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The Improvement of the Understanding of Mathematical Concepts through the Implementation of Realistic Mathematics Learning and Ethnomathematics

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***Abstract*—The easiness of learning can be experienced if learning contents and contexts are related to students' daily activities. One of them is a learning approach that has realistic characters based on ethnomathematics. The purpose of the study was to determine the influence of ethnomathematics and realistic mathematical approach on the ability to understanding concepts. The research was a quasi-experimental study to implementation of the realistic mathematics learning based on ethnomathematics. We were using the 2×2 factorial experiment design. The samples was 84 students of all students in one of the senior high schools in Rejang Lebong. Samples were selected with intact-group techniques. Data collection is done using instruments of understanding the ability of mathematical concepts. Data were analyzed by using covariate analysis. The results were the ability to understanding mathematical concepts from students taught with realistic mathematical learning approaches is higher than those taught with direct instruction, when two groups of students given ethnomathematics-oriented material.**

Keywords—ethnomathematics; realistic mathematics; understanding concepts

I. INTRODUCTION

Mathematical objects are abstract, including the concepts [1]. Therefore, learning mathematics was the learning about abstract material [2], so students have difficulty learning it [3,4]. The teacher must find the right approach to teach it [5]. The easiness of learning can be experienced if learning contents and contexts are related to students' daily activities [3]. One of them is a learning approach that has realistic characters [6]. This approach fulfills two mathematical components of mathematics learning. Both are horizontal mathematical and vertical mathematical [7-9].

The horizontal mathematical process, students with their knowledge can organize and solve mathematical problems based on real-world situations. The mathematical process moves from the real world to the world of symbols [10]. This is done through social interaction between students, or with the surrounding environment, through utilizing mathematics learning media [1]. Vertical mathematical process is the process of reorganizing using mathematics itself or "real world" is a source of mathematics and as a place to reapply mathematical concepts. Therefore vertical mathematical moves from the world of symbols [10]. So that students were able to attain the abstract of mathematical objects.

According to Widada *et. al.* the character of the student who was at the abstract level was able to use all the statements given to solve the problem, can explain the relation of the given statements to an argument in solving the problem, able to explain the usefulness of each statement used to solve the problem, as a result of a proven statement, can explain the statement composed as a result of the existing statement by using good arguments and drawing conclusions that have been made on paper and pencil, but have not been able to make the proof, and he tried to make a new statement more than his original statement refers to the existing statements, but fails to prove the truth. These students achieved it during learning ethnomathematics [2].

The ethnomathematics learning is an effective approach to mathematics learning to improve the ability to understand concepts [4,11]. According to D'Ambrosio, the ethnomathematics has given a vision of how mathematics and mathematics education can contribute to "a civilization for all, in which iniquity, arrogance and bigotry have no place" [12]. Therefore, for effective education actions not only intense experience in curriculum development is needed, but also investigative and research methods that can absorb and understand ethnomathematics [13]. The teacher should understand the needs of students in the process of understanding mathematical concepts. What are the knowledge students must achieve? Such as procedural and other knowledge. Procedural knowledge is knowledge about how to do things and how to do steps in a process. Conditional knowledge is knowledge about when to use procedures, skills or strategies and when not to use them, why procedures can be used and under what conditions and why such procedures are better than others [14].

The initial knowledge as a prerequisite for students to do the mathematical process. The results of Widada et al. [6] the students studied using the realistic mathematics learning approach, the mathematics understanding ability of students given the ethnomathematics-oriented materials was higher than the students learning with the non-ethnomathematics materials after controlling the students' initial ability. However, when students were taught using a conventional learning approach, the mathematics understanding of students obtained the ethnomathematics-oriented materials was lower compared to the students with non-ethnomathematics materials after controlling the student's initial ability.

The other study found that, the ability to understand the concept of trigonometry of students taught by the connected mathematics learning model (i.e. realistic and based on local culture) is higher than students taught conventionally for students who learn through a scientific approach [15]. During ethnomathematics learning, the process of mathematical communication of the students' with high cognitive has metacognitive thinking. It was a reflecting images into mathematical ideas related to the state of the Rejang Lebong traditional house. This idea was represented in the mathematical symbols associated with the traditional house. They can provide explanations about ideas, concepts, or mathematical situations in their own language in the form of mathematical writing related to the traditional house of Rejang Lebong [16].

The ethnomathematice learning based on the Kejei dance, students could be construct of the geometry concepts. They have the understanding ability of geometry through the following activities: identifying and making examples and examples of rejection of flat buildings found in the Kejei dance. Students were able to use models and symbols to attain the concept of the two-dimensional figure based on the Kejei dance [17]. The ethnomathematics learning was a learning environment that fosters good and pleasant motivation for students to learn mathematics. They have a great interest in learning mathematics [18]. This makes it easier for students to reach concepts through realistic mathematics learning [8,19].

Fauzan, *et. al.* state that the realistic mathematics learning is a mathematical learning approach that encourages students to master mathematical concepts, also to give a lot of attention to the related processes [9]. They are expected to know how to work in groups, be active and creative in rediscovering related concepts and developing their models in solving contextual problems. Students able to understanding the importance of providing explanations for solutions. In addition, teachers are expected to be able to attract students to solve contextual problems, stimulate students when they work in groups, to react to student contributions, and to guide class discussions.

For committed teachers who believe in a very successful realistic mathematical approach, the experience of teachers and students who have used realistic mathematical approaches with positive results [20]. The results were convincing that the students' mathematical communication abilities taught with realistic mathematics learning approaches are higher than those taught by traditional learning approaches. Also, the average ability of the students' mathematics communication learned using the ethnomathematics-oriented material was higher than those given [21]. The influence of contextual learning model (realistic mathematics) based on the cognitive conflict on the ability of students to understand the concept of mathematics better than conventional learning model when controlled by cognitive conflict covariate [5]. Students were able to organize activities and make algorithms that form concepts/principles correctly. Functional student was able to carry out abstraction processes using rules in the mathematical system [22]. Students who learn through realistic mathematics learning based on ethnomathematics are able to reach high levels. They can construct relations between actions, processes, objects, and other schemes (do retrieval of the previous schema), so that a mature scheme is formed. The scheme can be used to solve problems related to the scheme [23-25]. The learning is a mathematical learning model that can improve a comprehensive thinking process, think logically, rationally, and be able to be a problem solver that uses high-level thinking processes. Such students are expected to increase their cognitive level from Level i to Level (i+1) with i=0 [26]. Thus, this paper explains about increasing understanding of mathematical concepts through the implementation of realistic mathematics learning and ethnomathematics.

II. Method

The research was a quasi-experimental study to implementation of the realistic mathematics learning based on ethnomathematics. We were using the 2×2 factorial experiment design. We were to providing the treatment through realistic mathematics learning approaches and direct learning. Also, the teaching mathematics materials that consists of ethnomathematics and non-ethnomathematics. The study population was all students in one of the senior high schools in Rejang Lebong. The samples was 84 students. Samples were selected with intact-group techniques. The realistic mathematics learning approach with ethnomathematics teaching material in Rejang Lebong was conducted in **Group-1**. The realistic mathematics learning approach with non-ethnomathematics teaching materials was applied in **Group-2**. The direct learning approach with ethnomathematics teaching materials in Rejang Lebong was carried out in **Group-3**. Finally, the learning approach directly with the non-ethnomathematics teaching materials in Rejang Lebong carried out in the **Group-4**. Each group contains 21 students. Data collection is done using instruments of understanding the ability of mathematical concepts. Data were analyzed by using covariate analysis (Ancova).

III. Results and Discussions

The covariance analysis for data of understanding of mathematical concepts at Rejang Lebong High School students was done to test statistical hypotheses. As the design of this study, A1B1 is a group of students given realistic mathematics learning and ethnomathematics. Groups of students who were given realistic mathematics learning and non-ethnomathematics with the code was A1B2. Groups of students who were given direct instruction and ethnomathematics with the code was A1B1. The last group, A2B2 as a group given direct instruction and non-ethnomathematics. This analysis is done by controlling the students' initial abilities about the understanding mathematical concepts. The results are presented in Figure 1.

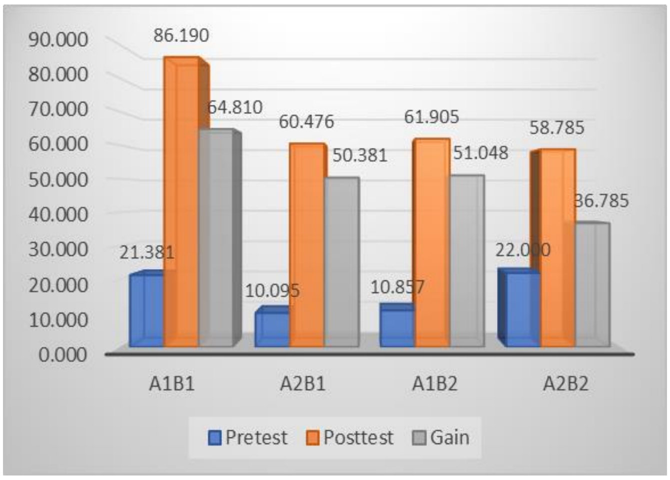

Fig. 1. Average concept comprehension ability.

Based on Figure 1, the average posttest scores of students' conceptual comprehension abilities were 86.190, 60.476, 61.905 and 58.785 for groups A1B1, A2B1, A1B2 and A2B2, respectively. This shows that the A1B1 group has been the highest average posttest score. Also, it was as a group that has the largest average gain of 64.810. Thus, students taught with realistic mathematical approaches and ethnomathematics are the most excellent students. This is a descriptive statistical count. To further test used covariate analysis by controlling students' initial abilities as covariates, the results are listed in Table 1.

TABLE I. TESTS OF BETWEEN-SUBJECTS EFFECTS

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	13384.990	4	3346.248	269.288	0.000
Intercept	29383.152	1	29383.152	2364.797	0.000
A	460.798	1	460.798	37.083	0.000
B	348.829	1	348.829	28.072	0.000
A * B	852.807	1	852.807	68.629	0.000
X	3456.419	1	3456.419	278.154	0.000
Error	981.676	79	12.426		

From Table 1, it was found that Fo (A) = 37.083, df = (1, 79) and p-value = 0.00 <0.05. This states that Ho is rejected. Therefore, there is a significant difference in the understanding ability of mathematical concepts between students taught with realistic mathematical learning approaches and direct instruction. In Table 1 for row B shows that Fo (B) = 28.072, df (1, 79) and and p- value = 0.00 <0.05. Also, Ho is rejected. This means that there are significant differences in understanding mathematical concepts between students who are given learning material through ethnomathematics and non-ethnomathematics. Still from Table 1, the calculation of Fo (AB) = 68.629, df (1, 79) and p-value = 0.00 <0.05. Ho was also rejected. Therefore, there is an interaction effect of the learning approach and mathematical material orientation on the ability to understand concepts. In addition, on line X of Table 1 shows that Fo (X) = 278.154, df (1, 79) and p-value = 0.00 <0.05. Ho is rejected which means that there is an influence of the students' initial covariate ability on the ability to understand mathematical concepts. Finally from Table 1, for the row of corrected model was Fo = 269.288 with df (4, 79) and p-value = 0.00 <0.05. Also, Ho is rejected. Thus, the students' initial abilities, the learning approaches and the mathematical material orientation together influence on the concepts understanding ability. Next note the results of the covariate analysis in Table 2.

TABLE II. PARAMETER ESTIMATES (1)

Parameter	B	Std. Error	t	Sig.
Intercept	46.100	1.387	33.236	0.000
A1	4.659	1.145	4.070	0.000

According to Table 2, obtained t count = 4.070 and p-value = 0,000 <0.05. This means that Ho is rejected. Therefore, the average of the understanding ability of students' mathematical concepts that the taught with realistic mathematics learning approaches was higher than students who are taught using direct instruction. Statistical analysis is then presented in Table 3.

TABLE III. PARAMETER ESTIMATES (2)

Parameter	B	Std. Error	t	Sig.
Intercept	46.058	1.429	32.235	0.000
B1	4.340	1.161	3.737	0.000

At the Table 3 presenting t count = 3.737 and p-value = 0,000<0.05. That meaning Ho was rejected. In other words, that the average of students' the concepts understanding ability learned by using the ethnomathematics-oriented material was higher than students' those given non-ethnomathematics.

TABLE IV. PARAMETER ESTIMATES (3)

Parameter	B	Std. Error	t	Sig.
Intercept	54.222	1.625	33.367	0.000
X	1.085	.065	16.678	0.000
A1B1	13.468	1.312	10.261	0.000

Based on the results of the statistical analysis shown in Table 4. We was found that t count = 10.261 and p-value = 0.000 <0.05. The meaning that Ho was rejected. The shows that there was an influence of interaction between learning approach factors and mathematical material orientation on the ability to understand mathematical concepts. We present the latest statistical analysis for this study in Table 5.

TABLE V. ESTIMATES PARAMETERS (4)

Parameter	B	Std. Error	t	Sig.
Intercept	54.222	1.625	33.367	0.000
X	1.085	.065	16.678	0.000
A1B1	12.866	1.285	10.009	0.000
A1B2	-4.701	1.335	-3.520	0.001

Finally we can present Table 5 as the most decisive hypothesis test. See row A1B1, t count = 10.009 and p-value = 0.000 <0.05 which states that Ho is rejected. Therefore, for groups of students given ethnomathematics-oriented material, the ability to understanding of mathematical concepts from students taught with realistic mathematical learning approaches is higher than those taught by direct instruction. Conversely, for groups of students given mathematics material oriented to non-ethnomathematics, the ability to understanding of mathematical concepts from students who learn uses a realistic mathematics learning approach is lower than students who learn with direct instruction. This is shown from the statistical test in Table 5 for row A1B2 which shows that t count = -3.520 and p-value = 0.001 <0.05. Also, Ho is rejected. Thus, we were the favoring a realistic mathematical approach by oriented to ethnomathematics to improve the ability to understanding mathematical concepts. This is also supported by our studies in other schools at the Bengkulu Province. As, the results of we research [6], bahwa after the students' initial ability was controlled, the average mathematical understanding ability of students taught in the classroom implementing the realistic mathematics learning approach was higher compared to those taught by implementing the conventional learning. Also, the average ability of students' mathematical understanding who learned the ethnomathematics-oriented materials was higher than students who were given non-ethnomathematics materials (their initial ability was also controlled).

In addition, the results of our research and other studies also support it. The results of our study in Bengkulu Selatan [11], those were that the abilities to mathematical representation of students that taught with the inquiry learning model were higher than students was taught with conventional learning models for students' given ethnomathematics-based material. If students were not given ethnomathematics-based materials, then the abilities to mathematical representation of students was that taught with inquiry learning models are lower than students taught with conventional learning models. Also, results of our study [18], those were there were differences in the ability of mathematical representation between students who were taught by realistic mathematical approach and conventional learning after controlling students' early ability; there is a difference in the ability of mathematical representation between students who are ethnomathematical and non-ethnomathematical oriented after controlling students' early abilities; there is an interaction effect of the learning approach and the orientation of mathematical material on the ability of mathematical representation after controlling the student's early ability.

In the field of mathematics education, ethnomathematics has a more prominent role, because it becomes meaningful and relevant to explore various aspects of mathematical literacy in the context of the Western curriculum. The ethnomathematics as an alternative, implicit philosophy of professional and school mathematics practices [27]. Ethnomathematics was a discipline that arises from a person involved multicultural perspective on mathematics and mathematics education and post structural theory [28]. Thus it is very feasible that we state that ethnomathematics and realistic mathematical approaches are strategies for learning mathematics that can improve the ability of teachers to manage learning and improve their students' mathematical abilities.

IV. Conclusion

We conclude that for groups of students given ethnomathematics-oriented material, the ability to understand mathematical concepts from students taught with realistic mathematical learning approaches is higher than those taught with direct instruction. Conversely, for groups of students given mathematical material oriented to non-ethnomathematics, the ability to understand mathematical concepts from students who learn using realistic mathematical learning approaches is lower than students who learn with direct instruction. We recommend that teachers and researchers of mathematics education continue to implement mathematical learning approaches that are oriented towards ethnomathematics.

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