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Sundanese Ethnomathematics Context in Primary School Learning

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Abstract. Mathematics is mostly related to human life, thus, humans are required to have the mathematical understanding ability in solving life problems since in the elementary school age. Therefore, mathematics learning at school should have relevance value to construct mathematical concept that can be used in real life. Innovative mathematics learning through Contextual Learning (CTL) model based on Sundanese Culture Ethnomathematics as a local wisdom at which humans use mathematics in their real life, was chosen as a deep solution to increase the mathematical understanding ability, because students live in their culture and society. This study employsan experimental method by conducting pretest and postest control group design. The purpose of this study is to determine the increasing of students' mathematical understanding ability on experiment class (using CTL model based on Sundanese Ethnomathematics) and control class (using conventional learning model). The result of this study produced conclusion that CTL based on Sundanese ethnomahtematics and conventional model can increasethe mathematical understanding ability significantly. However, the application of CTL model based on Sundanese Ethnomathematics was significantly better than conventional model (62.29%) to increase students' mathematical understanding ability on learning the basic concepts of rectangular geometry for 4th grade students of elementary school.

Keywords: Contextual Learning (CTL) Model, ethnomathematics, mathematical understanding ability, local wisdom learning, teaching mathematics, elementary school.

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INTRODUCTION ~ Thematic learning is an integrated learning model integrating subjects into a spesific theme that can be understood by student. The most important aspect from thematic learning is that it can emphasize the students' activities in learning physically, mentally, intelectually and emotionally to achieve optimal learning outcomes (Flewitt, et al, 2015).

Curriculum 2013 as a new curriculum in Indonesian education emphasized thematic approach by focusing on improving students' ability to the culture around (Fitroh & Hikmawati, 2015). Therefore, this curriculum can certainly be innovated by integrating subjects and the context of local wisdom content as a culture. Integrating the curriculum provides rich opportunities for students to focus on applications that are relevant to real life and make meaningful connections in various disciplines (Bazinet & Marshall, 2015).

Indonesia as a country maintaining cultural diversity, has many variations of cultural diversity from each region that includes traditional arts, traditional forms of local building, batik patterns as well as the existence of indigenous games and other things. Unconsciously, it is

believed that in every context of cultural activities carried out by the public, there are many mathematical ideas. One of these mathematical ideas is illustrated in the mathematical concept of geometry that has actually been applied into a cultural product.

Figure 1. Indigenous Games
(Mulyani, 2016)

The picture above, shows that the indigenous games contain mathematical concepts, especially geometry. This is an opportunity in teaching mathematics at school. The students' ignorance on how to use mathematics in solving everyday problems is a rational reason for the publics's view that mathematics has no relationship with culture and human life (Karnilah & Juandi., 2013; Putra, Herman & Sumarmo 2017). In fact, education and culture are unavoidable in daily life because culture is a unified, comprehensive, and appliable in a society, and education is a basic need for every individual in society (Budiarto, 2016).

In mathematics learning activities at school, teachers have not linked mathematics with culture or daily activities, as a result, the students have not been able to use mathematical concepts in solving everyday's problems (Arisetyawan, Suryadi, Herman, Rahmat & No, 2014; Nurhasanah, Kusumah & Sabandar, 2017; Widodo, Purmani, & Prahmana, 2017). The most dangerous effect is the emergence of students' assumptions that mathematics is a difficult and unpopular field of study (Maulana, Hanifah, Aeni, Julia & Syahid, 2018). This certainly has become something to be improved that the teaching of mathematics for everyone should be adapted to their culture (D'Ambrosio, 2003). The innovation of learning integration that links mathematics with local wisdom or cultural content and education is called ethnomathematics. Ethnomathematics learning helps teachers in teaching and learning activities, so students have the opportunity to learn mathematics in a culture (Nutti, 2018).

The ethnomathematics learning model is used to connect the students' own knowledge with theirunderstanding of the local environment. Thus, ethnomathematics is a cultural anthropology form mathematics and mathematics education. Ethnomathematics-based teaching has been researched several times in several countries, for example in teaching the concept of geometry, which is studied in the context of Yup'ik artifacts and Eskimos clothing patterns (Lipka, Andrew & Ihrke, 2009), and teaching concepts of geometrical analysis by utilizing ornaments in Israel culture resulted that this concept could help students to understand the concept of geometry (90, help the analysis of the nature of geometry (88.6%), and help proof skills (80%)(Massarwe, Verner, & Bshouty, 2013).

The word 'ethnomathematics' is derived from the word 'ethno' that means something t broad referring to the socio-cultural context, the word 'mathema' means to explain, know, understand and carry out activities such as coding, measuring, classifying, and concluding, and the word 'tics' means technique (D'Ambrioso in Rosa & Clark, 2011). The essence of ethnomatematics studies is studying ethnography, mathematical modeling and mathematics itself (Orey & Rosa, 2006). The relationship can be more clearly seen through the Venn diagram below (Orey & Rosa, 2006).

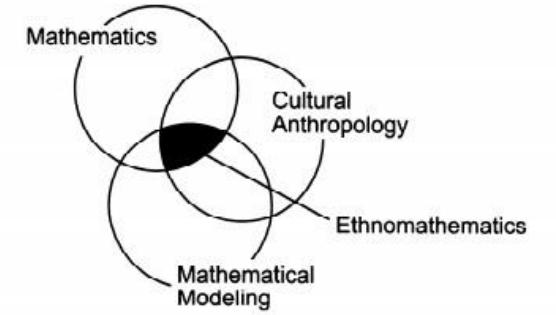

Figure 2. Ethnomathematics position

The ethnomathematics concept has made researchers interested in the application of classroom learning as a formula in teaching mathematics that is closely related to students. The development and application of mathematical concepts based on everyday problems are parts of the student learning process (Tanujaya, Prahmana, Mumu, 2017; Wahyu, Amin & Lukito, 2017). Involving ethnomathematics in the school curriculum will give a new nuance in mathematics learning considering that each region consists of diverse tribes and cultures that have their respective characteristics in solving problems (Sirate, 2012; Ulum, 2018). The ethnomathematics concept used in this research is the teaching and learning of building two-dimensional geometry using traditional Sundanese games as a local wisdom in West Java,, namely *bebentengan, galah asin/gobak sodor, bakiak*, and batik activities. Some of these activities of indigenous games are both having mathematical content and requiring active student involvement.

Furthermore, the application of ethnomathematics in classroom learning requires a learning model. The contextual learning (CTL) model as a constructivism learning model seeking to create meaningful learning experiences for students with the hope of solving long-term life problems was chosen as a solution for applying ethnomathematics. CTL is a learning concept that helps teachers link material taught with real-world situations of students and encourage students to make connections between the knowledge they have and their application in life as family and community members (Aqib, 2015). Contextual learning includes several components, namely making meaningful connections, doing meaningful work, self-managed

learning, working together, thinking critically and creatively, helping individuals grow and develop, achieving high standards, and using authentic assessment (Johnson, 2014).

Based on this explanation, a study entitled "Sundanese ethnomathematics context in elementary school learning" was carried out. The purpose of this study is to find whether ethnomathematical learning innovations is effective on increasing mathematical understanding abilities. This study expects that the development of mathematics learning based on local wisdom in elementary school will contribute to the realm of ethnomathematics education in elementary schools and provide ideas in designing learning nuances of think globally and act locally.

METHODS

By looking at the purpose of this study, two different sample groups selected by random sampling method are compared. Hence, this study is an experimental research with a pretest-posttest control group design (Arikunto, 2013; Cohen, Manion, & Morrison, 2007).

Experimental	RO_1	X	O_2
Control	RO_3		O_4

The samples were randomly sampled 4th grade students from two elementary schools in 2017, with a population of 29 elementary school in Cimalaka Sumedang, West Java Indonesia. In this study both sample groups were given a pretest, then,both of groups were given with different treatment; control class was given conventional learning, while the experimental class was given contextual teaching and learning based on Sundanese Ethnomathematics. These treatments were carried out based on lesson plans (RPP, *Rencana Perencanaan Pembelajaran*) that were designed for 4 meetings (10×35 minutes) using traditional games properties and students worksheets. At the end of this study both classes were given the same postest.

Research Instrument, Data Processing and Analysis

Data processing and analysis were reviewed based on data obtained through research instruments. The data consisted of the result of mathematics understanding ability test that was validated and tested beforehand. After that, the validity, reliability, index of difficulty, and distinguishing power to strengthen the feasibility of the instrument were analyzed..

Quantitative data obtained through pretest and posttest were processed and analyzed by calculating the mean value, a number of statistical tests such as normality test, homogenity test, and average difference test. On the other hand, data processing and analysis were done by calculating the correlation and gaining the coefficient in seeing an increase of mathematical understanding ability as learning outcomes. The flow of data processing is depicted in Figure 3. In addition, the data processing show is presented in Table 1.

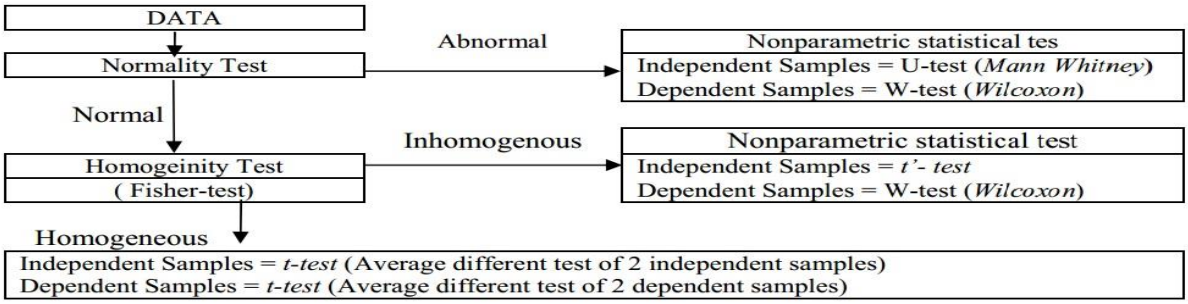

Figure 3. Data Processing and Analysis Techniques

Table 1. Data processing result

Data Processing	Normality	Homogeneity	Average Difference
Pre-Experiment	0.030	-	0.000
Post-Experiment	0.015	-	
Pre-Control	0.271	-	0.000
Post-Control	0.000	-	

RESULTS AND DISCUSSIONS

How the Ethnomathematics Value in Sundanese Embedded in Mathematics Activities

The concept of ethnomathematics applied in this study was integrated from Sundanese indigenous traditional games and batik activities. Some research shows that traditional games have a big role in the process of learning mathematics (Dewah, Wyk & Van, 2014; Jaelani, Putri & Hartono, 2013; Nkopodi & Mosimege 2009). Sundanese indigenous games as a traditional games that are played and preserved for generations by many indigenous communities that have character and mathematical values. Some mathematical concepts, especially geometry, found in traditional games for elementary schools among others, are shown in Sundanese *bébénténgan* games which have the following arena of play.

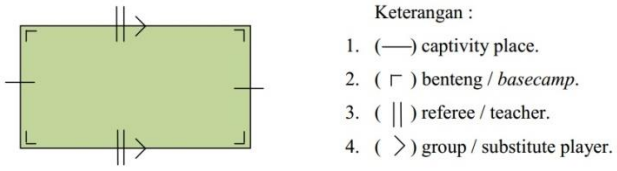

Figure 4. The arena of *bébénténgan* game

The *bébénténgan* game arena that was applied in experimental class was made with a length of 10 people and a width of 5 people in a row and stretched arms as a learning introduction to the concept of circumference and rectangular characteristic. Based on Figure 4, it is known that the geometry concept contained is the characteristic of a rectangle. So, it has two parallel sides, facing sides have the same length, facing angles are equal, all angles are equal to 90^0 (right angles). Therefore, the adjacent angles refer to 180^0.

The rectangle also has 2 folding symmetries, 2 rotating symmetries and 2 diagonal lines of the same length.

In addition, the traditional game *bébénténgan* has the values and benefits contained in a reflection of learning include the game teaches cooperation and thinking in developing strategies to achieve common goals in gaining victory like fighting for independence by seizing a fortress like a Indonesian previous hero.

Furthermore, Sundanese *bakiak* game, which has a cultural value of mutual cooperation in achieving a goal with an obedient attitude and tries to align steps with the leader, has a very meaningful value for children. This Sundanese *bakiak* game also teaches competition valuethat whoever is earnest and works hard in doing something, they will be the winner. Therefore, this game is used as a source of learning mathematics by modifying the race track. This modification was done to bring students closer to the concept of the circumference of the rectangle that is obtained by adding up all the sides of the rectangle that is two sides wide and two long sides. The arena for clogs can be seen in the figure 5.

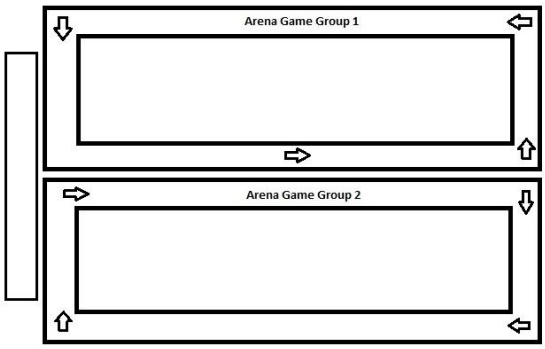

Figure 5. The track of *bakiak* game

Another ethnomatematics concept applied is the concept of batik. Batik is a work of art in the form of cloth with pattern and original Indonesian culture. This work has high artistic value and has become part of Indonesian culture. According to the technique of making batik, it is classified into three types, namely written batik, printed batik (fabric technique decorated with batik motifs formed with a stamp), and painted batik. This stamp batik technique is used as an ethnomatematics context in the learning of rectangular area, where students perform batik activities in understanding the concept of calculating the area of a rectangle. Another value contained in Sumedang batik pattern commonly used by students (Figure 6) is the existence of historical, cultural, and geographical description of the area so that the ancestral heritage is not lost in the times.

Figure 6. Sumedang's Batik Pattern

Galah asin as a Sundanese indigenous traditional game that has ethnomathematics values, applied in this mathematics learning with some modification or innovation in its implementation is clearly shown in Figure 7. *Galah asin* has the value of teamwork in developing strategies to achieve a goal that must be done seriously and train students to take advantage of opportunities.

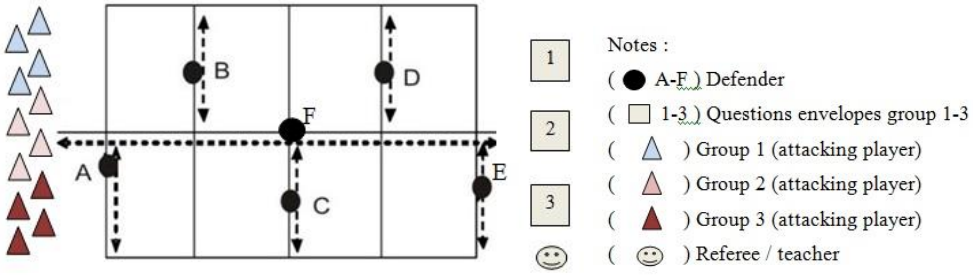

Figure 7. *Galah asin* as ethnomathematics

The Result of Mathematical Understanding

Based on the aforementioned data,the condition of students' mathematical understanding ability in the two classes samples before being given treatment was classified as low classification. This was certainly experiencing changes after the treatment. The results of data processing mathematical understanding ability obtained by students in the research conducted can be explained clearly in the following diagram.

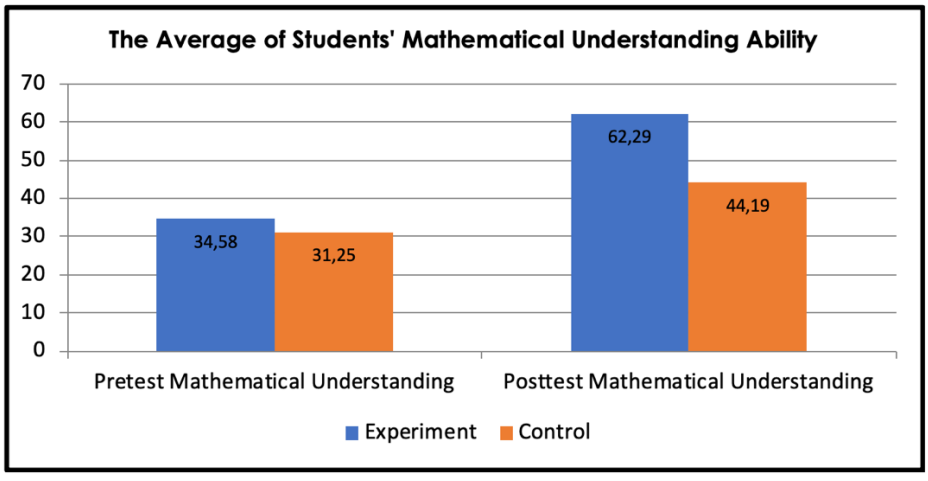

Figure 8. The Average of Students' Mathematical Understanding Ability

Changes in the value in the Figure 8 indcate an increasing mathematical understanding ability in both sample classes. This indicates that there were different influences from different treatments. In the experimental class given treatment with the application of ethnomathematics learning, while in the control class applying conventional learning.

The treatment given was designed through learning four meetings based on the learning objectives to be achieved. Some of the findings in the field are unique from this research, such as when students discover their own rectangular geometry concepts through the activities of forming a field of *bebentengan* by involving themselves as learning media. In addition, the formation of understanding is also done through *bakiak, gobak sodor* and batik activities that challenge students to work together. Some of these activities require the active students involvement directly in building mathematical understanding. There is a great potential for using indiigenous games in the mathematics classrooms (Mosimege & Ismael, 2004). This reinforces that in the use of ethnomathematics contexts such as traditional games that are combined in a contextual learning model has enormous potential in increasing students' mathematical understanding abilities.

In addition to traditional games, learning involves group discussions which in practice create the role of each group member in carrying out their respective tasks. Another finding is that students experienced confusion in solving mathematical problems which were arranged through story text problems, so the students were required to complete the abstract concepts that have been done. To overcome this condition, a discussion was made about the concepts that were learned so that students understood the significance of mathematical concepts to the problems they were solving.

Posttest was given after the whole learning is done. This posttest aims at measuring the improvement of students' mathematical understanding abilities both in the experimental and control classes with the same indicators questions when pretested. Posttest results obtained an average value of 62.29, resulting in an increase in the ability of mathematical understanding after being treated through a CTL based on Sundanese culture ethnomatematics. This increase was strengthened after calculating the statistical test namely the average difference test between the initial and final mathematical understanding abilities in the experimental class through the Wilcoxon test with a significance level of a = 0.05, which obtained a p-value (sig. 1-tailed) of 0,000. Thus, the p-value obtained <a, which results in H_0 being rejected, so that the CTL based on ethnomatematics of Sundanese culture could significantly increase students' mathematical understanding abilities on geometry learning concepts.

The average initial value of students' mathematical understanding ability in the control class was still low, obtained a value of 31.25. To overcome this, conventional learning was done to

increase the ability of mathematical understanding. In practice, conventional learning was carried out in a conducive manner, and ran optimally, although there were some students who were not actively contributing to learning. The role of teachers in conventional learning is teacher-centered, was very necessary and became very crucial, as a result the teacher must try harder in carrying out learning. High teacher skills in organizing or managing activities, and optimizing each stage of learning was needed so that conventional learning could run effectively. It is based that whatever learning strategies and models are used, basic teaching skills are very important mastered by the teacher so that the teacher can carry out his role in managing the learning process, therefore, learning can run effectively, and efficiently (Sanjaya, 2006).

The results of the posttest mathematical understanding ability in the control class obtained an average value of 44.19. This shows that when compared with the pretest scores, the students' mathematical understanding ability has increased. The statement was corroborated after an average difference test between the initial and final mathematical understanding through the W-test obtained a p-value (sig. 1-tailed) of 0,000. Thus, it was concluded that conventional learning could significantly increase students' mathematical understanding abilities in geometry learning concepts.

The increasing students' mathematical understanding abilities occurred in two sample classes, both in the experimental class and the control class. However, even though the two sample classes have succeeded in increasing their mathematical understanding ability, surely there were differences in increasing their mathematical understanding ability in both samples. Based on the results and findings of research in the field, it was concluded that the CTL based on Sundanese culture ethnomathematics was significantly better in increasing students' mathematical understanding abilities compared to conventional approaches. This is corroborated by the results of the average difference test of the mathematical understanding ability gain between the experimental class, and the control class through the U-test (Mann Whitney) which obtains a p-value (sig. 1-tailed) of 0,000, so H_0 was rejected.

In practical, the CTL based on ethnomatematics of Sundanese culture rose to meaningfulness in learning and facilitate students in related learning material with student life. Moreover, the existence of cohesiveness involving the ethnomatematics context can have its own characteristics in learning mathematics that is not as usual, so that students are able to understand learning material that is closer to student life.

Therefore, the attitude of students' mathematical understanding abilities in the experimental class can be strengthened by some findings in the field which are studied based on the contextual learning component (Johnson, 2014; Nurhasanah et al., 2017), including the students' self-confidence in research developed through components doing meaningful

work, learning that self-managed, and work together that exercise students to build their own understanding through group discussion activities which provide space for each student to motivate each other, so that the process is able to increase student confidence. The attitude of flexibility, and diligence is developed through providing opportunities for students to solve mathematical problems through giving questions that challenge students to find alternative methods of solving them.

The reflective attitude towards one's own abilities was developed through the appearance of problems, as a result students judged for themselves how far their knowledge can be applied in solving problems. Students 'interests and curiosity were developed through the component of making meaningful connections which in this study were carried out through activities facilitating students to perceive, ask questions, use unique media, and challenge traditional games. Therefore, students' interests and curiosity formed from the beginning to the end of learning. The attitude of assessing the application of mathematics to other situations and daily experiences was developed through components making meaningful connections and reflections that were full of elements of mathematical application in the context of community culture. Students were also able to appreciate the role of mathematics in culture, and the value of mathematics as a tool and language that was developed through a contextual approach based on ethnomatematics of Sundanese culture that was systematically designed from concrete to abstract.

CONCLUSION

Systematization of good learning and optimal teacher performance in planning and implementing learning activities has a very positive influence on CTL based on Sundanese culture ethnomathematics and conventional learning which both of them could significantly enhance the students' mathematical understanding abilities. The advantages of CTL based on Sundanese ethnomathematics are unique, in which it was able to directly involve students' active role through learning activities while playing, especially those applied in contextualization between mathematics learning materials, and traditional games activities such as *bébénténgan*, *galah asin*, *bakiak* and *batik* activities. Another thing that contextual learning based on Sundanese ethnomathematics was able to facilitate group discussion in problem solving activities, and the role of ethnomathematics context in CTL that rose to sense of meaningfulness for learning. Therefore, the characteristics of CTL based on Sundanese culture ethnomathematics were more reliable to facilitate students in constructing, and applying their knowledge which is in line with innovative learning theories. Thus, CTL based on Sundanese culture ethnomathematics was significantly better than conventional learning approaches in increasing students' mathematical understanding abilities, hence, the ethnomathematics learning innovation could be applied and optimized again in the future.

Regarding consideration for future research, it is necessary to pay attention to the relationship between the learning trajectories and the ethnomathematics learning design.

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