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The effect of ethnomathematics-based PBL models on problem solving ability in terms of student learning styles

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***Abstract*:** This study aims to analyze the influence of differences in learning models on problem-solving ability, the influence of differences in student learning styles on problem-solving ability, and the interaction between learning models and student learning styles on problem-solving ability. The design of this study is a pseudo-experimental design. The samples in this study were students of class VII A and class VII C of SMP Negeri 3 Muntilan who were selected by cluster random sampling. Based on the results of the hypothesis test conducted with the two-way ANAVA test, the results were obtained that 1) there were differences in the influence of learning models on problem-solving ability; 2) there is no difference in the influence of the four learning styles on problem-solving ability; 3) there is no interaction between the learning model and the student's learning style on problem-solving ability. The conclusions of this study are 1) students with ethnomathematics-based PBL models have better problem-solving abilities than students with direct learning models; 2) students with convergent, divergent, assimilated, and accommodation learning styles with an ethnomathematics-based PBL models have better problem-solving abilities than students with direct learning models.

Keywords: Ethnomathematics-based PBL; Learning style; Problem solving ability

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INTRODUCTION

Problem-solving skills are important in mathematics learning. The National Council of Teachers of Mathematics (2000) established five standard process skills in mathematics, namely problem solving, communication skills, connection skills, reasoning and proof, and representation skills. Meanwhile, Son et al. (2020) stated that problem solving is an inseparable part of all the main points of learning in mathematics. Thus, problem-solving ability is one of the abilities that must be possessed by students in solving problems in mathematics.

Problem solving skills include several steps in solving problems, one of which is based on Polya, namely understanding problems, planning solutions, implementing plans, and looking back (Polya, 1973). This problem-solving ability will certainly affect the final result because in mathematics there are often problem-solving problems. In Indonesia, the problem-solving ability possessed by students is relatively low, as evidenced by the results of the 2018 PISA survey conducted by the OECD, showing that the ability of Indonesian students in mathematics achieved an average score of 379 below the OECD average of 4899 and was ranked 72 out of 78 countries (Schleicher, 2019). Meanwhile, one of the benchmarks in PISA is to measure the ability of students' capacity to apply their knowledge and skills to identify, interpret, and solve problems in various situations (OECD, 2019). In addition, based on the results of the student problem-solving ability test conducted in class VII of SMP Negeri 3 Muntilan from 64 students,

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only 5 students obtained a score above KKM and obtained an average score of 40.44 below the KKM mathematics score of 75 so that it shows that the problem-solving ability of class VII students at SMP Negeri 3 Muntilan is still low.

Based on the observations made, the learning process during the pandemic was carried out online from home. However, many students are inactive during the learning process. This also happened in the face-to-face learning process in the classroom during the pandemic, where the mathematics learning process went one way and was informative from teacher to student. The teacher delivers the material, then the students only listen to what is being conveyed so that the involvement of students in the mathematics learning process is very lacking. Students become less active in following the learning process.

The lack of student activity in participating in learning results in students not being able to realize their ability to solve mathematical problems properly so that students' problem-solving abilities cannot develop as expected. This is because the learning model used by teachers does not make students actively involved in the learning process. If the learning model applied by teachers is less varied and tends to limit students from being creative in expressing their thoughts will result in students being less interested in mathematics learning, students become more passive, reluctant, afraid, and embarrassed to express their ideas in solving mathematical problems (Rohmah & Sutiarso, 2018). The process of learning mathematics can become more active if it is done by providing a challenge that stimulates students' curiosity to complete the challenge. Therefore, teachers need to use learning models that can involve problem solving in the mathematics learning process and be student-centered. One of them is by applying the Problem Based Learning (PBL) model.

The Problem Based Learning Model is one of the learning models that uses a constructivism approach based on real problems presented in the learning process. Through this learning model, students are trained to solve problems presented individually or in groups so as to encourage students to be active in the learning process. Barrows and Tamblyn (1980) state that the Problem Based Learning model can train or develop students' problem-solving abilities and involve them actively to acquire knowledge in the learning process. Problem Based Learning is also a learning model that allows the cooperation of a team because it encourages investigation, collaboration, and active participation in solving the problem being investigated (Major & Mulvihill, 2018).

Mathematics learning with the Problem Based Learning model will be more interesting if it can be related to the culture that exists in the environment around where students live so that learning materials become easier to understand. Herawaty et al. (2020) stated that the application of local culture and wisdom in mathematics can make learning more meaningful. This is because students can see and feel for real what is and is happening in the surrounding environment so that students will not be bored in participating in mathematics learning.

Based on observations and interviews conducted, it is also known that teachers have never applied cultural elements in mathematics learning. Meanwhile, Kusuma et al., (2017) stated that mathematics teachers are required to be creative and innovative in finding mathematical ideas contained in the local culture and applying learning approaches according to the character of students. One approach that applies culture in mathematics learning is ethnomathematics. Ethnomathematics is a mathematical linkage in culture. D'Ambrosio (1985) states that ethnomathematics is the application of mathematical elements among identifiable cultural groups, such as ethnic groups, labor groups, children of certain age groups, professional classes, and so on. Ethnomathematics itself is formed from the wedge between community culture, mathematics, and using mathematical modeling to solve real-world problems which are then translated into mathematical language (Rosa & Orey, 2016).

In the world of education, there are many factors that affect students' ability to learn, one of which is learning style. The learning styles possessed by each individual are of course different but there is a possibility of having few similarities that can be identified and grouped. This difference in learning styles that students have can cause the information obtained during

the learning process to be different so that it affects students' problem-solving ability. This is in line with Chasanah et al., (2020) who state that learning styles can affect problem-solving activities because they can determine how a person absorbs things through his senses in the learning process.

Learning style is the way in which each individual understands and processes the information he receives. Winarso and Toheri (2021) explain that learning styles are the way students react and motivate to absorb, organize, and process information in the learning process. Learning styles can be known based on a person's behavior in processing information and real experiences at the time of the learning process. A person learns from real experience, then observes and generates certain assumptions that can be applied to new situations and generate new learning experiences. This learning style is called kolb learning style. Kolb's learning style consists of four types of learning styles, namely convergent, divergent, assimilation, and accommodation determined based on the Learning Style Inventory (LSI) by taking measurements that emphasize individual relativity in four ways of learning, namely Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active Experimentation (AE) (Kolb, 1976).

Quadrangular material is one part of the geometry material of the field that requires students to be able to understand concepts and solve contextual problems related to the area and circumference of a quadrangle. Quadrangular material is closely related to students' problem-solving abilities which makes them very useful in everyday life (Setiawan et al., 2014). Quadrangles can be presented in the form of a problem that can train students' ability to solve problems. So that the rectangular material was chosen because it is often found its application in real life or the culture that is around and can be used to measure students' problem-solving ability.

Based on the problems that have been described, the author conducted a study with the purpose of the study to analyze 1) the effect of differences in learning models on problem-solving ability; 2) the effect of differences in students' learning styles on problem-solving ability; 3) the interaction between learning models and student learning styles towards problem-solving ability.

METHOD

This research is quantitative research with a pseudo-experimental design. The design of this study has a control group but does not fully control the external variables that affect the research (Lestari & Yudhanegara, 2015). The form of pseudo-experiment in this study was the nonequivalent posttest-only control group design, where there were two groups that were compared, namely the experiment group that obtained the ethnomathematics-based PBL model and the control group that obtained the direct learning model. Then after the learning process, a posttest is carried out to find out the student's problem-solving ability. However, before being given different treatment, the two groups filled out a learning style questionnaire to find out the learning style of each student. The research design in this study is presented in Table 1.

Table 1. Research Design

Learning Model (A_i)	Learning Styles (B_j)			
	Convergent (B_1)	Divergent (B_2)	Assimilation (B_3)	Accommodation (B_4)
Ethnomathematics-based Problem Based Learning (PBL) Model (A_1)	A_1B_1	A_1B_2	A_1B_3	A_1B_4
Direct learning model (A_2)	A_2B_1	A_2B_2	A_2B_3	A_2B_4

The free variables in this study are learning models (ethnomathematics-based PBL models and direct learning models) and learning styles (convergent, divergent, assimilation, and

accommodation). While the bound variable is the problem-solving ability. The population in this study was grade VII students of SMP Negeri 3 Muntilan for the 2021/2022 school year which consisted of seven classes, namely class VII A VII B, VII C, VII D, VII E, VII F and VII G which were then taken two classes by cluster random sampling / random classes as research samples, namely class VII A as a control class and VII C as an experimental class with a total of 32 students in each class.

The instruments in this study are observation sheets in the form of notes on the findings of observations, interview guidelines containing questions to find out problems in research schools, problem-solving ability tests in the form of social arithmetic and quadrilateral material descriptions (square, rectangular, and trapezoidal), Kolb learning style questionnaires taken from the Miami University website, namely https://miamioh.edu., and validation questionnaires. The social arithmetic material problem-solving ability test instrument is used as an initial ability test to analyze the initial ability of students. Meanwhile, the quadrilateral material problem-solving ability test instrument (square, rectangular, and trapezoidal) is used as a posttest which was previously carried out validity analysis of the content validation results carried out by material validators/experts and analysis of reliability, difference, and difficulty levels of test results in the trial class, namely class VII B. Test instrument analysis results are presented in Table 2.

Table 2. Test Instrument Analysis Results

Question Number	Validity	Reliability	Differentiation Power	Difficulty Levels	Information
1	0,7153 (Valid)	0,9214 (Reliable)	0,3 (Enough)	0,71875 (Easy)	Not Used
2			0,6889 (Good)	0,60938 (Medium)	Used
3			0,5778 (Good)	0,61563 (Medium)	Used
4			0,4111 (Good)	0,36250 (Medium)	Used
5			0,5556 (Good)	0,48125 (Medium)	Used
6			0,7111 (Very good)	0,47188 (Medium)	Used
7			0,3667 (Enough)	0,39063 (Medium)	Not Used
8			0,5 (Good)	0,29063 (Difficult)	Not Used

Based on the results of the analysis of the problem-solving ability test instrument above, from the eight question items validated and tested, five question items were obtained used in the posttest instrument.

Data collection techniques are carried out by means of documentation, observation, interviews, tests, and questionnaires. The test techniques carried out in this study were carried out before and after both classes obtained different treatments. The pre-treatment test called the initial ability test is used as the initial data to analyze the students' initial ability, while the after-treatment test called posttest is used as the final data to test the research hypothesis.

The data analysis technique in this study consists of initial data analysis and final data analysis. Preliminary data analysis was carried out statistical tests, namely normality tests using the Lilliefors method, homogeneity tests using the F test, and t tests. Meanwhile, the final data analysis was carried out statistical tests, namely normality using the Lilliefors method, homogeneity tests using the Bartlett test, two-way ANAVA tests, and follow-up tests after ANAVA using the Scheffe test'. Further post-ANAVA tests are carried out if H_0 are rejected on the results of the two-way ANAVA test.

RESULTS AND DISCUSSION

This research was conducted by applying an ethnomathematics-based PBL model in the experimental class and a direct learning model in the control class in learning mathematics for rectangular material (square, rectangular, and trapezoidal) to determine students' problem-solving abilities based on their learning style. The results of filling out the student learning style questionnaire are calculated based on the guidelines for scoring Kolb learning styles so that the

type of learning style of each student can be known. The types of learning styles that students of experimental classes and control classes have are presented in Table 3.

Table 3. Distribution of Types of Student Learning Styles

Class	n	Many Students Every Type of Learning Style			
		Convergent	Divergent	Assimilation	Accommodation
Experiment	32	4	19	4	5
Control	32	2	8	10	12

Before being given different treatment, the experimental class and the control class were carried out an initial ability test using a problem-solving ability test of social arithmetic material. A description of the initial ability data of students of the experimental class and the control class is presented in the following Table 4.

Table 4. Initial Data Description of Troubleshooting Capabilities

Class	n	A measure of central tendency		Dispersion size		
		$\bar{X}$	Me	Min	Maks	s
Experiment	32	39,63	40	2	86	24,88
Control	32	41,25	41	2	98	25,52

The results of the initial ability test or initial data are then carried out with a t-test to determine whether the experimental class and control class have the same initial ability or not. However, prior to the t-test, both classes were tested for normality and homogeneity. The following are the results of the normality test and the homogeneity test of the initial data.

Table 5. Initial Data Normality Test Results

Class	L	$L_{\alpha;n}$	Test Decision	Conclusion
Experimental	0,0736	0,1566	Accepted	Normal
Control	0,1075	0,1566	Accepted	Normal

Table 6. Results of Initial Data Homogeneity Test

Class	k	F_{count}	F_{table}	Test Decision	Conclusion
Experiment and Control	2	1,0514	1,8221	Accepted	Homogeneous

Based on the Table 5 and 6 of normality and homogeneity test results, it is obtained that the experimental class and the control class are derived from normally distributed populations and the variance of the two homogeneous classes, then the initial data can be carried out t-test. Based on the results of the t test, the initial data obtained $t_{count} = 0{,}2579$ who are not members of the $DK = \{t|t < -1{,}999 \text{ atau } t > 1{,}999\}$, so that H_0 accepted. Thus, it can be interpreted that there is no difference in the initial ability of the students of the experimental class and the control class. Because the two classes have the same or balanced abilities, then the two classes can be given different treatment.

The experimental class obtained mathematics learning with an ethnomathematics-based PBL model, and the control class obtained mathematics learning with a direct learning model. Then both classes are post tested Posttest results or the final data of the problem-solving ability test are presented in Table 7. The results of this post-test or final data are used to test the research hypothesis using the two-way ANAVA test, but first tested for normality and homogeneity. The results of the normality test and the final data homogeneity test are presented in the following Table 8 and 9.

Based on the table of normality test results, it was obtained that the experimental class, the control class, students with convergent learning styles, students with divergent learning styles, students with assimilation learning styles, and students with accommodation learning

styles came from normally distributed populations. Meanwhile, based on the table of homogeneity test results, it was obtained that the variance of the PBL class is ethnomathematics-based, and the direct learning class is homogeneous and the variance of students with convergent, divergent, assimilation, and accommodation learning styles is also homogeneous.

Table 7. Final Data Description of Problem-Solving Ability

Learning Model	Student Learning Style											
	Convergent			Divergent			Assimilation			Accommodation		
Ethnomathematics-based Problem Based Learning (PBL) Model	86	80	100	52	12	60	88	22	46	62	52	94
	86			92	28	38	74			30	96	
				52	98	64						
				16	10	26						
				76	88	80						
				72	28	34						
				32								
Direct learning model	64	30		18	56	32	92	88	58	74	34	52
				16	24	2	22	18	96	78	52	57
				12	98		52	54	44	62	66	98
							34			16	58	20

Table 8. Final Data Normality Test Results

Sources	n	L	$L_{\alpha;n}$	Test Decision	Conclusion
Experimental Class	32	0,1176	0,1566	Accepted	Normal
Control Class	32	0,1151	0,1566	Accepted	Normal
Convergent Learning Style	6	0,1525	0,3190	Accepted	Normal
Divergent Learning Style	27	0,1628	0,1705	Accepted	Normal
Assimilation Learning Style	16	0,1190	0,2270	Accepted	Normal
Accommodation Learning Style	17	0,0956	0,2060	Accepted	Normal

Table 9. Results of Final Data Homogeneity Test

Sources	k	χ^2	$\chi^2_{\alpha;k-1}$	Test Decision	Conclusion
Learning Model	2	0,0305	3,8410	Accepted	Homogeneous
Learning Style	4	0,7547	7,8150	Accepted	Homogeneous

After the sample meets the variance analysis requirements, namely normal and homogeneous distribution, the final data can be carried out a Two-Way ANAVA test with unequal cells. The results of the two-way ANAVA test with unequal cells of the final data are presented in the following Table 10.

Table 10. Summary of ANAVA Two Roads with Unequal Cells

Sources	JK	dk	RK	F_{count}	F_{table}	Test Decision
Learning Model (A)	3329,12	1	3329,12	4,55	4,01	H_{0A} rejected
Learning Style (B)	3822,05	3	1274,02	1,74	2,77	H_{0B} accepted
Interaction (AB)	2154,39	3	718,13	0,98	2,77	H_{0AB} accepted
Error	40960,45	56	731,44	-	-	-
Total	50266,01	63	-	-	-	-

Based on Anava's summary table, two roads with unequal cells were obtained that in the main influence of row (A) namely the learning model, $F_a = 4{,}55 > F_{tabel} = 4{,}01$ which is a member of the critical area so that the H_{0A} rejected which means that there are differences in the influence of ethnomathematics-based Problem Based Learning models and direct learning models on problem-solving ability. H_{0A} rejected, it is necessary to conduct further tests post

ANAVA to find out which learning model is significantly better at affecting problem-solving ability. However, because there are only two learning models, there is no need to conduct further tests post-ANAVA but can be done by comparing the marginal average of the two. The average and marginal average of the final data on problem-solving ability based on learning models and learning styles are presented in Table 11.

Table 11. Average and Marginal Average of Final Data

Learning Model	Learning Style				Marginal Average
	Convergent	Divergent	Assimilation	Accommodation	
Ethnomathematics-Based PBL Model	88,00	50,42	57,50	66,80	58,56
Direct Learning Model	47,00	32,25	55,80	55,58	49,28
Marginal Average	74,33	45,04	56,29	58,88	

Based on the marginal average, students who obtained learning with the Ethnomathematics-based Problem Based Learning model had a marginal average of 58.56 greater than the marginal average of students who obtained learning with a direct learning model of 49.28. So, it can be concluded that students who obtain learning with the ethnomathematics-based Problem Based Learning model have better problem-solving skills than students who obtain learning with a direct learning model. This is because in learning the Ethnomathematics-based Problem Based Learning model emphasizes students' problem-solving ability to solve real problems related to the surrounding culture. Students actively participate in learning through discussion activities in groups to construct their knowledge, identify problems, collect information, and apply the information to solve given problems so that students' problem-solving abilities develop properly.

Meanwhile, in the learning process, the direct learning model is carried out by the teacher explaining the material and sample questions, which then students are given the opportunity to ask questions and do practice questions in front of the class. However, there are some students who chat when the teacher explains the material and it is rare for students to ask about the difficulty in understanding the material. When the teacher asks students to do the exercises which then write them in front of the class, only certain students want to do it while others do not want to do it on the grounds that they have not been able to do it, even though when asked about the material and examples of questions that have been explained, they already understand so that the students' problem-solving abilities do not develop properly.

This result is in accordance with the first research hypothesis so that the first hypothesis is fulfilled and is the same as the results of previous studies conducted by Geni and Hidayah (2017) and Saputro, et al., (2020) where the results of the study show that students' problem-solving abilities in learning PBL models have ethnomathematics nuances are better than students in conventional learning.

The main influence of column (B) is the student's learning style, $F_b = 1{,}74 < F_{tabel} = 2{,}77$ ya who are not members of the critical area so that H_{0B} accepted. H_{0B} is accepted means that there is no difference in the influence of students' learning styles converging, divergent, assimilating, and accommodation on problem-solving ability or the four learning styles have the same influence on problem-solving ability. In other words, students with convergent, divergent, assimilated and accommodation learning styles have equally good problem-solving abilities. This result is not in accordance with the second research hypothesis and is not in line with the research conducted by Rokhima et al., (2019) where the results of the study show that students with convergent learning styles and accommodations are better than divergent learning styles and assimilation in solving mathematical problems so that the second research hypothesis is not met.

The non-fulfillment of this second research hypothesis is possible because of the presence of other factors that are not variables in the research process. This factor is students who do

not know their own learning style, resulting in students not being able to carry out learning activities properly so that each learning style owned by students does not have a different influence on problem-solving ability. A person who can know and understand his own learning style will be able to do learning activities well and get good learning outcomes as well (Bire et al., 2014).

In addition, it is also possible because of the factor of filling in the questionnaire learning style that is not in accordance with the actual situation of the student because the student does not understand the sentences of the statements in the questionnaire and is confused about choosing an answer that really describes himself so that the student fills out the questionnaire originally. This can be seen when filling out the learning style questionnaire, there are several students who see filling in their friends' questionnaires so that they affect themselves in filling out the questionnaire even though they have been told that filling in this questionnaire is used to identify the type of learning style of each student so that it does not affect any grades and there are some students who do not pay attention when the teacher explains the statement sentences in the questionnaire. Some students ask if filling out the questionnaire is not suitable for themselves because they are confused about choosing which one is appropriate and there is also a long time to think so that there are some students who have finished affecting it to be resolved in a hurry.

The main influence of interaction (AB) is the interaction between the learning model and the student's learning style, $\mathrm{F_{ab}} = 0{,}98 < \mathrm{F_{tabel}} = 2{,}77$ which is not a member of the critical area so that $\mathrm{H_{0AB}}$ accepted. $\mathrm{H_{0AB}}$ is accepted means that there is no interaction between the learning model and the student's learning style on problem-solving ability. There is no interaction between the learning model and the student's learning style, which means that students with convergent, divergent, assimilation, and accommodation learning styles who obtain learning with the ethnomathematics-based Problem Based Learning model have better problem-solving abilities than students with convergent, divergent, assimilation, and accommodation learning styles who obtain learning with a direct learning model. These results do not correspond to the third research hypothesis, so the third research hypothesis is not met.

No interaction between the learning model and the student's learning style is possible because the ethnomathematics-based PBL model already meets or facilitates all four student learning styles (convergent, divergent, assimilation, and accommodation). In the learning process of the ethnomathematics-based PBL model, students with convergent learning styles can solve problems well because in the process it is focused on solving the problems presented, students with a divergent learning style can see problems from various perspectives because the problems presented are related to the culture around, students with assimilation learning styles can find formulas for solving problems, and students with accommodation learning styles can solve new problems by obtaining information from discussion activities in groups. This is in accordance with Kolb (2015) which states that students with convergent learning styles have strength in problem solving, students with divergent learning styles have strength in the ability to imagine, students with assimilation learning styles have strengths in inductive reasoning, and students with accommodation learning styles have strengths in doing things and are directly involved in new experiences. In addition, in learning the ethnomathematics-based PBL model, the difficulties faced by students can be overcome by discussing in their groups and students' problem-solving abilities are paid more attention to.

Meanwhile, the learning process of the direct learning model, which although student involvement is guaranteed such as providing opportunities for students to ask questions, do exercises in front of the class, and respond to student work, has not been able to encourage students with different learning styles to fully apply their strengths in solving problems well because it is rare for students to ask about the difficulties so that the teacher does not know whether the students really understand or not and only certain students are willing to do the exercises in front of the class. This results in the problem-solving abilities of students with different learning styles (convergent, divergent, assimilation, and accommodation) unable to

develop properly. So that whatever learning styles students have (convergent, divergent, assimilation, and accommodation) who obtain ethnomathematics-based PBL model learning have better problem-solving skills than students who obtain direct learning models of learning. In addition, it is also possible due to the influence of other free variables that are not included in this research such as interest in learning, motivation to learn, student self-confidence, attitude, learning independence, creativity, and others.

CONCLUSION

Based on the results of the research and discussion presented, conclusions can be drawn, namely 1) students who obtain learning with an ethnomathematics-based Problem Based Learning model have better problem-solving skills than students who obtain learning with a direct learning model; 2) students with convergent, divergent, assimilation, and accommodation learning styles have equally good problem-solving abilities; 3) there is no interaction between the learning model and the student's learning style on problem-solving ability, namely students with convergent, divergent, assimilation, and accommodation learning styles who obtain learning with the ethnomathematics-based Problem Based Learning model have better problem-solving abilities than students with convergent, divergent, assimilation, and accommodation learning styles who obtain learning with a direct learning model.

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