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Regression of Discovery Learning Model and PBL Perspective Realistic Mathematics Education (RME) in Algebraic Materials

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Abstract

The benefit of this research is to overcome student learning problems in algebraic material. The low learning achievement of students with the average national exam is low below the minimum completeness of graduation, this is influenced by one factor, namely conventional learning models or methods that do not support mathematics learning. Based on this, an alternative learning model is needed that can provide an understanding of student achievement abilities. In this case the Model of Discovery Learning and PBL with the Realistic Mathematics Education (RME) perspective. This study aims to determine the Regression Model of Discovery Learning and PBL from the Realistic Mathematics Education (RME) Perspective on Algebraic Materials. This study was conducted in Surakarta Junior High School with the subject of class VIII students. This type of research is an experiment with a 3x3 factorial design with a random sampling technique, each of which is taught using the discovery model and PBL perspective Realistic Mathematics Education (RME). The data was collected using a test, while the data analysis technique used inferential analysis of two-way ANOVA through prerequisite, balance, hypothesis, and further tests. The conclusion is that the problem-based learning model is better than discovery learning and direct learning. Problem-based learning Students who have low, medium, and high initial abilities who are treated with the Problem Based Learning model with the Realistic Mathematics Education approach have better mathematics learning achievements than the Discovery Learning model and the direct learning model. Students who have moderate initial abilities who are treated with the Problem Based Learning model with a Realistic Mathematics Education approach have better mathematics learning achievements than the Discovery Learning model and direct learning model, while students who receive the Discovery Learning model treatment have the same mathematics learning achievement with a direct learning model on the material of a two-variable linear equation system.

Keywords
PBL; realistic mathematics education (RME); discovery learning; algebra

I. Introduction

Education is the right of everyone regardless of age, so that in today's technology education is considered to be a solution in solving all the problems of life. This is following the purpose of education to produce permanent changes in habits, thoughts, attitudes and behavior. Strengthened by the main function of education is the guidance of individuals to meet the needs and desires following their potential, to obtain satisfaction in

all aspects of personal life and social life. Education is something important and cannot be separated from a person's life, both in the family, society and nation (Sari, 2021). Education has a very strategic role in determining the direction of the forthcoming of the nation's quality of community knowledge (Musdiani, 2019). This compulsory education program is expected to provide minimum education for Indonesian citizens to be able to develop their potential so that they can live independently in a community environment or continue their education to a higher level (Martono, 2020). In its implementation, education must direct students to the use of various situations and opportunities to rediscover the mathematics of life in their way (G. Thompson, 1957; Crow and Crow, 1960; Hadi, 2005).

Success in education cannot be separated from the classroom learning process that involves educators and students. Steps in improving the quality of education are not only by improving the implementation of the learning process, but also need maximum effort in realizing satisfactory results with the selected learning model. In mathematics, the average percentage of geometry and measurement at the city/district level, especially in the Surakarta area, is 55.06 and nationally is 48.57, which means that geometry subjects have the lowest percentage of UN scores. After conducting a pre-survey on class VIII students, many students have difficulty understanding algebraic material rather than geometry material. Many students have not been able to operate algebraic forms, one of which is in the material of a two-variable system of linear equations. (Permendikbud no 5 of 2015).

Difficulties in understanding the material have an impact on the low learning outcomes of mathematics, this may be influenced by several factors, both internal and external. Internal factors include beliefs, motivation, skills, abilities, intelligence, achievement, critical thinking and others, while external factors include infrastructure, government policies, educators, selection of methods, approaches or learning models, environment and family (Slamet, 2013: 54) . Based on the results of researchers' observations related to the low value of the UN (National Examination) in mathematics material, educators still have not implemented the learning model recommended by the 2013 curriculum, one of which is the lack of understanding of the two-variable linear equation system material due to difficulties in understanding, if viewed from the National Examination, an innovative learning model is needed. which is needed based on the needs and abilities of students. Currently, the implementation of the learning model needs attention so that students have a good understanding (Septian, 2020).

Based on the results of observations, the initial ability to do the pretest, many students have difficulty in doing it. This is indicated by the results of the students' initial ability scores below the graduate completeness score. One of the efforts to overcome the difficulties of students understanding mathematics material and producing good graduation scores, it is necessary to innovate learning models with the application of Realistic Mathematics Education (RME) because mathematics learning is recommended to start from human activities. RME is a theory of teaching and learning in mathematics education while the concept of RME is in line with the need to improve mathematics education in Indonesia which is dominated by the issue of how to increase students' understanding of mathematics and develop reasoning power. The application of Realistic Mathematics Education (RME) is combined in problem based learning (PBL) and discovery learning models to determine the relationship between these learning models (Suyatno, 2009; Sukri & Widjajanti, 2015).

The Discovery Learning model has learning scenarios to solve problems that they get themselves. In the problem-solving process, students use their experiences that have been

experienced or better known as constructivists. In this case, being able to make improvements to student learning outcomes, both in terms of cognitive, affective, and psychomotor. In applying the discovery learning model, the teacher acts as a mentor by providing opportunities for students to learn actively, the teacher must be able to guide and direct students' learning activities according to the objectives. Then in the application of the Problem Based Learning model, it was chosen because it requires students to be active in the investigation and problem-solving process in learning (Hosnan, 2014; Abidin, 2014).

PBL is learner-centered learning and empowers students to conduct research, integrate theory and practice, and apply knowledge and skills to develop viable solutions to problems. a learning model that uses real-world problems that are not structured (ill-structured) and are open as a context for students to develop problem-solving and critical thinking skills and at the same time build new knowledge. Problem Based Learning (PBL) model is a learning model that provides authentic experiences that encourage students to learn actively, construct knowledge, and integrate learning contexts in real life naturally.

The low learning achievement of students in learning mathematics may be caused by the use of learning models, so it is necessary to research to determine the most appropriate learning model for students to apply to algebraic material. The selection of learning models and media in learning is a demand that must be considered by educators to create active learning conditions. Based on the results of Babys' research (2016: 43-49) that students who are taught using the Discovery Learning model with the RME-PISA and RME approaches meet classical completeness at the KKM limit = 70 and the classical completeness limit is more than 85%. This is because students prefer to learn in group discussions. After all, they work with friends in finding and finding solutions to problem-solving, dare to express opinions, and actively communicate to solve problems. Furthermore, the research results of Pradipta, Suadnyana, & Darsana (2013) concluded that the students' mathematics learning outcomes in the experimental class using the Problem Based Learning learning model through the Realistic Mathematics Education approach were 65 while the students' learning outcomes in the control class were taught using conventional learning (direct learning).) is 52.02. This shows that the mathematics learning outcomes of students who are taught using the Problem Based Learning model through the Realistic Mathematics Education approach are better than students who are taught using the direct learning model.

In the learning process, the initial ability is one of the factors that play a role and affect the level of mastery of learning materials for each student. The basic abilities that students have as a basis for understanding new things given by the teacher are often referred to as initial abilities. According to Dricoll (1994) states that activating relevant prior knowledge is very important to produce meaningful results. Students who have relevant initial abilities will be able to provide a foundation or basics in learning to absorb new things. The stronger the foundation that students have, the stronger the new things that students can understand easily. This is in line with Ivie (1998: 6) who states that learning will be meaningful when students can link old ideas and new ideas. If we are dealing with some students whose intelligence is not specifically chosen, then among them there are children with high, medium, and weak abilities. Ruseffendi (Herdian, 2010) said that from a group of children who were not specifically selected some highly gifted children were above moderate-ability students, which were the same number as children with low abilities.

Based on the problems above, the researcher intends to conduct research on the experimentation of the Discovery Learning model and the Problem Based Learning (PBL) model with the Realistic Mathematics Education (RME) approach on algebraic material in

a two-variable linear equation system in terms of the students' initial abilities to improve mathematics learning achievement learners.

II. Research Methods

This study uses a quasi-experimental research model (quasi-experimental) because it is not possible for the researcher to control all relevant variables related to mathematics learning outcomes in terms of student's initial abilities. The population in this study were students of class VIII SMP Negeri in Surakarta City for the 2018/2019 academic year, while the sample in this study were 3 schools from State Junior High Schools throughout the city of Surakarta State which implemented a five-day school system and were grouped into high, medium and high groups low. The group classification is based on data on the National Junior High School Exam scores for the 2016/2017 academic year with different strata consisting of three classes for each known different experimental model. Data collection methods include documentation and tests. While the instruments used include test instruments and learning outcomes. In testing the instrument, it can be done with instrument analysts by checking the results of validity and reliability, while the items of the instrument can be done with differentiating power, difficulty, and internal consistency.

This study used a two-way ANOVA analysis test with unequal cells with a 3×3 factorial design to determine the effect of two independent variables on the two dependent variables. The first independent variable is the next learning model symbolized by (A), namely the Realistic Mathematics Education (RME) perspective Problem-Based Learning (PBL) learning model symbolized by (A_1) hereinafter referred to as PBL-RME which is applied to experiment one, model discovery learning (DL) which is symbolized by (A_2) hereinafter referred to as DL which is applied to experiment two, and the direct learning model (PL) is symbolized by (A_3) hereinafter referred to as PL which is applied to the third experimental class. The second independent variable, namely the communication skills of students is symbolized by (B) which consists of three categories, namely high (B_1), medium (B_2), low (B_3). The dependent variable is mathematics learning achievement symbolized by (X⟧_1), hereinafter referred to as P

III. Discussion

3.1 Results

Table 1. Normality Test of Learning Achievement Data

Sample	Bound Variant	*N*	L_{obs}	$L_{\alpha;n}$	Test Decision
Discovery Learning Model	Student Mathematics Learning Achievement	92	0,992	0,092	H_0 *not* rejected
PBL model with RME approach	Student Mathematics Learning Achievement	91	1,000	0,091	H_0 *not* rejected
Live Learning	Student Mathematics Learning	93	0,883	0,092	H_0 *not* rejected

	Achievement				
KA Tall	Student Mathematics Learning Achievement	82	0,613	0,092	H_0 not rejected
KA Curently	Student Mathematics Learning Achievement	150	0,894	0,094	H_0 not rejected
KA Low	Student Mathematics Learning Achievement	44	0,976	0,090	H_0 not rejected

Based on the results of the analysis in the table, it is obtained that all samples have test statistics $L_{obs} \leq L_{\alpha;n}$ as a result $L_{obs} \notin DK$, so that it can be concluded for a significance level of 5% all samples came from a normally distributed population.

Table 2. Population Variance Homogeneity Test

Bound Variant	Data Source	S_j^2	χ^2_{obs}	$\chi^2_{(0,05:2)}$	Test Decision
Student Mathematics Learning Achievement	DL	153,795	30,793	5,991	H_0 rejected
	PBL RME	357,430			
	PL	120,895			
Student Mathematics Learning Achievement	KA Tall	6349,087	333,003	5,991	H_0 rejected
	KA Currently	42,857			
	KA Low	1145,938			

Based on the results of the analysis in the table, it is obtained that all initial abilities have a test $\chi^2_{obs} \leq \chi^2_{(0,05:2)}$ then $\chi^2_{obs} \notin DK$. Therefore, it can be concluded that the significance level of 5% of all populations has a homogeneous variance.

Table 3. Average Mathematics Learning Achievement

Model (A)	Early Ability (B)			Rerata Marginal
	Tall	Currently	Low	
DL	85,35	67,52	51,64	70,13
PBL RME	81,72	69,53	43,14	70,26
PL	83,63	70,42	55,70	70,68
Marginal mean	83,28	69,01	50,80	

Anova two unequal cell paths were used to test the hypothesis. By using a significance level of 5%, the results of the two-way analysis of variance with unequal cells are presented in the following table.

Table 4. Two Way Anava Summary Table with Unequal Cells

Source Variance	JK	DK	RK	F_{obs}	F_{α}	Kep H_0
Learning model (A)	939,36	2	469,68	5,80	3,03	H_{0A} rejected
Early Ability (B)	39011,15	2	19505.58	240,73	3,03	H_{0B} rejected
Interaction (AB)	1217,08	4	304,27	3,76	2,40	H_{0AB} rejected
Error	21229,17	262	81,03	-	-	-
Total	62396,77	270	-	-	-	-

a. Interline Test (*A*)

ANOVA calculation results obtained F_A = 5,80 dan F_{tabel} at a significance level of 5% with dk 2 and an error of 21229.17 of 3,03, Due to F_A = 5,80 > $F_{0,05;2,223}$ = *3,03* is in the critical region resulting in H_{0A} being rejected. The rejection of H_{0A} stated that there were differences in the effect of the learning model on students' mathematics learning achievement. This means that there is a difference between the Discovery Learning model, the Problem Based Learning model with the Realistic Mathematics Education approach, and direct learning on students' mathematics learning achievement.

Table 5. Interline Comparison Test Analysis

H_0	H_1	F_{obs}	$(2)F_{0,05;2:223}$	Decision
$\mu_{1.} = \mu_{2.}$	$\mu_{1.} \neq \mu_{2.}$	0,01	6,06	H_0 not rejected
$\mu_{1.} = \mu_{3.}$	$\mu_{1.} \neq \mu_{3.}$	0,16	6,06	H_0 not rejected
$\mu_{2.} = \mu_{3.}$	$\mu_{2.} \neq \mu_{3.}$	0,10	4,80	H_0 not rejected

b. Intercolumn Test (*B*)

ANOVA calculation results obtained F_B = 240.73 and F_{tabel} at a significance level of 5% with dk 2 and an error of 262 of 3,03. Because F_B = 240,73 > $F_{0,05;2,223}$ = 3,03 is in the critical region resulting in H0B being rejected. The rejection of H0B stated that there were differences in the initial ability level of students on students' mathematics learning achievement. This means that there are differences in the mathematics learning achievement of students who have high, medium, and low initial abilities.

Table 6. Summary Table of Inter-Column Comparison Test Analysis

H_0	H_1	F_{obs}	$(2)F_{0,05;2:223}$	Decision
$\mu_{.1} = \mu_{.2}$	$\mu_{.1} \neq \mu_{.2}$	108,30	6,06	H_0 rejected
$\mu_{.1} = \mu_{.3}$	$\mu_{.1} \neq \mu_{.3}$	611,19	6,06	H_0 rejected
$\mu_{.2} = \mu_{.3}$	$\mu_{.2} \neq \mu_{.3}$	181,93	4,80	H_0 rejected

c. Comparison Test between Cells on the Same Column

ANOVA calculation results obtained F_{AB} = 3,76 and F_{tabel} at the 5% significance level of 2,40. Because F_{AB} = 3,76 > $F_{0,05;4,223}$ = 2,40 means H0A is rejected. The rejection of H0AB states that it means that there is an interaction between the learning model and the student's initial abilities on the students' mathematics learning achievement.

Table 7. Intercellular Comparison Test Analysis in the Same Column

Dependent variable	Komparasi	F_{obs}	F_{tab}	Test Decision
Mathematics Learning Achievement	$\mu_{11} vs\ \mu_{21}$	169,23	8,46	H_0 rejected
	$\mu_{11} vs\ \mu_{31}$	658,53		H_0 rejected
	$\mu_{21} vs\ \mu_{31}$	138,32		H_0 rejected
	$\mu_{12} vs\ \mu_{22}$	79,09		H_0 rejected
	$\mu_{12} vs\ \mu_{32}$	862,45		H_0 rejected
	$\mu_{22} vs\ \mu_{32}$	381,94		H_0 rejected
	$\mu_{13} vs\ \mu_{23}$	92,84		H_0 rejected
	$\mu_{13} vs\ \mu_{33}$	125,53		H_0 rejected
	$\mu_{23} vs\ \mu_{33}$	427,65		H_0 not rejected

d. Comparison Test between Cells on the Same Row

ANOVA test results obtained F_{AB} = 3,27 and F_{tabel} at the 5% significance level of 2.40. Due to F_{AB} = 3,27 > $F_{0,05;4,223}$ = 2,40 means H_{0AB} is rejected. The rejection of H_{0AB} states that it means that there is an interaction between learning models and students' initial abilities on students' mathematics learning achievements.

Table 8. Comparison Test Analysis between Cells in the Same Row

Dependent variable	Comparison	F_{obs}	F_{tab}	Test Decision
Mathematics Learning Achievement	$\mu_{11} vs\ \mu_{12}$	7,45	8,46	H_0 not rejecetd
	$\mu_{11} vs\ \mu_{13}$	1,95		H_0 not rejecetd
	$\mu_{12} vs\ \mu_{13}$	1,65		H_0 not rejecetd
	$\mu_{21} vs\ \mu_{22}$	2,30		H_0 not rejecetd
	$\mu_{21} vs\ \mu_{23}$	0,42		H_0 not rejecetd
	$\mu_{22} vs\ \mu_{23}$	4,69		H_0 not rejecetd
	$\mu_{31} vs\ \mu_{32}$	40,91		H_0 rejected
	$\mu_{31} vs\ \mu_{33}$	85,11		H_0 rejected
	$\mu_{32} vs\ \mu_{33}$	9,20		H_0 rejected

3.2 Discussion

The first research hypothesis, Based on the results of the ANOVA test analysis, there are differences in the effect of the learning model on student achievement on algebraic material. The existence of these differences requires further post-MANOVA testing with two-way ANOVA with unequal cells. The results of the two-way ANOVA test show that there is no interaction between the knowledge aspect of the learning model and interpersonal communication and there is no interaction between the skills aspect of the learning model and interpersonal communication. Furthermore, judging from the aspect of knowledge and aspects of good skills between the learning and interpersonal communication models, a double comparison test was conducted.

The results of the multiple comparison test concluded that in mathematics learning achievement problem-based learning model with Realistic Mathematics Education approach provides better mathematics learning achievement than discovery learning model and PBL learning model, while discovery learning model provides the same learning achievement with direct learning. These findings are the same as the hypothesis proposed by the researcher.

Students who have high initial abilities who are treated with Problem Based Learning models with a Realistic Mathematics Education approach have better mathematics learning achievements. while the Discovery Learning Model has the same mathematics learning achievement as the direct learning model on algebraic material.

The second research hypothesis, based on the results of multiple comparisons, it was concluded that students' learning achievement in mathematics algebraic material. In conclusion, students who have moderate initial abilities who are treated with the Problem Based Learning model with a Realistic Mathematics Education approach have better mathematics learning achievements than the Discovery Learning model and direct learning models, while students who receive the Discovery Learning model treatment have better mathematics learning achievements. the same as the direct learning model on algebraic material.

In this case, problem-based learning with the Realistic Mathematics Education approach is better than the Discovery Learning model and direct learning model on mathematics learning achievement. Problem-based learning with a Realistic Mathematics Education approach can affect learning achievement in both low, medium, and high initial abilities.

The third research hypothesis, based on the results of the research analysis above, students who have low initial abilities who receive the treatment of the Problem Based Learning model with the Realistic Mathematics Education approach have the same mathematics learning achievement as the Discovery Learning model. However, students who were treated with the Problem Based Learning model with the Realistic Mathematics Education approach had better mathematics learning achievements than the direct learning model and students who were treated with the Discovery Learning model had better mathematics learning achievements than the direct learning model.

The fourth research hypothesis, based on students with Problem Based Learning model treatment with Realistic Mathematics Education approach who have the high initial ability have better mathematics learning achievement than students who have the moderate initial ability and low initial ability, and students who have the moderate initial ability have learning achievement mathematics is better than those who have the low initial ability.

In this case, problem-based learning has a good relationship with student achievement, even better when through a Realistic Mathematics Education approach, while related to discovery learning at the beginning it is better than direct learning, especially those with moderate abilities who can provide the same as problem-based learning. without the Realistic Mathematics Education approach.

The fifth research hypothesis, based on the results of the analysis, students with discovery learning model treatment who have high initial abilities have better mathematics learning achievements than students who have moderate initial abilities and low initial abilities, and students who have moderate initial abilities have the same mathematics learning achievement with low initial ability.

Based on this, students who have good initial abilities can be better than students who have moderate or low abilities when associated with the available learning models, namely direct discovery and direct learning.

The sixth research hypothesis, there are students with direct learning model treatment, students who have high initial abilities have better mathematics learning achievements than moderate initial abilities, and students who have low initial abilities. Students who have moderate initial abilities have better student mathematics learning achievements than students who have low initial abilities.

Based on this, students with lower or moderate abilities must be extra in applying appropriate learning models to be taught. Because the initial ability is low, it must be

adjusted to the lesson, it needs special attention, even the model needs an approach. After being approached through the Realistic Mathematics Education approach. It will be better than moderate abilities using a learning model without a Realistic Mathematics Education approach.

IV. Conclusion

Based on the results of the research and discussion above, conclusions can be drawn in this study as follows, the problem-based learning model is better than discovery learning and direct learning. Problem-based learning Students who have low, medium, and high initial abilities who are treated with the Problem Based Learning model with the Realistic Mathematics Education approach have better mathematics learning achievements than the Discovery Learning model and the direct learning model. Students who have moderate initial abilities who are treated with the Problem Based Learning model with a Realistic Mathematics Education approach have better mathematics learning achievements than the Discovery Learning model and direct learning model, while students who receive the Discovery Learning model treatment have the same mathematics learning achievement with a direct learning model on the material of a two-variable linear equation system.

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