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Mathematical Literacy Ability in Learning Problem-Based Learning with Ethnomatic Mathematics Based on Student Learning Styles

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Abstract

The purpose of this study is to determine the effectiveness of the problem-based learning model with nuances of ethnomatatics on the ability of mathematical literacy and determine patterns of mathematical literacy ability in terms of the students' leaning styles. The study was conducted at SMA Negeri 1 Mranggen. The research method used is a combination research method with a concurrent embedded model. The sampling technique uses cluster random sampling. Data collection uses documentation, questionnaires, test results, and interviews. The results showed (1) the model of problem-based learning nuanced effective ethnomatematics against students' mathematical literacy abilities; (2) The mathematical literacy ability of students with visual learning styles can choose and apply simple problem-solving strategies, students with audio learning styles can work effectively with concrete but complex models and situations, and students kinesthetic learning styles can conceptualize and generalize using information based on complex problems and situations.

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INTRODUCTION

In the globalization era, critical, creative and innovative individuals are needed. Individuals needed at this time are not just individuals who know certain knowledge, but more than that, each individual is required to optimize all their knowledges to become a critical, creative, and innovative person in receiving and processing information (Mukminan, 2014). Education has an important role to face these challenges. The results of the mathematics literacy abilities of Indonesian students in the international standard of PISA and TIMSS show poor results.

Table 1. Math scores and math literacy ranks of Indonesian students

Year	Score	International Ranking	Ranking	Participants
2000	367	500	39	41
2003	360	500	38	40
2006	391	500	50	57
2009	371	500	61	65
2012	375	500	65	66

Source: OECD, 2003; Baldi, et al., 2007; Fleischman, et al., 2010. OECD, 2013.

The study results were relatively similar in the TIMSS of Indonesian students in mathematical abilities in 1999 (ranked 34 out of 38); 2003 (ranked 35 out of 46); 2007 (ranked 36 out of 49); and 2011 (ranked 38 out of 42). Based on these international studies, it shows that the mathematical literacy ability of Indonesian students is still low.

Literacy includes mathematical reasoning and the ability to use mathematical concepts, procedures, facts and mathematical functions to describe, explain and predict phenomena (OECD, 2013). The simpler meaning of mathematical literacy is given by Ojose (2011) which suggests that mathematical literacy is the knowledge to know and apply basic mathematics every day. The definition of mathematical literacy is not just a mathematical operation based on the school curriculum but rather the use of mathematical knowledge and understanding in real life. Thus the knowledge and understanding of mathematical concepts is very important, but even more important is the ability to activate mathematical literacy to solve problems encountered in everyday life. With the mastery of mathematical literacy, each individual will be able to reflect mathematical logic to play a role in his life, community, and society. Mathematical literacy makes individuals able to make decisions based on constructive mathematical mindsets. OECD (2013) explains that PISA includes three main components of the mathematical domain, namely content, context, and competence.

The results of the pre-research trials show that 17% of students can interpret problems, 7% are able to interpret and plan problem solving, and 1.3% of students can solve problems properly by taking into account realistic and contextual conditions.

In the period of 2000 until now there have been three curriculums in force, namely the 2004 curriculum, the 2006 curriculum, and the 2013 curriculum. Although changing the curriculum, it turns out that Indonesia has not been able to raise the achievements of students in international forums. This is expected, although the curriculum has changed, the function and role of teachers in learning mathematics, especially related to the role and way of delivering subject matter, has never changed. According to (Trianto, 2012) the learning process up to this time still gives the dominance of teachers and kuang provides access for students to develop independently through discovery in their thought processes.

Dwijanto (2007) states problem-based learning begins by preparing problems that are relevant to the concept to be learned and proceed with solving the problem. Problem-based learning is a student-centered model that develops active and motivated learning, problem-solving abilities and broad field knowledge, and is based on deep understanding and problem solving.

Trianto (2012) explains the characteristics of the problem-based learning model, among others: (1) Authentic, namely the problem must be real rooted in scientific discipline, (2) The problem being solved must be clearly articulated, (3) Learning is the process of solving problems, (4) The problem demands a plurality of collaborative and cooperative thinking, and (5) Learning is done through a process.

One model of problem-based learning is PBL (Problem Based Learning). The research results of Fitriono, et al. (2015) PBL learning approached by PMRI was effective in improving mathematics literacy skills. The same thing was expressed Istianduri, et al. (2014) PBL learning with scientific realistic approach is effective in improving mathematics literacy skills.

Ethnomatematics is mathematical knowledge based on local culture (Sarjiyo, 2005). In this case, the process of culture in schools is the academic achievement of students, to cultivate the attitudes, knowledge, skills and traditions that exist in a cultural community, and to develop culture in a community through the academic achievement of students. Zaenuri & Dwidayati (2018) in their research results revealed various buildings laden with ethnomatematics, related to various mathematical concepts, such as flat shapes, space constructions, collections, symmetries, statistics, social arithmetic, and even trigonometry. Ethnomatemics-based mathematical learning tools that are valid, practical and effective are obtained by effective learning (Kaselin, et al.: 2013). An increase in the process of forming the ability of mathematical connections in the class of PjBL models containing ethnomatematics (Rizka, S., et al.: 2014).

In the students' academic achievement, a student must be able to understand and absorb lessons well. But the ability or way of students to understand and absorb lessons is certainly different from one to another. Knowledge about the learning styles of students is an important thing, both by the students themselves and for the teacher. A student can further maximize his ability to learn in order to improve his achievement. While for teachers, this knowledge will help a teacher in choosing learning methods that are in accordance with the interests of students. But in reality, there is ignorance of students' learning styles, both by students and or teachers.

The results of Vania & Xin's research (2014) state that teacher education holds the key in improving the practice of education in different learning styles as a strategy to improve students' mathematical performance. The results of research conducted by Mubarik & Rizal (2013) show that the profile of auditory students in understanding problems and planning problem solving has the same characteristics as students with kinesthetic learning styles. However, when carrying out problem solving and re-examining the results of his work, students with auditory learning styles have the same characteristics as students with visual learning styles. In addition, Mubarik & Rizal (2013) cites the results of Indarto's research which concluded that there is a positive and significant influence between learning styles and learning achievement.

This can lead to less effective and efficient learning process. How important it is as a teacher to understand the learning styles of students because that way the teacher humanizes students. When humans recognize their potential, their unique style, and the way they absorb information effectively, they will naturally achieve their goals as whole individuals.

Practically this research is expected to provide benefits as a reference material or input to teachers to design learning designs in accordance with the learning styles of students and provide references and input for schools in an effort to improve learning so that the quality of learning can improve.

METHODS

The study was conducted at SMA Negeri 1 Mranggen. Using the cluster random sampling technique, one experimental class and one control class were chosen. The experimental class as a class that received PBL nuanced ethnomatematics and the control class as a class that received PBL was not nuanced ethnomatematics.

The research method used in this study is a combination research method (mixed method) with a concurrent embedded model. The concurrent embedded model combination research method is a research method that combines quantitative and qualitative research methods by mixing the two methods unbalanced (Sugiyono, 2013). Imbalance is addressed by placing quantitative research methods as primary/primary methods and qualitative research methods as secondary/support methods.

Before conducting the research, research instruments and instruments are prepared. Peragkat prepared in the form of a syllabus, lesson plan (RPP), and learning media. Research instruments in the form of Learning Style Inventory (IGB), the pretest and posttest mathematics literacy skills. Each learning device was validated by an expert with a scale rating of 0 as the lowest value and 5 as the highest value for each learning device. The score of each item is calculated on average. The research instrument was validated by an expert with a scoring technique and the same criteria as the validation of the research tools. Specifically for the pretest and posttest instruments a trial is conducted to the non-experimental class and the control class is then tested for reliability, validity, distinguishing test, and difficulty level test.

Data collection techniques used in this study were test and interview techniques. Test techniques in the form of IGB, mathematics literacy ability pretest, and posttest mathematics literacy ability. IGB is given to the experimental class prior to learning and is used to group students according to the type of audio, visual, or kinesthetic learning style. Pretest and posttest mathematics literacy abilities are given to the experimental and control classes before learning (pretest) and after learning (posttest).

Quantitative and qualitative data were collected and then analyzed according to the concurrent embedded model research combination method. Quantitative data as primary/primary data and qualitative data as supporting/secondary data. Analysis of the data in this study uses the Miles and Huberman Model which includes: (1) data reduction, (2) data display, (3) conclusion/verification. Using the cluster random sampling technique selected class X IPA 3 as the experimental class and X IPA 2 as the control class. The experimental class is a class that uses PBL models with ethnomatematics nuances and the control class is a class that uses PBL models without ethnomatematics nuances.

Analysis of the results of the study aims to prove the research hypotheses. Analysis of the results of the study includes quantitative and qualitative analysis. Quantitative analysis aims to prove empirically the effectiveness of ethno-mathematical nuances of PBL on mathematical literacy skills. The effectiveness of ethno-mathematical nuances of PBL is shown by 1) Achievement of minimum completeness criteria, 2) Comparison of control classes with experimental classes, 3) Improvement of mathematical literacy skills and a love of local culture.

RESULTS AND DISCUSSION

The mathematics literacy test shows the following results:

Table 2. Mathematical Literacy Abilities pretest and posttest

No	Source of variation	PBL nuanced ethnomatematics		PBL
		Pretest	*Posttest*	*Posttest*
1	Many students	36	36	33
2	Average	38.02	72.11	62.73
3	SD	10.31	9.98	17.59
4	Maximum	62.76	91.00	87.57
5	Minimum	23.45	49.00	17.58

The first part is statistically proven complete achievement of mathematical literacy abilities. The data used is the posttest data on the final ability of mathematics literacy in PBL class with ethnomatematic nuance

Hipotesis

$H_o : \mu_1 \geq 70$ (the average class with PBL nuanced ethnomatematics more than or equal to 70)

$H_a : \mu_1 < 70$ (the average class with PBL with ethnomatics nuance is less than 70)

With $\alpha = 0.05$ and statistical test with One-sample t-test left side assisted by SPSS 16 obtained sig values. (tailed) = 0.213. Because the value of sig. (tailed) is more than α then H0 is accepted. H0 is accepted, it means that the average class with PBL with ethnomatics nuances is more than or equal to 70. This proves that the class with PBL nuances with ethnomatics reaches completeness criteria.

The second part is statistically proven differences in the ability of mathematical literacy before and after the PBL treatment nuanced ethnomatematics. The statistics used are paired-

samples t-test. The data used are pretest and posttest mathematical literacy abilities.

Hipotesis

$H_o : \mu_1 = \mu_2$ (the average mathematical literacy ability before and after is the same)

$H_a : \mu_1 \neq \mu_2$ (the average mathematical literacy ability before and after is different)

With α = 0.05 and test statistics With one-sample t-test two SPSS-assisted two parties obtained sig values. (2-tailed) = 0,000. Because the value of sig. (tailed) is less than α then H0 is rejected. H0 is rejected, it means that Ha is accepted, it means the average mathematical literacy ability before and after learning is different. By looking at Table 1 the average value of literacy ability after learning 72,11 is higher than the average literacy ability before learning 38,02. This shows that the ability of mathematical litration after receiving PBL treatment has a better ethnomatics nuance.

The third part is statistically proven to be a comparison of the average grade of the class getting PBN nuances with ethnomatematics with the class receiving PBL treatment only. The data used is the posttest data on the final literacy ability of the two classes of mathematics. The normality and homogeneity test shows that the data is normally distributed and not homogeneous so an independent statistical sample t-test is used. Independent statistical test sample t-test is used to determine differences in the average value of the mathematical literacy ability of students of the two groups.

Hipotesis

$H_o : \mu_1 = \mu_2$ (the average of the two samples is the same)

$H_a : \mu_1 \neq \mu_2$ (the average of the two samples is different)

With α = 0.05 and test statistics With the One-sample T test two parties assisted by SPSS 16 obtained the following results

Obtained sig. (tailed) = 0.010. Because the value of sig. (tailed) is less than α then H0 is rejected. If H0 is rejected then Ha is accepted, it means that the average class with PBL is ethnomatemically nuanced and the class with PBL learning is different. Because the two averages are different, further tests are needed. By looking at table 1 shows the average class with PBL nuanced 72.11 higher than PBL learning alone 62.73.

This shows that the ability of mathematical literacy in the class that received PBL treatment was ethnomatemically better than the class that got PBL treatment only. It was concluded that the PBL model with an ethno-mathematical nuance was better than PBL.

The fourth part is statistically proven to be a comparison of the value of the gain/increase in the literacy ability of the class that gets the PBL treatment with ethnomatatic nuances with the class that gets the PBL treatment only. The data used are pretest and posttest data for the final ability of mathematics literacy of the two classes. With SPSS16, the data are normally distributed (sig. 0.20) and not homogeneous (sig. 0.03) so that the independent sample t-test statistical test is used.

Hypothesis

$H_0 : \mu_1 = \mu_2$ (the average of the two samples is the same)

$H_a : \mu_1 \neq \mu_2$ (the average of the two samples is different)

Table 3. PBL Class Gain Value with Ethnomatematics and PBL Class

No	Source of variation	PBL nuanced ethnomatematics	PBL
1	Many students	36	33
2	Average	0,56	0,47
3	SD	0,13	0,20
4	Maximum	0,76	0,72
5	Minimum	0,22	0,04

With α = 0.05 and the independent test statistical test t-test two parties assisted by SPSS 16 obtained the following results

		Levene's Test for Equalty of Varilances				
		F	Sig	t	df	Sig. (2-tailed)
Value	Equal variances assumed	4,893	,030	2,152	67	,035
	Equal variances not assumed			2,114	54,200	,039

		Levene's Test for Equalty of Varilances				
		F	Sig	t	df	Sig. (2-tailed)
Value	Equal variances assumed	11,6985	,001	2,754	67	,008
	Equal variances not assumed			2,693	49,721	,010

From the output data, the value of sig is obtained. (2-tailed) = 0.039. Because the value of sig. (tailed) is less than α then H_0 is rejected. If H_0 is rejected then Ha is accepted, it means that the average value of the class gain with PBL has ethnomatemics nuance and the class with PBL learning is different. Because the average gain values of the two are different, further tests are needed. By looking at table 2 shows the average grade gain value with PBL nuanced 0,56 higher than PBL learning 0,47. This shows that the increase in the ability of mathematical literacy in the class that received PBL treatment was ethnomatemically better than the class that got PBL treatment only.

Table 4. Average Ability of Initial Math Literacy Judging from the Level

Level	% maximum	Learning Styles					
		Visual		Audio		Kinesthetic	
		pre	post	pret	post	pre	post
L1	100	82	84	85	90	83	98
L2	100	29	78	27	83	50	95
L3	100	31	82	40	85	60	94
L4	100	27	66	33	81	39	69
L5	100	28	59	32	64	41	59
L6	100	19	51	16	42	28	77

In this discussion seen the ability of mathematical literacy in terms of levels and components. There are six levels of literacy and seven components of mathematical literacy abilities. The following are the results of the pretest and posttest mathematical literacy based on learning style groups and the levels of mathematics literacy levels.

According to the level, before learning PBL nuanced ethnomatematics three groups of learning styles only reached level 1. The results showed that before PBL learning nuanced ethnomatematics, new students were able to answer questions in general and known contexts and all relevant information available with clear questions. They can only identify information and complete routine procedures according to explicit instructions. They can only take action in accordance with the stimuli given. After learning PBL nuanced visual group ethnomatematics reaches level 1,2, and 3 while the audio group reaches level 1,2,3, and 4 kinesthetic groups reach level 1,2,3, and 6. Not all levels of mathematical literacy are achieved but quantitatively all three groups have increased literacy values at each level.

Table 5. Average Ability of Initial Math Literacy Judging from the Literacy Component

Component	% maximum	Gaya Belajar					
		Visual		Audio		Kinesthetic	
		pre	post	pre	post	Pret	post
C_1	100	97	100	97	99	100	100
C_2	100	81	86	85	86	87	94
C_3	100	61	85	65	82	74	84
C_4	100	17	45	15	52	24	64
C_5	100	10	55	9	60	25	75
C_6	100	13	63	17	66	33	78
C_7	100	23	66	31	78	46	83

Information

C1 : *Communication*
C2 : *Modeling*
C3 : *Representation*
C4 : *Strategies*
C5 : *Symbolic*
C6 : *Tools*
C7 : *Reasoning*

Judging from the mathematics literacy component, before learning PBL nuanced visual and audio ethnomatematics groups have good communication and modeling components. while the kinesthetic group has the ability to communicate, modeling, and representation. It shows that before learning, students are able to understand the problem, change the problem to the mathematical form, and present the mathematical object or problem in the form of images, charts, neural, tables and concrete objects to photograph the problem. The following table is a mathematical literacy ability in terms of the literacy component for learning style groups.

After learning PBL nuanced ethnomatematics visual group has components of communication, modeling, and representation; audio groups have components in communication, modeling, representation, and reasoning; the kinesthetic group has almost seven components only less than the strategy component.

The results showed that PBL models were effective in ethnomatemics on students' mathematical literacy abilities. In line with the study of Fitriono, et al. (2015) PBL learning effectively improves mathematics literacy skills. Kaselin research results, et al. (2014) also states that learning mathematics based on ethnomatemics that is valid, practical and effective is obtained by effective learning.

PBL model by raising the culture of Demak provides an atmosphere of learning that is close and real. The selection of tourist attractions and historic objects of the problem gives students more understanding in understanding the problem.

The culture of visiting religious tourism appropriately such as the Great Demak mosque, Kadilangu tomb, and the floating tomb of Mbah mudzakir are still thick in the Demak community. These habits make students have a positive character and love of culture in the district of Demak. The research results of Sudirman, et al. (2014) Leaders, fishermen, and tour guides foster positive character of religious spirit, hard work, responsibility, and love for the community, care for the environment, religion and democracy.

Based on the results of the interviews of the three groups the visual, audio and kinesthetic learning styles revealed that with ethno-mathematical nuances they were facilitated in illustrating the problems given. Judging from the work of TKLM on students' communication skills can reveal the problems faced, their representation can sketch or illustrate problems, and the reasoning and argument components of students can provide arguments for the answers obtained.

One of the activities carried out is that students make direct observations on the problem object. Learners can feel the benefits of the activities carried out. In addition to learning the use of mathematics in everyday life, students also learn to understand the environment and local culture.

CONCLUSION

Based on the results of the study and discussion it can be concluded that the results of the study show (1) the model of problem-based learning nuances of effective ethnomatatics on students' mathematical literacy abilities; (2) The mathematical literacy ability of students with visual learning styles can choose and apply simple problem-solving strategies, students with audio learning styles can work effectively with concrete but complex models and situations, and students kinesthetic learning styles can conceptualize and generalize using information based on complex problems and situations.

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