EM 10 (3) (2021) 403-409

Educational Management

http://journal.unnes.ac.id/sju/index.php/eduman

The Effectiveness of Problem-Based Learning on Mathematical Connections in Terms of the Student's Learning Style

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Article Info

Article History:
Recived 15th September 2021
Accepted 20th November 2021
Published 23th December 2021

Keywords:
Problem-based learning, Learning Styles, Mathematical connections, Ethnomathematics

Abstract

This study aimed at determining the effectiveness of problem-based learning (PBL) on the ability of mathematical connections in terms of learning styles. The research type was Sequential Explanatory type of the Mixed Method. The population was class IV consisting of two classes, class A with 28 students as the experimental class and class B with 28 students as the class control. These classes were also the sample. The data collection techniques were tests, questionnaires, and interviews. The data analysis methods were the average completeness test, classical completeness test, and average difference test. The study showed: The ethnomathematical teaching of the PBL model was efficacious on students' mathematical connections abilities. It was proven on (1) the ability of mathematical connections using PBL model including ethnomathematical reaching the KKM individually; (2) the classical completeness reached 75%; (3) the average of mathematical connections ability of students in the experimental class was more than the control class. Analysis of students' mathematical connections abilities based on learning styles showed every student with visual, auditory, or kinesthetics learning styles was able to complete the test according to the indicators.

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p-ISSN 2252-7001
e-ISSN 2502-454X

INTRODUCTION

Education is an optimization of self-development as the preparation to adapt to the environment competently and make changes to themself so people can be helpful for their environment.

Mathematical connections study the students' understanding in connecting mathematical ideas that help them to formulate and verify the deductive conjectures between topics. The new advanced mathematical concepts can be used to solve other mathematics problems also in other disciplines (Rohendi, 2012).

It is essential to have mathematical connection's ability because it supports problem-solving skills, whether at home, at school, or in the community. Students need to develop their mathematical connections skills because it will help them to understand concepts and increase their understanding of other fields by connecting mathematical concepts with other concepts (Hendriana, 2014).

One of the learning activities that make the students actively understand, formulate, and solve problems, develop interaction between teacher and students, also students and students become valuable is learning based on the problems, known as problem-based learning. The problem-based learning model is a learning model aimed at developing student learning motivation, encouraging students to think at higher levels, encouraging students to optimize their metacognitive abilities, and making learning meaningful so that it encourages students to have a sense of trust, high self-esteem, and ability to learn independently (Suminar & Meilani, 2016). Problem-based learning is known as a systematic way to conduct an investigation or research on a problem and determine a solution to be applied later. Then, it is used to describe learning methods that develop new insights and thinking processes through active learning by conducting research (Rahmadani & Acesta, 2017).

Geni & Hidayah (2017) various problems encountered in the students' environment can be appointed as the learning problems that need to be solved. The characteristics and culture in the environment will be interesting to develop according to the additional subjects at school. Learning requires a learning innovation that encourages students to build their own knowledge (Alfi et al., 2016). Learning from problems encountered in their surrounding make the students understand how to overcome the problems. The condition of students who are close to the environment and the culture will make the learning process fascinating. This is related to mathematics that is based on a culture known as ethnomathematics.

The term ethnomathematics was introduced by D'Ambrosio a Brazilian mathematician (Putri, 2017). According to Rusliah (2016) ethnomathematics is mathematics applied by certain cultural groups such as labour or farmer, children from certain classes of society, professionals, and others. Ethnomathematics is defined as the cultural anthropologist of mathematics and mathematics education. Thus, it can be concluded that ethnomathematics is the liaison between culture and education through the mathematics learning process. According to Shirley as quoted by Hartoyo (2012) ethnomathematics is mathematics that grows and thrives in society and suitable to the local culture, namely learning process also learning method. The ethnomathematical approach aimed to establish mathematics subject more relevant and meaningful to the students, also to equitize education quality as whole (Sirate, 2012; Suminar & Meilani, 2016).

Based on interview and observation conducted in Al Madina Elementary School Semarang, the problems that occur are lack of mathematical concept application to the daily activities that makes the students' mathematical connection ability is not optimal, least amount of learning variation to the students' different learning styles, and students' low awareness of their local cultures due to lack of early inculcation.

In summary, it can be determined that mathematics and culture have a solid connection. Every culture has their own characteristic and it is possible to find the mathematical concepts in them. Therefore, mathematical connection skills

must be improved and developed to make the students capable to solve the existing problems. It is necessary to create an interesting learning process by familiarizing students solving problems that are related to their everyday life activities. It is important because the students still difficult to find the solution to the problems in their surroundings even though they can solve them. Thus, the ethnomathematical problem-based learning model is suitable for the learning process because it connects culture, mathematics, and problem-solving skill in everyday life.

Therefore, the researcher is interested in conducting research entitled: "Mathematical Connections Ability from the Perspective of Learning Style in the Problem-Based Learning Model Including Ethnomathematics".

METHOD

This research used the combination of qualitative and quantitative research method namely Mixed Method type of Sequential Explanatory. Sequential Explanatory Research is a combination research method that combines quantitative and qualitative research methods sequentially, in other words the quantitative method is implemented on the first stage and the qualitative methods is implemented on the second stage (Sugiyono, 2013).

This research was conducted at Al Madina Elementary School Semarang in 2020. The population of this study was class IV consisting of two classes, class A with 28 students as the experimental class and class B with 28 students as the control class. These classes were also the sample. Randomly selected, class A was the experimental class that applied Problem Based Learning method containing ethnomathematics and class B was the control class that applied the Discovery Learning method.

The data source in this study was the inventory of fourth-grade students' learning styles. It consisted of an answer sheet containing data from the mathematical connections test and the results of interviews with the students. These data described the ability of mathematical connections from their visual, auditory, or kinaesthetic learning styles.

The data were collected by conducting tests aimed at obtaining data on mathematical connection abilities, questionnaire techniques aimed at obtaining data on student learning styles, and interviews to find out more about their mathematical connection's abilities based on their learning styles. As a result, it showed the effectiveness of the Problem Based Learning method containing ethnomathematics compared to Discovery Learning.

The data analysis technique in this study consisted of two stages. The first stage was initial data analysis to determine the validity of the sample by carrying out the normality test by conducting Kolmogrorov Smirnov Test (Sukestiyarno, 2013), and homogeneity test using the F test formula (Sugiyono, 2013) and average similarity test. The second stage was the final data analysis that consisted of quantitative, qualitative, and combination data analysis. The effectiveness of the Ethnomathematical PBL model in Improving Mathematical Connections Ability was determined by using (1) the average completeness test of the mathematical connections test using one-sample t-test if the data is normally distributed, (2) the classical completeness test using the Z test, (3) the difference average test using independent sample t-test.

RESULTS AND DISCUSSIONS

The initial data of the students in the experimental class and control class from the initial mathematical connection's ability test (initial TKKM) are shown in table 1.

Table 1. Data of Initial Ability of Experimental and Control Class

No.	Aspect	Experiment class	Control Class
1	Total student	28	28
2	Average score	6060	60,95
3	Maximum score	76,67	83,33
4	Minimum score	43,33	43,33
5	Variance	82,58	96,83
6	Standard deviation	9,09	9,83

The next step was examining the two classes to see whether the characteristics of the two classes were the same or different. The tests included the normality test, homogeneity test, and average similarity test on the initial ability data. The results of the initial normality test of mathematical connections show in table 2.

Table 2. The Results of Normality Test of The Initial Ability

Kolmogorov- Smirnov		
	Df	Significance
Initial Data	28	.170

Table 2. shows the significance score for the normality of the initial data = 0.170 > 0.05, it indicates that H_0 is accepted. This shows that the initial data for the experimental class and control class had a normal distribution.

The results of the homogeneity test of the initial ability are presented in table 3.

Table 3. The Results of Homogeneity of Initial Ability Test

Levene Statistic		
	Df	Sig. score
Initial Data	54	.170

Table 3 shows the significance of the initial homogeneity data = 0,170 > 0,05, it states that H_0 is accepted. It shows that the experimental class variance is equal to the control class variance.

The result of the average similarity of the initial ability data test are presented in table 4.

Table 4. The result of the average similarity of the initial ability data test

		T_{count} Score	*Df*	Sig. Score
Initial data	Same variance as assumed	.155	54	.877

Based on the results of the average similarity test of the initial data in table 4, it shows significance score 0.877 > 0.05. It is stated that $\boldsymbol{H_0}$ is accepted. It can be concluded that the initial mathematical connections abilities of the experimental class and the control class are the same. The learning process is described as effective.

Learning could be described as effective if: (1) the students' mathematical connections abilities on shapes material reach the minimum score criteria (KKM) which was 70; (2) students' mathematical connections abilities achieve classical mastery at least 75% individually; (3) the average result of the students' mathematical connection ability test using the problem-based learning method with ethnomathematics is better than the class using the discovery learning method.

Before testing the effectiveness of the learning process towards students' mathematical connections ability, the first step was testing the prerequisites, namely the normality test of the final ability data and the homogeneity test of the final ability data. The results of the final data normality test are presented in Table 5.

Table 5. The Result of Normality Test of Students' Final Ability of Mathematical Connections

Kolmogorov- Smirnov		
	Df	Significance
Final data	28	.200

According to Table 5 above, the significant value of the final data is = 0,200 > 0,05, therefore it stated that $\boldsymbol{H_0}$ is accepted. This shows that the final data of experimental class and distribution control are normal.

The result of homogeneity ability data is shown in Table 6.

Table 6. The Result of Homogeneity Data of Students' Mathematical Connections Ability

Levene Statistic		
	Df	Sig. Value
Preliminary data	54	.309

According to Table 6, the significant value of homogeneity final data is = 0,309 > 0,05, thus, stated that $\boldsymbol{H_0}$ is accepted. This shows that the variant of the experimental class is the same as the variant of the control class.

The result of the individual completeness test is shown in Table 7.

Table 7. The individual completeness test result of Students' Mathematical Connections abilities.

KKM Score = 70			
	T_{count} Score	*df*	Sig. Score
Final experiment class	6.029	27	.000

Analysis result on Table 7, obtained that Significance value (α) = 0,000< 0,05, thus $\boldsymbol{H_0}$ is rejected. It implies that the average score of students' mathematical connections abilities reached the limit of minimum completeness criteria (KKM=70).

The result of the final class experiment obtained data that those who achieved minimum completeness criteria (χ) were 25 students. The number of students in experimental class ($\boldsymbol{n}$) were 28 students. Thus, from existing data obtained score $\boldsymbol{z_{count}}$ = 1,7452.

The score $\boldsymbol{z_{0,5-\alpha}}$ = $\boldsymbol{z_{0,5-\ldots}}$ = 1,645 due to the score $\boldsymbol{z_{count}}$ = 1,7452 > $\boldsymbol{z_{0,5-\ldots}}$ = 1,645 thus $\boldsymbol{H_0}$ is rejected. Therefore, the proportion of students' completeness using the Problem-based learning model with ethnomathematics (experimental class) reached 75%.

The final result data of experimental class and control class obtained data that the average of experimental class is 80,60, the average control class is 73,93, Variants experimental class and control class is 2.72 and the number of students of experimental class and control class were 56 students. Thus, the data obtained score was $\boldsymbol{t_{count}}$ = 2,449.

According to the calculation above, obtained data score $\boldsymbol{t_{count}}$= 2,449 is higher than the score $\boldsymbol{t_{table}}$= 1,67252 with error rate (α) = 5% =0,05 and dk = $\boldsymbol{n_1 + n_2 - 2}$ thus $\boldsymbol{H_0}$ is rejected. Thus, can be concluded that the average of students' mathematical connection abilities in the class of problem-based learning model with ethnomathematics is higher than the average of students' mathematical connection abilities in the discovery learning class.

Learning style have an important role in individual's life because when the individual understood their learning style, they will integrate it in the learning process therefore, they will learn more easily, faster, and succeed (Gilakjani, 2012). The classification learning style of IV grade A students of Al Madina Elementary School Semarang carried out by using students learning style inventory sheet developed from learning style indicator.

For the most part, the classification of the experimental class students' learning styles is showed in Table 8.

Table 8. Classification of Students' Learning Style of Experimental Class

Category	Number of students	Percentage
Visual	11	39.29
Auditory	9	32.15
Kinesthetic	8	28.56
Total	28	100

Table 8 shows that the percentage of each category of students' learning styles in the experimental class is different. Visual learning style have highest percentage in the experimental class which is 39,29%.

The result and analysis show that the visual learning style students were more thorough when working on the question test. Students with auditory learning style were able to work on the question according to the procedure, nonetheless still less thorough on solving the problem because

they tend to think fast and hurriedly. Kinesthetic learning style students were less thorough and work on the problem while doing something else therefore they couldn't stay still. Students with different learning style had different mathematical connection as well. The differences of learning style cannot determine whether the student is getting better or less good. Learning style is the way in which a person absorbs and process information (De Porter & Hernacki, 2013). Thus, the role of learning style in learning is crucial to determine a suitable learning strategy. Some research proved that if the teacher knows the student's learning style and their best way to learn, then the student's learning achievement will be higher (Amin et al., 2020).

Problem-based learning with ethnomathematics is effective on the mathematical connection abilities with a percentage completeness of 75%. Thus, this is in accordance with the result of Padmavathy & Mareesh's research (2013) which shows that using problem-based learning methods in learning increases the effectiveness of teaching mathematics.

Problem-based learning was effective because it facilitated the dominant learning styles in class that were auditory and kinesthetic learning styles, also the students were able to connect the lesson to their daily life activity. Based on Santoso's research (2013) the use of a problem-based learning model is effective to increase student's mathematical understanding and activity in the learning process.

The data became the teacher's reference to manage the class. The teacher designed the learning tools and the support tools based on the student's learning style and the potential in the student's environment so it could full fill the students' needs and be applicable to their daily life activities. It was because the problems *that they learn came from their environment itself.*

CONCLUSION

Based on the research result and discussion that have been described, it can be concluded that problem-based learning model with ethnomathematics is effective on students' mathematical connections abilities. This can be seen from the student's individual score that reach the minimum completeness criteria (KKM), classical completeness, and the average score of the students' mathematical connection abilities in the problem-based learning model class with ethnomathematics was more than the average of the students' mathematical connection abilities in the discovery learning class.

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