Differences in Students Mathematical Representation Ability Taught with *Problem Based Learning* Model and *Missouri Mathematics Project* in Class X High School Students

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Abstract. The goals of this study are to determine two things: (1) whether students who are taught using a problem-based learning approach have better mathematical representation skills than those who are taught using a Missouri mathematics project approach; and (2) how students' mathematical representation skills change depending on their early math skills.This study is kind of like an experiment.This study used students from class X at SMA Negeri 2 Bagan Sinembah as the population, and a random sample was used to select the sample.The instruments used were a math pre-ability test and a post-test of the students' ability to represent math.Two-way ANOVA was used to analyze the data.The findings demonstrated the following: (1) There is no interaction between the learning model and early mathematics ability on students' mathematical representation ability; (2) There are differences in the mathematical representation abilities of students who are taught through the problem-based learning model and students who are taught through the Missouri mathematics project model..

Keywords: *The Missouri Mathematics Project, Problem-Based Learning, and Students' Ability to Represent Mathematical Concepts*.

1 Introduction

Mathematics is a science that cannot be separated from human life. Mathematics also has a very important role in the development of science and technology. The role of mathematics in the life and development of today's era is the reason for the importance of studying mathematics and improving the quality of mathematics education. Learning mathematics is expected to make students think logically, analytically, systematically, critically and creatively, as well as problem solving abilities.

Materials in learning mathematics are interrelated with one another, even mathematics also has links with other disciplines and problems in everyday life. Therefore, it is very important

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to improve students' mathematical abilities. Thus, mathematics needs to be considered at every type and level of education in order to improve the quality of education. However, the high demands for mastering mathematics are still not directly proportional to student learning outcomes. Sumarno (Simamora, 2019: 2) suggests that students' mathematics learning outcomes have not been satisfactory, as well as learning difficulties faced by students and difficulties faced by teachers in teaching mathematics.

The low student learning outcomes can also be seen from the basic competencies that have not been met by students in learning mathematics, this agrees with Maulydia, Surya and Syahputra (2017: 2966) who say that: "in the process of learning mathematics there are still many students who have not achieved the basic competencies required. has been established". In addition, there are still many students who do not realize the importance of mathematics and consider mathematics as a difficult, scary, abstract subject, and a compulsory subject which is only limited to routine calculations.

This is in accordance with the findings of the researcher based on the results of observations and interviews at SMA Negeri 2 Bagan Sinembah. Is one of the math teachers at SMA Negeri 2 Bagan Sinembah. said that: "most students are afraid and even hate learning and studying mathematics, this is because mathematics is known to be difficult because of the characteristics of mathematical material that is abstract, logical, systematic, and full of symbols. and formulas that confuse students. This is in line with what Russeffendi (Muhtarom, et al., 2016: 21) stated that "the weakness of mathematics in Indonesian students is because mathematics lessons in school are feared and even hated by students". So many students say that the math teacher is a killer teacher. This happens because the lessons are difficult to understand plus the learning process carried out by the teacher is less varied. In addition, the experience of learning mathematics with the teacher is not pleasant during the learning process. The teacher still uses a one-way learning process, and students are passive in learning.

In addition, he also stated that "students have difficulty in translating or interpreting mathematical ideas contained in the problem and describing it in a visual form so that students cannot develop a mathematical model correctly to be able to solve the problem. Students are also still difficult to understand what is known, what is asked and find solutions to the problem in the form of a story. And there are still many students who are not sure of their own answers, so when the teacher gives the opportunity for students to answer questions, they refuse and there are even students who depend on their friends' answers. Based on the explanation above, it can be seen that the mathematical ability, especially mathematical representation and self-efficacy of students at SMA Negeri 2 Bagan Sinembah is still low.

To find out more about students' representational abilities at SMA Negeri 2 Bagan Sinembah, the researchers also gave a diagnostic test of representational abilities adopted from the National Examination questions at the Junior High School level to 60 students (X1 and X3).

From the results obtained, students have not been able to, as can be seen use visual representations to solve problems, create geometric figures to clarify problems and facilitate settlement, solve problems by involving mathematical expressions, and write interpretations of data from representations. Thus, it is possible to draw the conclusion that the procedure for completing the answers provided by students at SMA Negeri 2 Bagan Sinembah took an initial ability test for mathematical representation in every way is still in the poor category.

Mathematical representation ability is one of the abilities that need to be considered because the ability to make mathematical representations facilitates and clarifies mathematical solutions, transforms abstract ideas into real concepts, for example with pictures, symbols, words, graphs, tables, and others (Hasratuddin, 2015). : 125). According to Jones & Knuth (Handayani, 2018: 211) representation is a model or substitute form of a problem situation that is used to find a solution. Mathematics learning experts who are members of the NCTM set mathematical representation as a separate standard of ability that is important to be developed in the implementation of the school curriculum. NCTM (2000) "Students in the middle grades solve many problems by creating and using representations to organize and record their mathematical ideas-related thinking states".

Mathematics learning activities involve students practicing and communicating using a variety of representations, resulting in a richer learning environment (Mc. Coy, Baker & Little in Hasratuddin, 2015: 128). Furthermore, it is said that in the classroom learning of mathematics, representation does not have to be restricted to changing one form into another in a single direction; rather, it can be two-way and even multi-directional. Aspects that show students have mathematical representations are (1) making pictures to clarify problems and facilitate solutions. (2) solving problems by involving mathematical expressions, and (3) answering questions using words or written text.

However, based on the findings of research carried out by Rahmawati (Hanifah, 2015: 192), it is stated that the maximum mathematical representation ability of students has not been achieved due to students' lack of understanding of the concept as a whole. Seifi, et al. (2012: 2923) conducted an experiment to detect students' difficulties in solving math story problems from their teacher's perspective. The results show that most of the students' difficulties stem from the inability to represent and understand a problem, make plans and define the terms used.

One of the reasons for the lack of students' mathematical representation skills is due to the limited knowledge of teachers who do not develop students' representational power. This is consistent with the study by Hutagaol (2013:86), stating that although representation has been declared as one of the standard processes in the curriculum that must be achieved by students through learning mathematics, its implementation is not a simple matter. The limited knowledge of the teacher and the habits of students studying in the conventional way have not made it possible to develop optimal mathematical representation power. In line with that, Amri (Mandur, Sadra and Suparta, 2013: 3) found that teachers did not provide opportunities for students to present and use their mathematical representation skills, so students tended to follow the steps for solving problems made by their teachers. Furthermore, Surya & Syahputra (2017: 12) state that: Students are presented with routine problems during the classroom learning process that can be solved through straightforward analysis and mechanistic solutions.Nearly all instruction in mathematics is provided in school uses definitions, formulas, examples and ends with practice questions. Occasionally, evidence is found that solving mathematical problems is done using numbers or simple sketches.

Responding to the problems that exist in learning mathematics, especially related to students' mathematical representation abilities which ultimately lead to low student learning outcomes in learning mathematics, teachers must strive for learning by applying learning models that can provide opportunities and encourage students to practice students' representational abilities. In learning mathematics with a conventional approach, students' representational abilities are still very limited to short verbal answers to various questions posed by the teacher.

So it is necessary for teachers or researchers to choose a lesson that can change the paradigm. Where is a process of learning mathematics that gives students the opportunity to see and experience the usefulness of mathematics in real life.

Problem based learning learning model besides being able to improve students' representational abilities. Piaget (Arends, 2008: 47) that good pedagogy must involve offering various situations where children can experiment in the broadest sense, experimenting with various things to see what will happen, manipulating objects, manipulating symbols, asking questions. and looking for answers on their own, conciliating what was found at one time with what he found at another time, comparing his findings with those of other children.

Problem based learning learning model is one of the constructivist learning models that enable students to collaborate in solving problems. Problem based learning learning model requires active students to construct mathematical concepts and solve given problems, students can communicate in mathematical language well so as to foster student confidence in the given potential and improve students' abilities both in student representation abilities.

Based on the opinion above, mathematics learning is emphasized on the relationship between mathematical concepts and the experiences of students in everyday life. So that students will feel familiar and happy with the material they are learning and be able to understand the material through their activities. Then it can be used learning carried out by educators and learning processes based on real life, namely PBL.

The Missouri Mathematical Project (MMP) learning model is another learning model that is in line with constructivism theory in addition to the problem-based learning model.The Missouri Mathematics Project (MMP) learning model is a structured learning model that includes a mix of activities for teachers and students as well as practice questions for groups and individuals to develop ideas and expand mathematical concepts.Understudies in this MMP learning model are given the opportunity to work together to solve problems posed by the teacher about learning materials.

The first stage of MMP is a review. In this review stage the teacher reviews learning related to the learning to be taught, then enters the second stage, namely development. For this second stage the teacher delivers the material being taught by instilling new concepts and ideas. In the third stage, students are formed into several small groups which are then given the opportunity to work on assignments with their group members, and the teacher guides them. This third stage is called cooperative work (controlled exercise). In the group there was a group discussion, so that it was seen that there were student activities, namely asking each other questions, arguing, and convincing each other of answers. After that, class discussions between groups were carried out to ensure each other's group answers, and the teacher led the discussion which would also conclude the results of all groups, then entered the fourth stage, namely seat work (independent exercise) in the independent training stage the teacher gave a post-test to find out the results. the learning that has been done and in the last stage, namely homework (PR) the teacher gives homework (PR) to students so that students continue to study even at home. From the MMP steps, it can be seen that the function of this learning model is as a facilitator.

MMP is quite effective and efficient in accordance with the student-centered learning model (student-centered), which combines all components, including teacher skills and student activity, which will both have a significant impact on learning outcomes for students.In addition, it is hoped that the Missouri Mathematics Project Learning Model will enable students to better represent mathematical concepts skills. As a result, it is hoped that student learning outcomes will improve and that students will continue to reap the benefits.

By using the MMP learning model in learning mathematics, it will certainly motivate students, that learning mathematics has enormous benefits and uses in their daily lives. As a result, MMP learning is anticipated to be a solution for creating a student learning paradigm rather than a teacher teaching paradigm, as is the case with conventional learning, which in turn may lead to an improvement in the mathematical abilities of students representation abilities. It also shows that there is a difference between the impact of the Missouri mathematics project the problem-based learning model and the learning model on students' ability to represent math.

In addition to learning factors, there are other factors that affect students' mathematical representation abilities, namely students' early mathematical abilities (KAM). KAM is divided into high, medium, and low groups. Furthermore, the learning model and students' initial mathematical abilities which are divided into high, medium and low ability groups are thought to have no interaction with students' mathematical representation abilities, as well as learning models and students' initial mathematical abilities which are divided into high, medium and low ability groups. does not have an interaction with students' mathematical representation abilities which in the end can show that it is the learning model that affects students' mathematical representation abilities.

For students who have moderate or low abilities, if the learning model used by the teacher is interesting, according to the cognitive level of students, it is very possible that students' understanding will be faster, and in the end can improve mathematical representation skills in mathematics. On the other hand, for students who have high abilities, the effect of learning models on mathematical representation abilities in mathematics is not too large. This happens because students who have high abilities understand mathematics faster, because they are used to learning that is disciplined, enthusiastic, and challenging even without using various interesting and ordinary learning models.

Given the preceding context, it is believed that it is necessary to determine whether Missouri mathematical projects and problem-based learning contribute differently to students' mathematical representation abilities.A research project with the title "The Differences Between Missouri Mathematics Project Models and Problem-Based Learning Models in the Mathematical Representation Skills of Class X SMA Students".

2 Research Method

This research is categorized into a quasi-experimental research. This study aims to see the difference in the mathematical representation ability of students who receive PBL and MMP learning, as well as to see the interaction between learning models and early mathematics abilities on students' mathematical representation abilities.

The population in this study were all students of class X SMA Negeri 1 Riau totaling 205 students which were divided into 7 classes with 4 classes majoring in science and 3 classes majoring in social studies. The sample in this study consisted of two classes, namely class X MIA 2 as the experimental class I with a total of 30 students and class X MIA 3 as the experimental class II with a total of 30 students.

Prior to being given treatment, students were given an initial mathematical ability test to determine the extent of students' readiness. After that, the experimental class I was treated by applying PBL learning and the experimental class II was treated by applying MMP learning. Then at the end of the meeting a final ability test (post-test) was conducted. The experimental design can be seen in table 1 below:

Table 1 Research Design

Group	**KAM**	**Treatment**	***Post-test***
Experiment I	T_1	X_1	T_2
Experiment II	T_1	X_2	T_2

Information :

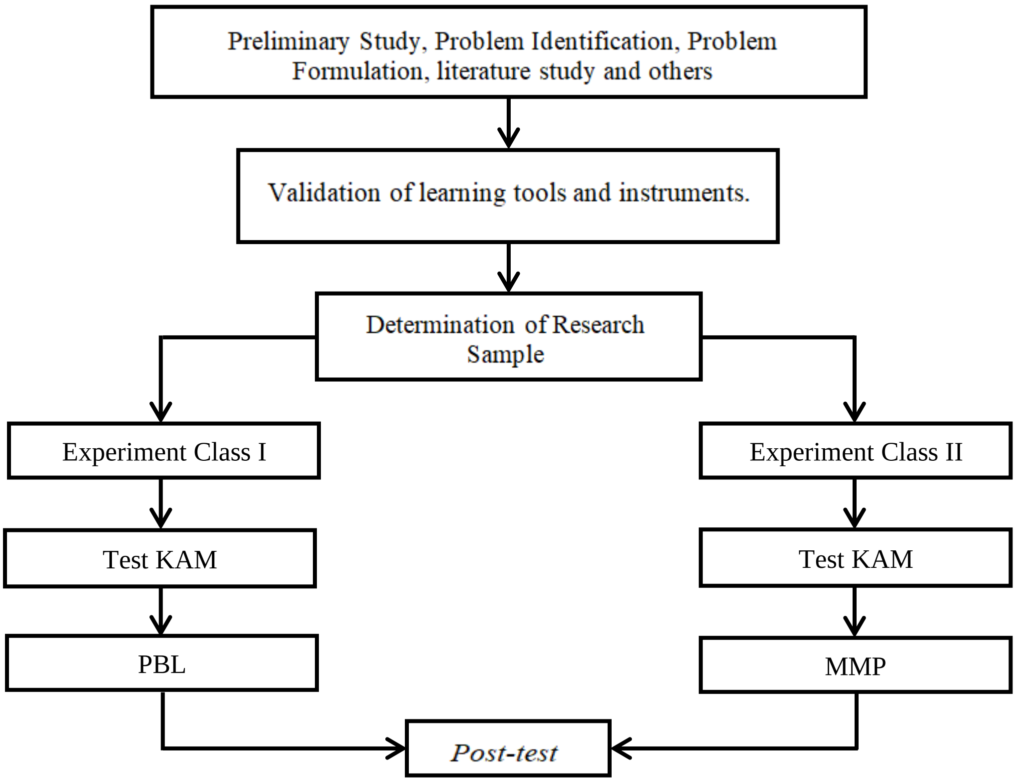
T_1 : The KAM test is before being given treatment

T_2 : Post-test (final test) that is after being given treatment

X_1 : Treatment by applying PBL

X_2 : Treatment by applying MMP

The research procedure is the stages of activities with a set of data collection tools and learning tools. The stages are as follows: preliminary study, compiling learning tools and instruments, validating tools and instruments, conducting research, and data analysis. Figure 1 is a chart in this study that can be found below.



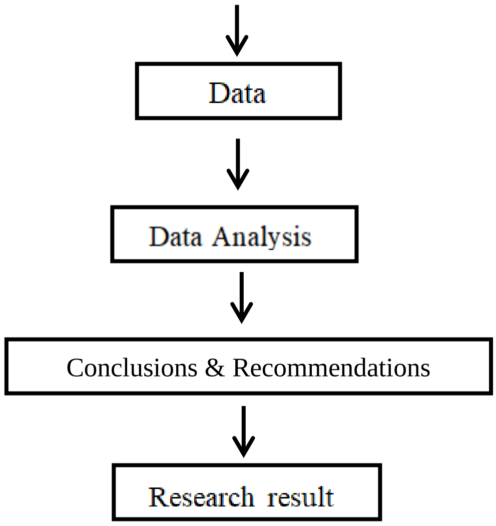


Figure 1. Research Design

3 Research result

Analysis of the description of students' early mathematical ability

To obtain an overview of the KAM of students, the calculation of the average and standard deviation (standard deviation) is presented in Table 2. below:

Table 2. Description of Student KAM

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
KAM_Experiment _I	30	50	85	68,17	10,866
KAM_Experiment _II	30	50	85	66,67	10,114
Valid N (listwise)	30				

A description of the mathematical representation ability post-test results

A post-test of mathematical representation abilities was administered following the application of the learning model to each test class to assess the extent to which students' abilities in representing mathematical problems were enhanced following learning.Table 3 provides a description of the two classes' post-test results:

Table 3. Description of the Student's Post-Test Mathematical Ability Results

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
KRM_Experiment _I	30	62	92	78,57	7,605
KRM_Experiment _II	30	50	80	59,63	6,975
Valid N (listwise)	30				

Data normality post-test assessment of students' capacity for mathematical representation

The goal of the normality test is to see if the post-test value data of students' mathematical representation skills in two classes are normally distributed.Table 4 displays the results of the Kolmogorov-Smirnov test performed on the data used in this study using the SPSS version 22.0 program tool:

Table 4. Normality Test Results Post-Test Values of Students' Mathematical Representation Ability

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
KRM_Experiment _I	,153	30	,071	,950	30	,164
KRM_Experiment _II	,146	30	,104	,935	30	,067

a. Lilliefors Significance Correction

Test of homogeneity of post-test data students' mathematical representation ability

Testing the homogeneity of the post-test scores of students' mathematical representation ability test results in testing class I and class II aims to determine whether the data obtained from the post-test scores of students' mathematical representation ability test results come from a homogeneous population or not. The results of the homogeneity test in the two classes were analyzed using the Lavene test using the SPSS version 22.0 program tool as shown in Table 5 below:

Table 5. Result of Homogenity of Variance of Post-Test Values of Mathematical Representation Ability

Test of Homogeneity of Variances

*Post-test*_KRM

Levene Statistic	df1	df2	Sig.
,115	1	58	,736

Two-way ANOVA statistical analysis students' mathematical representation ability

Using formulas and conditions that have been established, a Two-Way Analysis of Variance with F statistics is used to examine the hypothesis testing.Table 6 displays the results of the summation of the hypothesis testing analysis performed with SPSS version 22.0 program tools:

Table 6. Two-way ANOVA Test Results of Mathematical Representation Ability

Tests of Between-Subjects Effects

Dependent Variable: KRM

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6365,751[a]	5	1273,150	32,744	,000
Intercept	213932,652	1	213932,652	5502,045	,000
KAM	904,430	2	452,215	11,630	,000
Learning	3798,231	1	3798,231	97,685	,000
KAM * Learning	21,108	2	10,554	,271	,763
Error	2099,649	54	38,882		
Total	294954,000	60			
Corrected Total	8465,400	59			

a. R Squared = ,752 (Adjusted R Squared = ,729)

4 Research discussion

Students are placed into one of three KAM groups based on their scores on the KAM test.Problems with the PBL and MMP learning models that concern students' capacity for mathematical representation can also be solved using KAM grouping.The study found that the KAM group in the first test class consisted of 8 high-capacity students, 17 tolerably fit students, and 5 low-capacity students. In the second test class, the KAM group consisted of 5 high-capacity students, 19 respectably proficient students, and 6 low-capacity students. The first test class had an average value of 68.17 and a general deviation of 10.866, while the second test class had an average value of 66.67 and

Because mathematical theories are arranged in a hierarchical fashion, students must first comprehend the fundamental ideas of the previous theory before moving on to the next one.This requires students to have basic mathematical skills.Students won't be able to move on to the next theory if they don't understand the main ideas behind it.Descriptive data analysis revealed that students whose treatment was based on the PBL model performed better in mathematical representation than those whose treatment was based on the MMP model.The first test class received an average post-test score of 78.57, while the second test class received an average post-test score of 59.63.

In light of the aforementioned clarification, students who utilized the PBL model had a higher numerical portrayal capacity than students who utilized the MMP model.Two-Way ANOVA was used to break down these results based on the learning factor. The value indicates that the value was dismissed, so it was dismissed and acknowledged. As a result, it is generally thought that students who used the PBL model had different numerical portrayal capacities than students who used the MMP model.This is in line with PBL studies involving MMP-applied students.As indicated by Nurfitriyanti et al. (2020), which is consistent with the study's findings that "there is a significant difference in mathematical representation abilities between prospective educator students who learn through the PBL model and the direct learning model."The results of the covariance analysis show that the direct learning model is inferior to the average PBL model.

This study alludes to the joint effort between early numerical capacities and learning in affecting understudies' numerical portrayal abilities.Inferential statistical analysis of the students' capacities for mathematical representation was carried out using the two-way ANOVA test for the KAM*Learning factor.Given that the results were obtained using, the value of is accepted.This suggests that the students' prior mathematical proficiency and the learning model do not interact.This is predictable with the discoveries of Eviyanti's (2018) study, which discovered that KAM and learning models meaningfully affected understudies' capacities to address math.

5 Conclusion

In view of the consequences of the information examination of this review, the ends are portrayed as follows:Students who use the Missouri mathematics project learning model and students who use the problem-based learning model have different capacities for mathematical representation.There is no connection between the learning model and the numerical portrayal capacity of the understudies' underlying numerical capacities.This indicates that students' abilities in mathematical representation are solely influenced by the provided learning model.

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