-Smirnov Test

		Pretest_ Kontrol	Pretest_ Eksperimen_ PjBL	Pretest_ Eksperimen_ PBL
N		21	22	23
Normal Parameters [a,b]	Mean	46,7262	48,5795	47,5543
	Std. Deviation	8,05718	10,37464	11,26563
Most Extreme Differences	Absolute	,216	,225	,154
	Positive	,216	,225	,154
	Negative	-,126	-,143	-,125
Kolmogorov-Smirnov Z		,988	1,054	,738
Asymp. Sig. (2-tailed)		,284	,217	,647

a. Test distribution is Normal.

b. Calculated from data.

Table 5. Results of Normality Test for the Posttest Items

One-Sample Kolmogorov-Smirnov Test

		Postest_ Kontrol	Postest_ Eksperimen_ PjBL	Postest_ Eksperimen_ PBL
N		21	22	23
Normal Parameters [a,b]	Mean	65,7738	84,3750	81,5217
	Std. Deviation	9,18964	9,97579	13,90898
Most Extreme Differences	Absolute	,211	,195	,145
	Positive	,211	,195	,092
	Negative	-,123	-,168	-,145
Kolmogorov-Smirnov Z		,965	,916	,693
Asymp. Sig. (2-tailed)		,309	,371	,722

a. Test distribution is Normal.

b. Calculated from data.

Next, the variance homogeneity test is intended to identify whether the data from the samples of two groups or more are taken from the population with similar variance or not to identify the significant differences between one group to another. In order to be considered homogeneous, the significance value should be higher than 0.05. The results of the prerequisite test for the normality test are provided in Table 6 and Table 7.

Table 6. Results of Homogeneity Test for Experiment I

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
Pretest	0.411	1	41	0.525
Posttest	0.144	1	41	0.707

Table 7. Results of Homogeneity Test for Experiment II

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
Pretest	3.514	1	42	0.068
Posttest	2.244	1	42	0.142

The data from Table 6 and Table 7 show that the significance value of all data has been higher than 0.05 ($p > 0.05$). Since the data have been homogenous, it can be concluded that the data have met the requirements for the administration of the ANOVA Test.

The hypotheses in the study are tested by using the Two-Way Univariate Analysis of Variance (ANOVA) test and the subsequent test. The conduct of the hypothesis test is assisted by SPSS 20 Software with a degree of trustworthiness of 95%. If the degree of significance ≥ 0.05, then H_0 is accepted. The hypothesis test results by using the Two-Way ANOVA Test are provided in Table 8.

Based on the results in Table 8, the significance value of the mathematical creative thinking skills for both experimental groups is $0.000 < 0.050$. **Therefore, H_0 is rejected, or H_1 is accepted.** The statement implies that both PjBL-STEM and PBL have an influence on mathematical creative thinking skills. On the contrary, still based on the results in Table 8, the significance value of the learning motivation among the students is $0.000 < 0.050$. **Therefore, H_0 is rejected, or H_1 is accepted as well**. The statement implies that high, moderate, and low learning motivation have an influence on mathematical creative thinking skills. Meanwhile, the significance value for the interaction between the PjBL-STEM learning model and the PBL learning model with the learning motivation toward the mathematical creative thinking skills is $0.030 > 0.050$. **Therefore, H_0 is rejected, or H_1 is accepted as well.** The statement implies that there is an interaction between the PjBL learning model and the PBL learning model with the learning motivation toward the mathematical creative thinking skills.

Table 8. Results of ANOVA Test

Tests of Between-Subjects Effects

Dependent Variable: Kemampuan_Berpikir_Kreatif_Matematis

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	9401,931[a]	8	1175,241	22,845	,000
Intercept	336112,054	1	336112,054	6533,460	,000
Model	3222,748	2	1611,374	31,322	,000
Motivasi_Belajar	4508,245	2	2254,123	43,816	,000
Model * Motivasi_Belajar	596,484	4	149,121	2,899	,030
Error	2932,349	57	51,445		
Total	408359,375	66			
Corrected Total	12334,280	65			

a. R Squared = ,762 (Adjusted R Squared = ,729)

Since the results of the hypothesis testing show that there has been an already expected influence, the researchers proceed to the Tukey Test in order to identify the size of the influence from each variable. The significant differences are marked with the sign *. Then, the results of the Tukey test are provided in Table 9.

Table 9. Results of Tukey Test

Multiple Comparisons

Dependent Variable: Kemampuan_Berpikir_Kreatif_Matematis
Tukey HSD

(I) Model	(J) Model	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
PjBL_STEM	PBL	2,8533	2,13895	,382	-2,2940	8,0005
	Konvensional	18,6012*	2,18818	,000	13,3355	23,8669
PBL	PjBL_STEM	-2,8533	2,13895	,382	-8,0005	2,2940
	Konvensional	15,7479*	2,16483	,000	10,5385	20,9574
Konvensional	PjBL_STEM	-18,6012*	2,18818	,000	-23,8669	-13,3355
	PBL	-15,7479*	2,16483	,000	-20,9574	-10,5385

Based on observed means.

*. The mean difference is significant at the ,05 level.

Based on the results in Table 9, it can be concluded that: (1) the mean score of the posttest results from the students who have been exposed to the PjBL-STEM learning model and the PBL learning model is 2.85 and the mean score implies that the mathematical creative thinking skills of the students who have been exposed to the PjBL-STEM learning model are 2.85 points higher than the those of the students who have been exposed to the PBL learning model; (2) the mean score of the posttests results from the students who have been exposed to the PBL learning model and the conventional learning model is 15.74 and the mean score implies that the mathematical creative thinking skills of the students who have been exposed to the PBL learning model are higher 15.74 points than those of the students who have been exposed to the conventional learning model; and (3) the mean score of the posttest results from the students who have been exposed to the PjBL-STEM learning model and the conventional learning model is 18.60 and the mean score implies that the mathematical creative skills of the students who have been exposed to the PjBL-STEM is 18.60 points higher than those of the students who have been exposed to the conventional learning model.

Discussions

Based on the findings in the study, it is found that the first hypothesis has been accepted, and it has emphasized the influence of Project-Based Learning with Science, Technology, Engineering, and Mathematics Approach (PjBL-STEM) and the Problem Based Learning (PBL) on the mathematical creative thinking skills. The influence is shown by the significance value 0.000, which is lower than

0.050 (0.000 < 0.050). One of the learning models that can develop the student's creative thinking skills is the Project-Based Learning Model, also known as PjBL (Wena, 2014). However, the Project-Based Learning Model should be modified still to adjust the learning model to the demands of the Century and develop the students' creative thinking skills optimally. One of the ways that can be taken in order to modify the Project-Based Learning Model is to integrate the Project-Based Learning Model into the Science, Technology, Engineering, and Mathematics (STEM) approach. Both the PjBL and the STEM have strengths and weaknesses that can complete each other. Through PjBL, the students can understand concepts through product-manufacturing activities, whereas through STEM, the students can learn about the process of design and re-design (the process of design technique), which will encourage the students to draw out their best product (Lutfi et al., 2017). The PjBL-STEM learning process is proven to have the capacity to trigger the students' curiosity, creative imagination, and critical thinking skills (Lukman et al., 2015). The integration of Project-Based Learning into the Science, Technology, Engineering, and Mathematics Approach is expected to develop the students' creative thinking skills in a more optimum manner.

In addition to PjBL-STEM, another way that can benefit the student's creative thinking skills is using Problem-Based Learning (PBL). The PBL Model is a learning model that benefits the real-world problems as a context for the students to learn about creative thinking and problem-solving skills and also to attain essential knowledge from the subjects (Komalasari, 2013). The PBL Model aims to assist the students in developing/improving creative thinking skills, developing the initiative of the students to work, encouraging the internal motivation of the students to learn, and developing the interpersonal relationship within the problem-solving skills throughout the groupwork (Rusman, 2014).

Furthermore, still based on the findings in the study, it is found that the second hypothesis has been accepted, and it has emphasized the influence of high, moderate, and low learning motivation on the mathematical creative thinking skills. The influence is shown by the significance value 0.000, which is lower than 0.050 (0.000 < 0.050). Then, one of the ways to improve the students' creative thinking skills is forging the learning motivation within the students to encourage them to be able to perform any learning activities that lead to the achievement of the learning objective, namely the creative thinking skills of the students. In line with what has been exposed by Sardiman, motivation refers to the transition of the energy within the students, and it is marked by the presence of the feeling toward the objective that the students have desired. The internal learning motivation of the students becomes an important factor for the survival of the good learning process. The presence of both the internal and the external learning motivation within the students will lead to behavioural changes that can result in the achievement the creative thinking skills.

These findings are in line with the findings of a study by Anditiasari et al. (2021) which is entitled "Systematic literature review: the influence of learning motivation toward the mathematical creative thinking skills of the students." The findings in their study show that motivation has an influence on the mathematical learning skills of the students since the students who do not have learning motivation will display low learning interest, and the low learning interest will influence the mathematical creative thinking skills of the students (Anditiasari et al., 2021). In addition, the results of a study by D. R. Sari et al. (2019) show that the mathematical creative thinking skills display different results in each category, namely students with high learning motivation, students with moderate learning motivation, and students with low learning motivation. The students with high learning motivation will have better mathematical creative thinking skills in comparison to the students with moderate learning motivation. Similarly, the students with moderate learning motivation will have better mathematical creative thinking skills in comparison to the students with low learning motivation.

Furthermore, based on the findings in the study as well, it is found that the third hypothesis has been accepted, and it has emphasized the interaction between the Project-Based Learning with the Science, Technology, Engineering, and Mathematics Approach and the Problem Based Learning with the learning motivation toward the mathematical creative thinking skills. The influence is shown by the significance value 0.030, which is lower than 0.050 (0.030 < 0.050). One of the ways to improve the thinking skills is pursuing good motivation within the learning process because through motivation, the students will understand themselves, and they will have the willingness and the encouragement to be engaged with the learning activities that will exert all of their skills, powers, and efforts in order to

achieve the objectives that they have demanded. In this regard, the objective will be critical thinking (Setianti et al., 2016).

The STEM-integrated PjBL learning model can serve as a learning context that the teachers have designed to encourage the students to be directly engaged in the learning activities (Siew et al., 2015). As a result, such a learning model improves thinking skills and explores the ideas that have appeared to the surface. The statement has been confirmed by the results of the previous studies, which state that the STEM-based Project Based Learning Model can improve the students' creative thinking skills (Lestari et al., 2018). Thus, the PjBL learning model can influence the students' learning motivation, creativity, critical thinking skills, and cognitive skills (Insyasiska et al., 2015). The use of the STEM approach can improve the students' creative thinking skills (Almuharomah et al., 2019). In other words, Project-Based Learning can improve creative thinking skills that cover fluency, originality, elaboration, and flexibility (Suryandari et al., 2018).

Problem-based learning (PBL) is a compulsory learning approach in the 2013 Curriculum. Through PBL, the students are encouraged to be active and creative. Such a learning approach is focused on mathematical problems. In practice, the teachers deliver the problems to the students, and the students will be able to solve the problems with all of the knowledge that they attain from sources of information, including the experiences that the students have previously had. One of the PBL characteristics lies in the fact that learning is student-centred. The statement implies that the learning activities of PBL situate the students in the centre of the learning activities. Therefore, the PBL approach is supported by the theory of constructivism, in which the learning process expects the students to create and develop their own knowledge (Islamiah et al., 2018).

The aspect that discerns the current study from the previous studies lies in the method that has been used. In the current study, the independent variables consist of PjBL-STEM Learning Model and the PBL Learning Model, while the moderating variable is Learning Motivation, which has an influence on a dependent variable, namely Mathematical Creative Thinking Skills. The results of the previous studies have only found the influence of PjBL-STEM on the students' creative thinking skills and communicative skills. On another occasion, there is classroom action research whose results are related to the improvement of creative thinking skills through the use of PBL.

CONCLUSIONS

Based on the results and the discussions within the study, it can be concluded that: (1) the project-based learning with the approach of Science, Technology, Engineering, and Mathematics (PjBL-STEM) and the Problem Based Learning (PBL) has an influence on the mathematical creative thinking skills; (2) the high, moderate, and low learning motivation has an influence on the mathematical creative thinking skills; and (3) there is an interaction between the Project-Based Learning Model with the approach of Science, Technology, Engineering, and Mathematics (PjBL-STEM) and the Problem Based Learning (PBL) with the learning motivation toward the mathematical creative thinking skills. Departing from these conclusions, it is suggested that future researchers conduct similar studies by using different methods, such as classroom action research, so that the results may complete those of the current study.

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