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Effectiveness of the application of the problem-based learning model based on Kampar culture towards improving students' mathematical representation abilities

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Abstract

This research is motivated by the importance of mathematical representation ability. The results of the field study indicate that students' mathematical representation ability falls in the low category because they are not given the opportunity to develop their representations during the mathematics learning process. The purpose of this study is to determine the effectiveness of the Kampar culture-based Problem Based Learning model to improve students' mathematical representation ability. The Kampar culture used is traditional Kampar clothing, traditional Kampar games, traditional Kampar musical instruments, and traditional Kampar food. The study population is all students of SMA N in Bangkinang City; the sample of this study is grade X students of SMA N 2 Bangkinang City. The data collection technique used is the test technique. The data analysis techniques used are the normality test, the homogeneity test, the t-test, and the one-way ANOVA. The results of the study indicate that there is effectiveness in applying the Kampar culture-based PBL model to mathematical representation ability viewed from the overall students, and there is effectiveness in applying the Kampar culture-based PBL model to mathematical representation ability viewed from the level of students' abilities.

Keywords: Kampar culture; mathematical representation ability*;* problem-based learning

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I. Introduction

Mathematical representation skills are crucial because they serve as the foundation for understanding and applying mathematical concepts in problem-solving (Hijriani, Rahardjo & Rahardi, 2018). Mathematical representation skills are crucial for students because they express mathematical ideas, such as problems, mathematical statements, and definitions, in various ways (Syafri, 2017)

Benefits for teachers and students during learning involving representations include encouraging teachers to improve their teaching skills by learning from students' representations; enhancing students' understanding; strengthening students' ability to connect mathematical representations to problem-solving; and preventing misconceptions (Khoeirunnisa & Maryati, 2022).

In representing their knowledge, students

are required to understand various concepts in their learning activities. Therefore, mathematical representation is crucial and necessary during the mathematics learning process. Rofiatul (2019) Stated that mathematical representation plays an important role in helping students understand problems that arise in everyday life. Mathematical representation can also help students develop critical thinking skills and deepen their understanding of mathematics. The indicators of mathematical representation ability measured in this study are: (1) visual representation; (2) symbolic representation; and (3) verbal representation. However, field data indicate that students' mathematical representation abilities have not been fully realized.

Research by Suningsih & Istiani (2021) analyzing students' mathematical representation abilities found that these abilities remained relatively weak. This was evident in several indicators of mathematical representation, such as the ability to represent equations or mathematical expressions, with a 43.5% score, which is still considered low. Research by Ristiani & Maryati (2022), which analyzed mathematical representation abilities, also found that students' mathematical representation abilities were relatively low. This was due to students' inability to express their own ideas or methods in the given problems and their lack of understanding of the problems' meanings, which made it difficult for them to determine the formulas used.

The results of the study Hardianti, Nia & Effendi (2021) indicated that students with high, medium, and low initial mathematical representation abilities were still classified as moderate. This was evident in several indicators of mathematical representation abilities. Students were able to solve problems with visual, symbolic, and verbal indicators, but made several errors. Research conducted by Fajriah, Utami & Mariyam (2020), which stated that the level of students' mathematical representation ability is in the high criteria with a percentage of 20%, the level of students' mathematical representation ability is in the medium category with a percentage of 27% and the level of students' mathematical representation ability is in the low category with a percentage of 53%, it can be seen that the level of mathematical representation ability is still relatively low.

Students' low mathematical representation skills are caused by several factors related to classroom learning, such as students' lack of mastery of the problem, students' inattention to the teacher during instruction, and teachers' inadequate application of mathematical problems to everyday life, resulting in students' inability to solve problems effectively (Ribkyansyah & Nopitasari, 2018). One of the difficulties students experience in solving problems is low mathematical representation skills, which occurs in most mathematics materials, including probability (Ruamba, Dwijayanto & Mariani, 2022).

This is consistent with the opinion of Fitri, Munzir & Duskri (2017), who stated that students' low mathematical representation skills are caused by their rarely being given opportunities to develop their own representations, leading them to tend to follow the teacher's lead in solving problems. Teachers are still accustomed to presenting information, providing examples, and ordering students to complete practice problems. Consequently, students are unable to develop their best representation skills. The representations put forward by students are a collection of ideas presented by students in an effort to find solutions to the problems they are being presented with (Kumalasari, 2022).

This statement aligns with the opinion expressed by Muthmainnah (2014), who stated that teachers believe mathematical representations in the form of graphs, tables, and images are merely complementary to learning and that teachers rarely pay attention to the development of students' mathematical representation skills. This indicates that representation skills are under-appreciated in mathematics learning, resulting in low levels of students' mathematical representation skills.

Therefore, teachers are required to present

contextual problems that students can represent. One example is problems related to local culture. This is because local culture is part of students' immediate knowledge and experience, which can facilitate students' connection to their own culture. However, to encourage students to represent their mathematical ideas in problem-solving, they need to be guided through problem-solving through the stages of problem orientation, problem analysis, data collection, presentation, and evaluation. These stages constitute the PBL phase, in which PBL learning trains students to understand and solve problems, starting from their own knowledge and experience. PBL phases require students to analyze problems and express their ideas with their groups, thus fostering a positive attitude throughout the learning process.

In this situation, students need learning designed to enhance their representation skills, actively engage them in learning, and provide meaningful learning experiences. Maryati & Monica (2021) in their research, they recommend using the Problem-Based Learning model to help teachers meet students' needs and positively impact students' mathematical representation. According to Hosnan (Pratiwi & Setyaningtyas, 2020). PBL is a model that supports problem-based learning; students can learn to manage their own knowledge, improve their skills and levels of inquiry, and gain greater self-confidence.

Research conducted by Fitri et al. (2017) reported that students who learned using the PBL model improved their mathematical representation skills better than those who learned using conventional methods. Research by Sari (2024) stated that implementing the PBL model can improve students' learning outcomes and mathematical representation skills. This includes students' ability to process data to present it as images or diagrams, their ability to draw conclusions or interpret the information obtained, and their ability to solve problems by applying mathematical concepts.

PBL learning activities are carried out by linking the learning process to the real world and the learning process in class. This is the context in which the learning process is used. The PBL model has five learning phases, namely: (1) student orientation to the problem; (2) analyzing the problem; (3) developing ideas or strategies; (4) investigation; and (5) evaluation.

Their implementation of PBL, which is modified according to their local wisdom, their water point is that their students are given according to their local wisdom and the local culture of their local population. Zuhri, Agustina & Winda (2022). State that to make learning easier to understand and more interesting for students, namely by playing the role of their cultural components that are present in their environment around the participants, especially their local culture, to prevent students from becoming uninterested in participating in learning, making learning more interesting for students by playing the role of cultural components from the students' own culture as a learning tool. PBL can function in different contexts and opens up a broader, student-centered approach to education. Research on PBL approaches can focus on factors that attract students' interest in learning (Frambach, Talaat & Wasenitz, 2019)

Mathematics that arises and develops in accordance with local culture is a learning process and a learning method. From their information above, it is evident that there is a relationship between culture and mathematics (Febriani, Widada & Herawaty, 2019). The implementation of culture in the implementation of mathematics learning (Richardo, 2016) is that culture in learning can facilitate students to be able to construct mathematical concepts with prior knowledge that they already know because it is through the students' own environment, culture in learning can provide a learning environment that creates good motivation and is enjoyable and free from the assumption that mathematics is scary and culture in learning can create affective competencies in the form of the creation of a sense of appreciation, nationalism and pride in the legacy of tradition, history and national culture.

Based on several opinions from experts, it

can be concluded that PBL is a learning model that begins with real problems. In this regard, to overcome the problem of students' low mathematical representation abilities, researchers implemented a PBL learning model based on the Kampar culture. Their research began with real-world problems and the importance of implementing an appropriate learning model for the material to be taught to improve students' mathematical representation abilities.

II. Research Method

This research is quasi-experimental research, with a Nonequivalent Control Group design as shown in Table 1 below.

Table 1. Non-equivalent design group

Group	Pretest	Treatment	Posttest
Experiment	O_1	X_1	O_2
Control	O_3	-	O_4

Source: Modification from Sugiyono, 2022

Infomation:
O_1: Pretest experiment group
O_3: Pretest control group
O_2: Posttest experiment group
O_4: Posttest control group l
X_1: Treatment with the PBL learning model PBL
- : Conventional learning

The population of this study was all grade X students of SMA Negeri in Bangkinang City. The research sample was determined using purposive sampling, namely the technique of intuitive sampling with intuitive consideration (Sugiyono, 2022). The researcher selected a school with at least 30 students, with a relatively diverse range of cultural backgrounds, academic achievement, and gender. Therefore, the sample chosen was the students of grade X of SMA N 2 Bangkinang city, because the average school in SMA N 2 Bangkinang city is relatively low, and based on the results of the researcher's interview with one of their mathematics teachers at SMA N 2 Bangkinang city, it was stated that in class they rarely set problem-based questions during learning, problem-based questions are only given in certain materials, and their school has implemented a curriculum according to the curriculum needed in this study. This study comprised six classes: three experimental classes that used the PBL model based on Kampar culture and three control classes that used conventional learning. Each sample class consisted of 30 students, with different numbers of boys and girls in each experimental and control class.

The data used in this study were the results of a mathematical representation ability test administered before and after the treatment. The data collection technique used was a test technique, and the test instrument consisted of mathematical representation ability questions that were first evaluated for their suitability through validity, discrimination, and difficulty levels. These are presented in the following table.

Table 2. Item validity test results

No	Question	*Corrected Item Total Correlation*	Status
1	1	0,5765	Valid
2	2	0,60238	Valid
3	3	0,844	Valid
4	4	0,56667	Valid
5	5	0,909	Valid

In Table 2, all questions have a Pearson Correlation r > 0.3388. This indicates that the validity of the question is valid.

Table 3. Distinguishing power of question items

No Question	Distinguishing Power	Interpretation
Question-1	0,05	**Bad**
Question -2	0,17	Bad
Question -3	0,42	Good
Question -4	0,09	Bad
Question -5	0,28	Enough

Table 4. Item difficulty level index

Question	Average	Maximum Score	IK	Criteria
Question -1	7,44	9	0,83	Easy
Question -2	6,67	12	0,56	Medium
Question -3	7,11	9	0,79	Easy

Question -4	3,33	12	0,28	Difficult
Question -5	4,61	6	0,77	Easy

Based on Table 4 above, three questions have easy criteria, one has medium criteria, and one has difficult criteria. This can be interpreted as indicating that the mathematical representation ability test devised has varying levels of difficulty.

Their data analysis technique begins with prerequisite tests, namely normality and homogeneity tests. After the prerequisites are met, the data are tested according to the requirements of each hypothesis, typically using the t-test and one-way ANOVA to compare the effectiveness of improving representation skills across the learning models received from the perspective of students' initial mathematical abilities.

III. Results and Discussion

The results of calculations to analyze the effectiveness of applying the PBL model on mathematical representation abilities, viewed at the student ability level (high, medium, and low), are presented in Table 5 below.

Table 5. Normality test result

Level	Class	Sig.	Status
High	Experiment	0,200	Normal
	Control	0,125	Normal
Medium	Experiment	0,130	Normal
	Control	0,64	Normal
Low	Experiment	0,200	Normal
	Control	0,177	Normal

Table 5. shows that all six sign values are > 0.05; thus, H_0 is accepted. This means that all groups of data on the improvement in students' mathematical representation abilities, whether receiving PBL or conventional learning, across all KAM groups are normally distributed. The next test conducted was the homogeneity test, which is presented in Table 6 below.

Table 6. Homogenity test result

Level	Class	Sig.	Status
High	Experiment	0,351	Homogeneous
	Control		
Medium	Experiment	0,491	Homogeneous
	Control		
Low	Experiment	0,053	Homogeneous
	Control		

Based on Table 6. It was found that the significance >0.05, so H_0 was accepted; in other words, the variance of the data on the increase in mathematical representation ability based on high, medium, and low ability levels was homogeneous. Furthermore, the results of the calculation of the analysis of the effectiveness of the application of the Problem-Based Learning (PBL) model on mathematical representation ability, reviewed from all students, are presented in Table 7 below.

Table 7. Results of the t-test of mathematical representation ability viewed from all students

Class	N	Std. Deviation	*Sig. (2-Tailed)*	Information
Experiment	96	0,11710	0,004	There is a different
Control	96	0,11299		

Based on the calculation results contained in Table 7, it is obtained that the significance value is < 0.05, so H_0 is rejected, and H_1 is accepted. This can be interpreted as an influence of PBL on students' mathematical representation abilities viewed from all students.

Their calculations analyze the effect of implementing the PBL model on mathematical representation abilities, viewed at the level of student ability (high, medium, and low), as presented in Table 8.

Table 8. Test result *One Way ANOVA*

Level	Average	*Sig. (2-Tailed)*	H_0
Hiigh	0,66277	0,024	Rejected
Medium	0,6003		
Low	0,5473		

Based on Table 8. The significance value

(sig.) is 0.024. Because of the sig. The number obtained is a 2-tailed sig. < 0.05, then H_0 is rejected. This means that there is an effective improvement in students' mathematical re-imagination abilities using the Kampar culture-based PBL model, with students using conventional learning at high, medium, and low levels of student ability.

This study's findings relate to indicators of mathematical representation ability. Before implementing the PBL model, students tended to ignore or question the problems presented by their teacher, leading to a lack of understanding of the problems and difficulty solving them. However, after the implementation of the PBL model, differences and improvements were observed, occurring because students were directly involved in the learning process implemented by the PBL model at each stage.

The results of this analysis of mathematical representation ability indicate that the PBL model has a significant impact on students' mathematical representation abilities across the entire student body. Thei findings obtained in their class, there is an increase in mathematical representation ability in their experimental class compared to their control class, because in their experimental class learning is carried out using LKPD where in LKPD there are a PBL steeps by giving problems related to Kampar culture which is a local culture and is their closest experience of students such as traditional games, traditional food, and traditional clothing so that it can Makei it easier for students to connect their knowledge and be able to represent their mathematical ideas such as students can easily present information from problems, and are able to make steeps to solve problems.

This is in accordance with the research conducted by Sari (2024), which states that there is an influence on the ability of mathematical representation between students who learn using the Problem-Based Learning model and students who are taught by conventional learning. Their research above shows that the Kampar culture-based PBL model used in the experimental class improves students' mathematical representation ability, regardless of ability level (high, medium, or low). Innovative learning with cultural elements can increase students' interest in learning. This aligns with research by Yusriadi, Zubaidah & Berlian (2023), which found that learning grounded in Kampar culture's local wisdom can improve students' mathematical understanding. Culture-based learning can also improve students' mathematical representation, in accordance with research conducted by Fuzana (2022), which states that culture-based learning has an influence on the achievement of students' mathematical representation abilities.

This can happen because during their learning process, students conduct heterogeneous group discussions, where when students discuss working on LKPD, there are problems related to the culture that exists in the students' environment, so that with the discussion, students are able to work together and are able to present problem-solving based on mathematical expressions and are able to determine the steps to solve their problems given. Because the problem-based learning paradigm is closely related to the reality of students' daily lives, students are able to relate directly to the problems they are studying, and their learning abilities do not depend only on their teachers (Handayani & Mandasari, 2018)

Problem-Based Learning (PBL) is a learning model that is commonly referred to as a problem-based learning model to acquire knowledge and concepts through critical thinking and problem-solving skills that use real problems found in everyday life (Fakriyah, 2014). This is in line with the opinion of Widarti, Yunarti & Asnawati (2014), who state that when working on worksheets, students conduct investigations and balance their answers to questions in accordance with their ideas, using various forms of representation. State that the PBL model can improve the mathematical re-imagination ability of both students with the criteria of individual abilities and the criteria of students with the criteria of re-imagination ability because students are guided to intuitively solve problems created

through re-imagination, which is possible with PBL.

Students need sufficient time to develop an intuitive understanding of and become accustomed to using their mathematical rei-imagination ability through solving various problems. In line with their research conducted by Susanti, Duskri & Rahmi (2019), the research results show that students with high and medium abilities have three indicators of mathematical representation ability, namely writing down the steps for solving mathematical problems in words, presenting data or information from a problem in the form of pictures, diagrams, graphs, or tables, and solving problems that involve mathematical expression.

The results of research Fauzia (2018) state that the PBL model can improve and optimize the process and learning outcomes of students, learning with the PBL model begins by raising problems that must be solved by students, where the problems raised are related to contextual problems, which will make it easier for students to understand the material provided and to consider their own knowledge so that learning is more meaningful. Research conducted by Andani, Pranata & Hamdu (2021) shows that the PBL model has a significant impact on mathematics learning, as seen in their improvement in the achievement of learning objectives, namely improving students' cognitive abilities, problem-solving abilities, improving students' learning outcomes, and improving students' ability to communicate ideas and balance character.

Research by Agusdianita, Supriatna & Yusnia (2023) found that learning with a culture-based problem-based learning model can significantly improve learning outcomes. This is seen in students becoming happier and more enthusiastic in participating in learning and achieving better learning outcomes. Research by Widana & Diartiani (2021) indicates that a culture-based problem-based learning model can improve students' mathematics learning outcomes, leading to positive interactions between teachers and students that foster independent learning skills and encourage students to solve contextual problems. This research is considered relevant because it also examines a culture-based PBL model in learning.

The factor that causes the mathematical representation ability of students who follow the PBL learning model to be higher than that of students who follow the conventional learning model is that, in the PBL model, their learning begins with the creation of problems presented in the form of a worksheet. The students are asked to work in groups to solve the problem. Each group consists of four students.

IV. Conclusion

Based on the research results and discussion, it can be concluded that the application of the PBL model is effective in improving students' mathematical representation skills when viewed across all students. The application of the PBL model is also effective in enhancing students' mathematical representation skills at high, medium, and low ability levels.

Based on the findings of this study, it is recommended that when using the PBL model to improve students' mathematical representation skills, attention should be given to appropriate time management and discipline during learning. When researchers and teachers are able to manage time more effectively, learning outcomes can also be improved. For further research, different research models may be used by involving larger samples and populations so that improvements in students' mathematical representation skills can be observed more comprehensively.

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