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MATHEMATICAL SELF-ESTEEM ABILITY OF JUNIOR HIGH SCHOOL STUDENTS IN PROJECT-BASED LEARNING

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ABSTRACT

The main objective of this research is to study the achievement of their mathematical self-esteem, as a result of Project-based Learning (PBL) and Conventional Learning (CL). This research is conducted mathematical self-esteem to be possessed by students, but in reality shows their self-esteem are still low. This research used quasi experimental methods. The population of this study is students of State Junior High Schools in Bandung City, West Java Province. The sample comprises the students of grade VIII. One class as an experimental group that received PBL learning and another class as a control group that received CL learning. The instruments used in this study are Prior Mathematical Knowledge (PMK) worksheet and mathematical self-esteem scale. The results indicate that: (1) the achievement of mathematical self-esteem of the students who received PBL learning is better than the students who received CL learning; (2) there is no interaction effect between learning model and PMK on the achievement of students' mathematical self-esteem.

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1. INTRODUCTION

The demands of life in the 21st century force human resources not only to increase their knowledge abilities. Knowledge ability must be balanced with attitude and skills in managing the ongoing comprehensive self-potential development. The driving factor that is no less important is the 2013 curriculum which demands multidimensional competence on students. The competencies that must be achieved are not only limited to the cognitive domain, but also to attitude and psychomotor competencies.

Students' mathematical thinking abilities are influenced by their internal elements (Pamungkas et al., 2017). Young and Hoffmann (2004) suggested that the success of students in school is strongly influenced by the self-admiration or self-esteem of these students for their ability to solve problems. This is in line with the opinion of Fisher and Kusumah (2018), the findings are that there is a positive correlation between student achievement and mathematical self-esteem. Based on several arguments about the importance of self-esteem, it is increasingly clear that mathematical self-esteem has very important implications for education (Casino-García et al., 2021). Students need to have a sense of worth, deserve and useful when involved in learning. Such feelings are termed self-esteem (Fauzan & Herman, 2011). Rosenberg (2015) defines self-esteem as a person's overall positive or negative assessment of himself or in other words self-esteem is the overall attitude that a person holds about himself, ranging from negative to positive. The essence of the notion of self-esteem raises the growing feeling that “I am capable and I am worthy".

The current fact regarding students' mathematical self-esteem is that less than 40% of students have self-admiration in solving mathematical problems (Fitriah & Aripin, 2019). In the previous year, Fisher and Kusumah (2018) conducted a study involving 140 junior high school students. The results of the study revealed that the average score of mathematical self-esteem obtained by male and female students was 63.84 and 63.27 respectively, while the ideal maximum score was 100. Paying attention to the facts that occur in the field, it is very necessary to implement learning models that can improve students' mathematical abilities, attitudes and skills.

Research Results from Nielsen et al. (2010), Struyven et al. (2010), and La Nani et al. (2020), revealed that a learning model that can improve students' learning abilities and achievement is a project-based learning model (PBL). Through PBL, students are prepared cognitively and emotionally to solve complex challenges collaboratively. Constructivism perspective views learning as an experiential process. Learning becomes more meaningful and produces quality values. Through PBL, the learning atmosphere becomes active, collaborative, increasing students' self-confidence so that students feel worthy, precious, capable and useful for others. According to Dias and Brantley-Dias (2017), the goal of PBL is to help students increase their knowledge and understanding of the subject as well as success skills (i.e., 21st century skills). They highlighted that students were expected to put their subject-matter knowledge into practice while working on the project. Thus, through understanding and applying a variety of abilities, including critical thinking, problem solving, collaboration, and self-management, students encourage their deep learning of the subject.

PBL is a learning model that is based on project development, imagination, planning, design, and is a student-centered teaching method that allows students to build interdisciplinary relationships as they work by bringing real-life environments to the classroom (Fisher et al., 2020, 2021; Kalayci, 2008). Klein et al. (2009) explained that PBL is a learning model that empowers students to gain new knowledge and understanding based on their experiences through various presentations. PBL contains project-based complex tasks based on very challenging questions and problems, and requires students to design, solve problems, make decisions, carry out investigative activities, and provide opportunities for students to work independently (Nasution et al., 2021). The characteristics PBL show that students can choose topics and/or presentation projects/products, produce final products such as presentations, recommendations for solving problems related to the real world, involve various disciplines, vary in duration of time, feature teachers in facilitator role (Hernández-Ramos & De La Paz, 2009; Kamdi, 2015).

This study tries to dig deeper into the mathematical self-esteem of students who learn to use PBL. Some of the literature is well studied to enrich the novelty in this research, so that it can be seen more comprehensively how PBL can provide a new paradigm in learning mathematics. Based on these considerations and problems, the researcher took the title “Mathematical Self-Esteem of Junior High School Students In Project-based Learning”.

2. METHOD

2.1. Research Design

The method used in this study was a quasi-experimental method. There were two groups of students. As the experimental group was students who acquire teaching mathematics under Project-based Learning (PBL) model, while the control group were students who acquaire teaching mathematics under Conventional Learning (CL). This study implemented postest only for both groups of students.

The research design involved two factors, namely learning models and student broup based on factors prior mathematical knowledge (PMK). The first factor consisted of PBL model and direct instructions. The second factor consisted of a group of students based on PMK (high, middle, and low). This research design could be described as the relationship between the factors as presented in Table 1.

Table 1. Relationship of mathematical self-esteem ability

PMK	**Teaching Model**	
	PBL	**CL**
High (Hi)	HiPBL	HiCL
Middle (Mi)	MiPBL	MiCL
Low (Lo)	LoPBL	LoCL

2.2. Sample

The population of this study is students of State Junior High Schools in Bandung City, West Java Province. The sample comprises the students of grade VIII at Junior High School. Whereas the sample was 130 students (66 students as an experiment group and 66 as a control group).

2.3. Research Procedure

Research activities initiated by determining the study sample. After the sample was set, each student was given a PMK test. The test is intended to classify students based on PMK (high, middle, and low). After the experimental and the control groups were formed, the students were given the treatment using PBL and CL. After the treatment, posttest on mathematical self-esteem scale. This scale consists of 25 statements items arranged with four answer choices (responses), and the scale consist of positive statements (favorabel) and negative statements (unfavorable). For data analysis, researchers used IBM SPSS Statistics 25.

2.4. Data Analysis

There were two main hypotheses to be tested. The first one was related to test two independent samples with the interval ratio of measurement. The data was analyzed by t test, t' test. In the second hypothesis, data could be tested using two ways ANOVA if the conditions were available. If the conditions were not available, the interaction effect would be add the count using Aligned Rank Transformation (ART).

2.5. Instrument

2.5.1. Test of Prior Mathematical Knowledge (PMK)

All of the instruments were developed by the researchers in this study and through doing the try outto fulfill the requirements of qualified validity, reliability. Test of PMK became required to measure the students' mathematical prior knowledge about the substances of mathematics which have been studied before, after they have been at grade VII. The materials assist in mastering the core of discussion which became discussed throughout this research. Researchers choose test questions from the National Examination (UN) during 2010 to 2017 junior high school mathematics class VII material. The selection of UN questions is assumed to have met national standards as a good measuring tool. The question is in the form of multiple choice and each item has four answer choices.

The purpose of the initial mathematical ability test is to place students on the basis of their initial mathematical ability. The indicators are as follows: (1) Students are able to perform arithmetic operations with rational numbers; (2) Students can use the principles, division, addition and subtraction in integer operations; (3) Students are able to perform arithmetic operations on problems related to comparisons; (4) Students are able to determine the solution of a one-variable linear equation; (5) Students are able to present data; (6) Using the concept of circumference of a flat shape in daily life. The PMK categories are presented in Table 2.

Table 2. Category of PMK

PMK	Category
$PMK \geq \bar{x} + s$	High
$\bar{x} - s \leq PMK < \bar{x} + s$	Middle
$PMK < \bar{x} - s$	Low

3. RESULT AND DISCUSSION

3.1. Result

Descriptive statistical analysis of the result of mathematical self-esteem ability was presented in Table 3.

Table 3. Description statistics of students' mathematical self-esteem ability

Prior Mathematical Knowledge (PMK)	Stat.	Experiment		Control		Mixed	
		Posttest	n	Posttest	n	Posttest	n
High	$\bar{x}$	86.98	7	80.73	8	83.86	15
	s	3.62		3.90		3.76	
Middle	$\bar{x}$	73.47	48	67.99	49	70.73	97
	s	7.35		5.30		6.32	
Low	$\bar{x}$	48.54	9	48.26	9	48.40	18
	s	8.17		7.51		7.84	
Mixed	$\bar{x}$	69.66	64	65.66	66	67.66	130
	s	6.38		5.57		5.97	

Table 3 show that the achievement of mathematical self-esteem ability that students acquire teaching under PBL was relatively higher than students who acquire teaching under CL, the well-viewed as a whole and viewed based on the level of PMK. The percentage of achievement in students' mathematical self-esteem based on learning, PMK (high, medium, low), and overall can be seen more clearly in the bar chart in Figure 1.

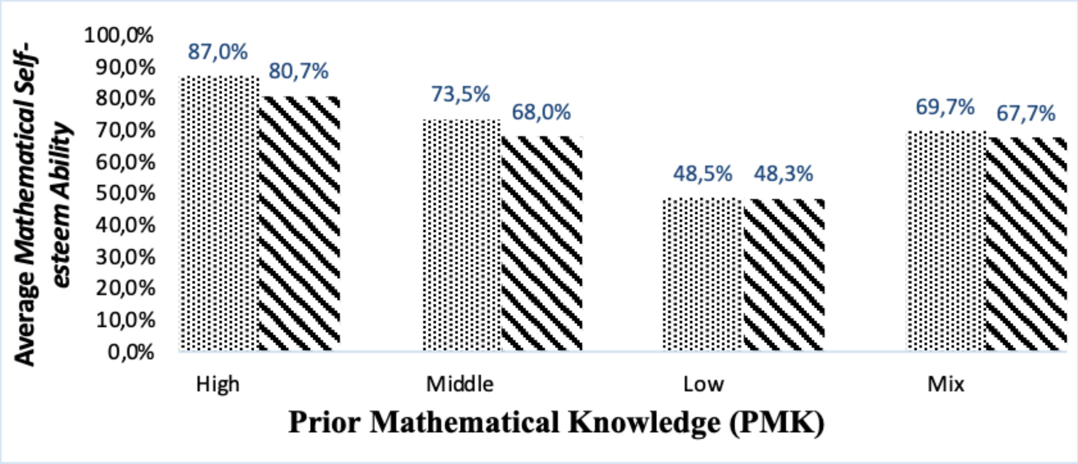

Figure 1. The percentage of achievement mathematical self esteem ability

Inferential statistical analysis of the results of students' mathematical self-esteem ability to experimental and control groups were presented in Table 4.

Table 4. Difference of students' mathematical self-esteem ability

Variable	Group	Difference Test		
SE Mixed	Experiment Control	t-test	0.028	Different
SE High	Experiment Control	t-test	0.030	Different
SE Middle	Experiment Control	t'-test	0.000	Different
SE Low	Experiment Control	t-test	0.930	Not Differrent

Table 4 show that there was difference in achievement mathematical self-esteem ability significantly between students who attained teaching under PBL (experimental group) and students who attaind teaching under conventional learning (CL), the well-viewed as whole (mixed) and viewed based on the prior mathematical knowledge (high and middle). If these results were associated with the results in Table 3 and Figure 1. it can be concluded that the achievement of students' mathematical self esteem ability who attained teaching under PBL were higher than students who attained teaching under CL.

The interaction effect between model learning and PMK toward achievement of students' mathematical self-esteem ability would be tested by using Two Ways ANOVA. Before using Two Ways ANOVA, it was necessary to be viewed whether the data of each facor was distrbuted normally and homogeneity test. The result of distributution normality was presented in Table 5.

Table 5. Normality distribution on mathematical self-esteem ability

Grup	Ability	Distribution Normality Test		Implications
		Sig.	Conclusions	
Experiment	-	0.200	Normal	Two Ways ANOVA is used
Control	-	0.200	Normal	
Experiment	High	0.137	Normal	
Control		0.200	Normal	
Experiment	Middle	0.200	Normal	
Control		0.218	Normal	
Experiment	Low	0.254	Normal	
Control		0.096	Normal	

Furthermore, the homogeneity test of the variance of the data on the achievement of students' mathematical self-esteem based on learning and PMK was carried out using the Levene statistical test. The result of the homogeneity test was presented in Table 6.

Table 6. The homogeneity test on mathematical self-esteem ability

Statistik Levene (F)	df_1	df_2	*Sig.*	H_0
2.845	5	126	0.018	Not Homogeneous

From the Table 6, it could be stated that there was not homogeneity the variance of mathematical self-esteem ability significantly between model learning and PMK. Because the data is not homogeneous, the test uses the Adjusted Rank Transformation Test (ART Test) (Aubuchon & Hettmansperger, 1984; Conover & Iman, 1981; Higgins et al., 1990; Leys & Schumann, 2010; Sawilowsky, 1990). The first step is to calculate the average score of the observations contained in each row and column according to the variables studied. Furthermore, each observation score in each row and column is reduced by the average. ART test is presented in Table 7.

Table 7. Adjusted Rank Transformation Test

	B_1		B_2	
	Score	Rank	Score	Rank
A_1	$\bar{x}_{A1.B1.1} - \bar{x}_{A1} - \bar{x}_{B1}$ $\bar{x}_{A1.B1.2} - \bar{x}_{A1} - \bar{x}_{B1}$ $\bar{x}_{A1.B1.3} - \bar{x}_{A1} - \bar{x}_{B1}$ $\vdots$ $\bar{x}_{A1.B1.i} - \bar{x}_{A1} - \bar{x}_{B1}$	$Y_{A1.B1.1}$ $Y_{A1.B1.2}$ $Y_{A1.B1.3}$ $\vdots$ $Y_{A1.B1.i}$	$\bar{x}_{A1.B2.1} - \bar{x}_{A1} - \bar{x}_{B2}$ $\bar{x}_{A1.B2.2} - \bar{x}_{A1} - \bar{x}_{B2}$ $\bar{x}_{A1.B2.3} - \bar{x}_{A1} - \bar{x}_{B2}$ $\vdots$ $\bar{x}_{A1.B2.i} - \bar{x}_{A1} - \bar{x}_{B2}$	$Y_{A1.B2.1}$ $Y_{A1.B2.2}$ $Y_{A1.B2.3}$ $\vdots$ $Y_{A1.B2.i}$
A_2	$\bar{x}_{A2.B1.1} - \bar{x}_{A2} - \bar{x}_{B1}$ $\bar{x}_{A2.B1.2} - \bar{x}_{A2} - \bar{x}_{B1}$ $\bar{x}_{A2.B1.3} - \bar{x}_{A2} - \bar{x}_{B1}$ $\vdots$ $\bar{x}_{A2.B1.i} - \bar{x}_{A2} - \bar{x}_{B1}$	$Y_{A2.B1.1}$ $Y_{A2.B1.2}$ $Y_{A2.B1.3}$ $\vdots$ $Y_{A2.B1.i}$	$\bar{x}_{A2.B2.1} - \bar{x}_{A2} - \bar{x}_{B2}$ $\bar{x}_{A2.B2.2} - \bar{x}_{A2} - \bar{x}_{B2}$ $\bar{x}_{A2.B2.3} - \bar{x}_{A2} - \bar{x}_{B2}$ $\vdots$ $\bar{x}_{A2.B2.i} - \bar{x}_{A2} - \bar{x}_{B2}$	$Y_{A2.B2.1}$ $Y_{A2.B2.2}$ $Y_{A2.B2.3}$ $\vdots$ $Y_{A2.B2.i}$

For data ART, researchers used IBM SPSS Statistics 25. The results are then arranged sequentially (rank) and only then can the Two-Ways ANOVA method as usual. Two Way ANOVA Test was presented in Table 8 and Figure 2.

Table 8. Two ways anova on mathematical self-esteem ability

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	128239.563[a]	5	25647.913	50.963	.000	.669
Intercept	327171.983	1	327171.983	650.098	.000	.838
Teaching Model	3793.111	1	3793.111	7.537	.007	.056
PMK	108406.702	2	54203.351	107.703	.000	.631
Teaching Model* PMK	1513.955	2	756.977	1.504	.226	.023
Error	63411.437	126	503.265			
Total	775388.000	132				
Corrected Total	191651.000	131				

a. R Squared = .669 (Adjusted R Squared = .656)

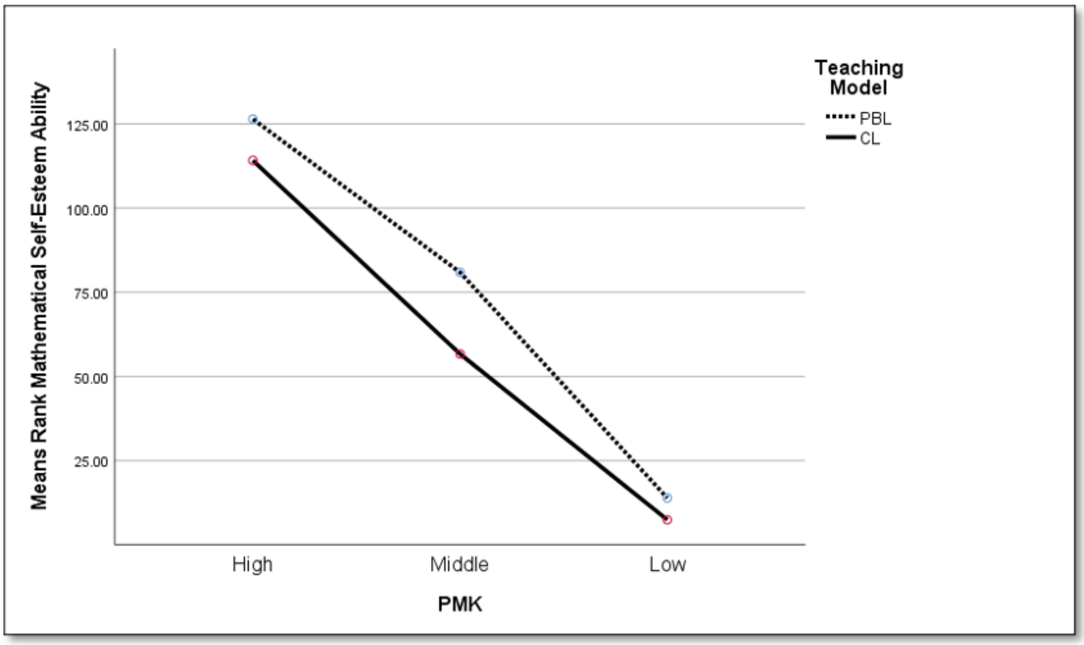

Figure 2. The Interaction Effect Teaching Model and Prior Mathematical Knowledge

From the Table 8 and Figure 2, it could be stated that there was no interaction effect between teaching models and prior mathematical knowledge toward achievement of student's mathematical self-esteem ability.

3.2. Discussion

Overall, the average achievement of mathematical self-esteem of students who received PBL was higher than students who received CL. The average mathematical self-esteem achievement of students who received PBL was 69.66 from the ideal maximum score which was classified as moderate, and students who received CL of 65.66 were also classified as moderate. Unlike the research conducted by Fadillah (2012), which used learning with an open-ended approach, this study found that students' self-esteem in mathematics who received learning with an open-ended approach was not better than those who received ordinary learning, in terms of overall students. In PBL in a group, someone with high self-esteem tends to be more courageous and critical of the group. Although it does not affect directly, self-esteem can affect a person's leadership traits (Baumeister, 2013). In line with Lawrence (2006), students with high self-esteem will maintain a natural curiosity in learning and have enthusiasm and enthusiasm when facing new challenges. These two opinions further strengthen the findings in this study, that the average achievement of mathematical self-esteem of students who receive PBL is higher than students who receive CL.

Although the average Self-esteem achievement of students who received PBL and students who received CL were both classified as moderate, the results of statistical tests confirmed that the overall mathematical self-esteem achievement of students who received PBL was significantly better than students who received CL. This means that overall, PBL learning is higher than students who receive CL.

These results are possible, because as suggested by Fatah et al. (2016), that one of the efforts to increase students' self-esteem is by giving responsibility to students. In PBL, students learn to be responsible for solving a given situation or problem, starting from making a project implementation schedule to reporting the results of project work to express perceptions of the project problems faced according to the results of their respective thoughts. Then individually, students are responsible for being able to explain their work to their friends. The teacher's role as a facilitator in PBL emphasizes more on the efforts made by students, not on the results. No matter how simple the results of student thinking, teachers still appreciate and give appreciation. When students make mistakes, the teacher emphasizes to students that mistakes are part of the learning process. It is not a failure. Thus, students become more confident to be actively involved in learning, feel that their existence is valued, feel that they are needed by others, and in the end students can respect themselves.

Based on the PMK category, the average achievement of mathematical self-esteem of high PMK students who received PBL was 86.98 from the ideal maximum score of 100 (classified as high). Meanwhile, the average achievement of mathematical self-esteem of high PMK students who received CL had an average achievement of 80.73 from the ideal maximum score (high). The statistical test concluded that the achievement and increase in self-esteem of high PMK students who received PBL learning were better than those who received CL.

Based on the PMK category, the average achievement of mathematical self-esteem of moderate PMK students who received PBL was 73.47 from the ideal maximum score (classified as moderate). The average mathematical self-esteem achievement of PMK students who received CL had an average achievement of 67.99 from the ideal maximum score (classified as moderate) based on the results of statistical tests, the achievement of mathematical self-esteem of middle PMK students who received PJBL learning was more than students who received CL. Like the research conducted by Pamungkas et al. (2017), which used the inquiry cooperation learning model, this study found that for each category of initial mathematical ability (high, middle, and low) and school ranking (high and middle), achievement and self-improvement The mathematical self-esteem of students who received PBL learning was better than students who received CL.

Based on the PMK category, the average mathematical self-esteem achievement of low PMK students who received PBL learning was 48.54 from the ideal maximum score (classified as low). The average achievement of mathematical self-esteem of low PMK students who received CL had an average achievement of 48.26 from the ideal maximum score (classified as low). The results of statistical testing concluded that the achievement of mathematical self-esteem of low PMK students who received PBL was not better than students who studied conventionally.

The results of statistical tests for each category of PMK (high, middle, low), concluded that the achievement and improvement of mathematical self-esteem of students who received PBL were better than students who received CL. This shows that in the three PMK categories (high, middle, low), PBL learning is better than CL. Therefore, PBL is more appropriate for students who have high and middle initial abilities than CL.

Based on the results of the study, it was found that there was no significant interaction between learning (PBL, CL) and PMK (high, middle, low) on the achievement of students' mathematical self-esteem. It means, the interaction between learning and PMK does not have a significant effect on differences in students' self-esteem achievement. Differences in the achievement of students' self-esteem are only caused by differences in learning factors. In other words, the learning factor does not depend on the PMK factor. In any PMK category, the achievement of self-esteem of students who received PBL was better than students who received CL. Even though at high and middle PMK, the achievement of mathematical self-esteem of students who received PBL was better than students who received CL, but when it seen from the difference in average achievement, high and middle PMK students who benefited much more from learning PBL compared to low PMK.

4. CONCLUSION

The achievement of self-esteem of students who received PBL learning was better than students who received Conventional Learning. The percentage of students' achievement of mathematical self-esteem who received PBL learning and those who received learning were both relatively high. There is no interaction effect between learning model (PBL-CL) and PMK (high, middle, and low).

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