Journal of Research and Advances in Mathematics Education

Volume 5, Issue 3, October 2020, pp. 331 – 344
DOI: 10.23917/jramathedu.v5i3.11679
p-ISSN: 2503-3697, e-ISSN: 2541-2590

Contextual learning with Ethnomathematics in enhancing the problem solving based on thinking levels

Andi Saparuddin Nur[1*], Stevanus Budi Waluya[2], Rochmad Rochmad[2], Wardono Wardono[2]

[1)] *Department of Mathematics Education, Universitas Musamus, Indonesia*
[2)] *Department of Mathematics Education.Universitas Negeri Semarang, Indonesia*

*Corresponding author: andisaparuddin@unmus.ac.id

ARTICLE INFO

Article history:
Received: 23 July 2020
Revised: 19 September 2020
Accepted: 21 September 2020
Published online: 30 September 2020
Published regularly: October 2020

Keywords:
Contextual learning, Ethnomathematics, culture, problem-solving, thinking level

ABSTRACT

The differences in the development of students' thinking levels, especially in adolescence, impact the way they perceive problems. Contextual learning with ethnomathematics can provide opportunities for students to develop problem-solving abilities based on their level of thinking. This study examined the contextual learning with ethnomathematics to enhance problem-solving abilities based on thinking levels.This experimental research was conducted by posttest only control group design. The participants of this research were 60 students at a junior high school in Gowa Regency, South Sulawesi Province.Data were collected using observation sheets to determine local cultural characters that appeared at the time of treatment. The thinking level category uses the group assessment for logical thinking (GALT) test. The students' mathematical problem-solving abilities use the curved side space material to suit the local cultural context. The data analysis technique used descriptive statistics and covariance analysis (ANCOVA). This study results indicate that contextual learning with ethnomathematics influences problem-solving abilities based on the level of thinking. Furthermore, local cultural characters appear in each category of students' thinking levels. Students with formal thinking levels have better problem-solving abilities than transitional and concrete thinking levels. Contextual learning with ethnomathematics fosters problem-solving abilities based on the thinking levels.

© 2020 Universitas Muhammadiyah Surakarta

Introduction

Ethnomathematics is a way to express mathematical concepts that grow in various aspects of life and students' contextual experiences (Balamurugan, 2015; Rosa & Orey, 2011; Widada, Herawaty, & Lubis, 2018). Ethnomathematics can act as a connecting bridge between cultural preservation and local wisdom with technological

To cite this article:
Nur, A.,S., Waluya, S.,B., Rochmad, R., & Wardono, W. (2020). Contextual Learning with Ethnomathematics In Enhancing the Problem Solving Based on Thinking Levels. *JRAMathEdu (Journal of Research and Advances in Mathematics Education), 5*(3), 331-344. doi: https://doi.org/10.23917/jramathedu.v5i3.11679

and artistic advances through science. Mathematics learning based on ethnomathematics that applies local culture can change people's perceptions about applying mathematics in everyday life (Widada et al., 2018). The submission of mathematical concepts related to students' culture and daily experiences can improve their ability to decipher meaningful connections and deepen their understanding of mathematics (Rosa & Orey, 2011). The relevance of learning to the context prevailing in the environment around students is a form of actualizing the integration of local culture in mathematics learning. Ethnomathematics builds students' thinking spaces by gaining knowledge from the context in the environment around students (Supriadi, Suryadi, Sumarmo, & Rakhmat, 2014).

The application of ethnomathematics perspectives in mathematics learning helps develop students' intellectual, social, and emotional use of their unique cultural references (Rosa & Orey, 2011). Important steps in developing the ethnomathematics curriculum have provided wider space in discussing thought and investigation of problems based on cultural practices (Alangui, 2017; Rosa & Orey, 2011). However, a paradigm shift and the readiness of teachers to apply culture-based mathematics learning are challenges that require serious attention (Orey & Rosa, 2006). The application of ethnomathematics and mathematical modeling tools can clearly be traced through the activities of *Sundanese* society, namely the uses of measure units and symbolic clocks, and the making of woven patterns (Abdullah, 2017; Muhtadi & Prahmana, 2017). The Batak community can also find the concepts of social arithmetic, comparison, clan genealogy, and geometric instruments in traditional clothing and houses (Saragih, Napitupulu, & Fauzi, 2017). In the Bugis Makassar cultural context, the application of ethnomathematics can bring about attitudes that are universally appropriate to people's customs and habits (Cheriani, Mahmud, Tahmir, Manda, & Dirawan, 2015). There are also buildings in the form of fortresses, palaces, *pinisi* boats, and weaving motifs in Bugis Makassar culture which includes mathematical elements. These examples are only a small part of the broad picture ethnomathematics applying in the life of the Indonesian archipelago and it will not be possible to be fully inventoried.

Learning by integrating local cultural values has been applied through various approaches and methods. The concept of local culture in mathematics learning can improve students' knowledge and reasoning (Widada et al., 2018). Meanwhile, the ability to make mathematical modeling in the classroom with contextual learning based on ethnomathematics is better than the methods commonly used by teachers (Supriadi et al., 2014). Other findings show that learning mathematics with a local culture-based model is fostering higher-order thinking skills (Saragih et al., 2017). The ability to think at a high level in solving mathematical problems provides an opportunity for students to actualize the knowledge they have into innovative and independent learners.

Furthermore,local cultural characters' value have a significant meaning in shaping students' attitudes in mathematics learning. In Bugis Makassar culture,

mathematics learning can be integrated with local cultural characters that appear in students' learning activities. Local cultural character is an attitude that reflects the morals and noble values in society. The cultural characters of Bugis Makassar can appear in mathematics learning (Akib, 2016; Cheriani et al., 2015), namely: *siri'* (dignity), *pacce* (empathy), *sipatuo-sipatokkong* (live together-unified), *sipakatau* (respect), *reso* (hard work), and *abbulo sibatang* (working together). Local cultural characters can emerge if they use the right approach to allow the actualization of specific attitudes in mathematics learning activities (Cheriani et al., 2015). Integrated contextual learning of local cultural content is a means that enables students to develop knowledge while fostering character and noble values in society (Simamora & Saragih, 2019; Supriadi et al., 2014).

Contextual learning with ethnomathematics is related to a teaching approach that connects mathematical concepts with the cultural context prevailing in the student environment so that it becomes more meaningful (Muhtadi & Prahmana, 2017; Rosa & Orey, 2011; Simamora & Saragih, 2019). Contextual learning consists of seven components: constructivist, inquiry, asking questions, modeling, learning community, reflection, and authentic assessment (Saragih et al., 2017). The main characteristic possessed by contextual learning is the topic of material related to the context of everyday life (Simamora & Saragih, 2019). Ethnomathematics builds students' thinking spaces by acquiring knowledge from context in the students' environment and enhancingproblem-solving skills (Imswatama & Lukman, 2018; Supriadi et al., 2014).

NCTM (Nur & Dadi, 2018) argued that the ability to solve problems is at the heart of mathematics learning. Problem-solving is a necessary tool in decision making to avoid mistakes from interpreting mathematics. In Vygotsky's constructivist theory, a person can solve a problem if it is in the area of his thinking reach (Simamora & Saragih, 2019). Someone will meaningfully understand problems if the context is in daily activities. Mathematical concepts can cross various disciplines and applications in everyday life through problem-solving. Mathematical problem-solving steps presented by various experts indicate the similarity of problem-solving stages, namely: identifying problems, analyzing and classifying problem spaces, exploring various problem-solving strategies, implementing solutions, and checking and evaluation of the solutions obtained (Schoenfeld, 2016).

The problem for each individual is very dependent on the context and problem space faced. Problem-solving is needed to obtain several non-routine algorithms so that the problems encountered can be solved. This situation is greatly supported by one's thinking level in order to solve the problems properly. Contextual learning with ethnomathematics provides space for students to explore problem-solving methods that suit their knowledge (Naresh, 2015; Simamora & Saragih, 2019). The role of culture as a pillar of life does not only carry local values and wisdom but also promotes non-formal knowledge to grow in society.

Mathematical problem solving is a means needed by every student to be able to develop rational and logical thinking methods. It is also an important tool so students can understand mathematics at the level of formal thinking (Nur & Rahman, 2013). Piaget classifies levels of thinking in adolescence to adulthood with concrete, transition, and formal thinking levels (Fah, 2009). Each thinking level is distinguished according to the stage of mental development which is based on specific characteristics (Karplus, 1977). The concrete thinking levels are the ability to seriation, sequence, and conservation reasoning. The transition thinking levels with abstract thinking abilities are based on conservation reasoning, proportionality, and probability. The formal thinking levels are the tiered ability possessed by the previous thinking level coupled with correlational and combinatoric reasoning and controlling variables.

Logical thinking is an ability in the concrete and abstract action stage, where each stage supports mental operations that can be used to solve problems (Sezen & Bülbül, 2011). The ability to think logically raises curiosity to obtain more information so that it supports mental development. Students moving from the concrete operations to the formal operations stage still need several reasoning skills. The development phase between concrete and formal operations is called the transition stage which allows students to solve problems in a concrete context (Nur & Rahman, 2013).

Contextual learning with ethnomathematics provides an opportunity for students to solve problems by linking real-world situations and cultural values that grow in the community and facilitate learning interactions at different thinking levels. The research aims to foster problem-solving abilities based on thinking levels by applying of contextual learning with ethnomathematics. Thus, the following research questions were proposed: first, how is the effect of contextual learning with ethnomathematics on mathematical problem-solving abilities in terms of different thinking levels?; second, what is the character's local culture of students in contextual learning with ethnomathematics? third, how are the students' problem-solving skills after the application of contextual learning with ethnomathematics based on thinking levels?

Research Methods

This experimental research was used the randomized posttest only control group design. The pretest is not carried out by assuming that the students' mathematical problem-solving abilities in the experimental and control classes are equal because there is no superior class. This research was conducted at a junior high scholl in Gowa Regency, South Sulawesi Province in January-February 2020. The participants of this study were 60 nine-grade students. The material used is related to the Makassar cultural context. The learning process is carried out by observing theirattitudes that

reflect local cultural characters such as *siri'* (dignity), *pacce* (empathy), *reso* (hard work), and *sipakatau* (respect) or other skills that emerge in various daily activities.

The integration of contextual approaches with ethnomathematics can use direct learning to enhance mathematical problem-solving abilities and accommodate various students thinking levels development. Therefore, the formulation of contextual learning with ethnomathematics must place culture as the basis for finding knowledge (Saragih et al., 2017; Supriadi et al., 2014). Data were collected using observation sheets to determine local cultural characters that appeared at the time of treatment. The observation sheet instrument's development was carried out by referring to the grid and indicators of local cultural characters in learning. Classification of students' thinking levels is obtained through a standardized logical thinking test that is the Group Assessment for Logical Thinking (GALT) test (Roadrangka, 1983). The GALT test used is a modification of the standard test and adapted to the needs of this study. The research instrument was developed by modifying validated devices so that the instrument validation process used face validation. The developed construction of mathematical problems in the culture context that represent thinking levels can be seen in Table 1.

Table 1

Mathematical problems in culture context

Thinking Level Indicator	Problem	
Conservation reasoning, correlational reasoning		*Maudu lompoa* is a traditional ritual of the Cikoang community. During the ritual there is a red egg that adorns the surface of the cone-shaped object. Before decorated, the eggs are placed in a tube-shaped container. If the radius and height of the tube are half as small as a cone, is there enough eggs to use or not?
Seriation, sequence, combinatorial reasoning, probabilistic reasoning		*Bosara* is a typical Makassar dish which is in the shape of a half ball. There are three identical circular plates whosee radius r will be placed at *Bosara*. The dishes that will be served each occupy a space $\frac{1}{5}\pi r^3, \frac{1}{4}\pi r^3$, $\frac{1}{3}\pi r^3, \frac{1}{2}\pi r^3$, and $\frac{3}{5}\pi r^3$. Determine the combination of the placement of these dishes so that everything is contained in *bosara*and sort the dishes with the most dishes to the least!
Proportional reasoning, controlling variables		*Paraga* is a traditional Makassar dance that uses *takraw*. *Takraw* is a ball made of woven rattan. The ratio between the length of the rattan and the diameter of the takraw is 5:3. Determine the minimum used rattan length to make *takraw*!

Mathematical concepts in schools may not always be the same as those generally known in society (Abdullah, 2017; Alangui, 2017; Orey & Rosa, 2006). In Table 1 for problem 1, we can use the concepts of cone and tube volume. Problem 2 can be solved using the concept of spherical volume, a combination of various possibilities and sequences. Problem 3 deals with the concept of proportions or fractions, and the surface area of a sphere.

The data were analyzed using descriptive statistics and analysis of covariance (ANCOVA). The level of thinking acts as a covariate factor. Meanwhile, students' mathematical problem-solving ability is the dependent variable and contextual learning with ethnomathematics as the independent variables. The results of the observations of attitudes were analyzed using a bar chart for each indicator of local cultural characteristics shown in the learning process. Analysis of problem-solving skills is carried out by displaying the solution stages of each thinking level group.

Results and Discussion

The steps to contextual learning with ethnomathematics in developing problem-solving skills based on thinking levels can be seen in Table 2.

Table 2

Steps in contextual learning with ethnomathematics

Stage	Students activity	Teacher activity	Contextual component
Introduction	Observing various cultural contexts related to teaching materials.	Bringing up topics related to cultural context.	Constructivism
Reconstructing knowledge	Look at the relationship between the cultural context and relevant mathematical concepts.	Explained the relationship between the local cultural context and the concept be studied.	Constructivism, inquiry
Exploration	Find various community activities related to the curved side space concept on the worksheets.	Bring up various phenomena of daily life as a form of learning experience.	Inquiry, Community learning
Elaboration	Finding problems and implementing problem-solving strategies to produce solutions from various examples of cultural activities in the environment.	Guide, monitor, and evaluate students' problem-solving activities according to the context.	Question, modelling, community learning, authentic assesment
Confirmation	Present the assignment results by showed them on the board and providing an opportunity to discuss the solutions obtained.	Provide space for discussion, question and answer, and reflection on the results of work that has been done.	Question, authentic assesment, reflection
Closing	Make conclusions about mathematical concepts used in various cultural activity.	Facilitated students to summarize learned activities.	Authentic assesment, reflection

Table 2 shows that the steps of contextual learning with ethnomathematics can go parallel with the concept of character learning. Learning begins with bringing up the cultural context as a source of learning and seeking a process of integration into the classroom through reconstruction of knowledge. The questioning and learning community activities are the most important components that students and teachers must undertake before entering core activities. This is necessary so students understand the function of cultural contexts appearing in learning activities. The assessment process is carried out during the learning process by observing student activities. In the final stage it is intended that students reflect on learning independently and realize the relationship of material content with the cultural context that exists in the environment.

Math Problem-Solving Ability

The face-to-face learning process is carried out four times and one meeting to measure students' mathematical problem-solving abilities. The results of mathematical problem-solving abilities are shown in Table 3.

Table 3

Descriptive statistics

No	Statistical measure	Experiment class	Control class
1	Sample	30	30
2	Mean	69,17	60,30
3	Median	68	60
4	Varians	293,52	194,29
5	Standar deviation	17,13	13,94
6	Minimum	42	30
7	Maximum	98	87

Students' mathematical problem-solving abilities in the experimental class showed a greater diversity of data than the control class. The average mathematical problem-solving ability of the experimental class students is greater than the control class with the data set tighter at the mean value. Furthermore, a description of the data of mathematical problem-solving ability based on the thinking level can be seen in Table 4.

Table 4

The ability to solve mathematical problems based on thinking levels

Statistical measure	Experiment class			Control class		
	Thinking level					
	Formal	*Transition*	*Concrete*	*Formal*	*Transition*	*Concrete*
Sample	10	13	7	10	11	9
Mean	80,17	64,62	61,9	69,33	61,06	49,07
Varians	180,52	350,07	137,43	138,4	106,82	164,66

In Table 4, the greatest variation in the experimental class is at the transition thinking level while the control class is at the thinking level. The next step is to conduct normality test using Kolmogorov Smirnov test whose results are shown in Table 5.

Table 5
Data normality test

Test	Class	Statistic	Sig.
Normality	Experiment	0,078	0,200
	Control	0,118	0,200

The normality test results show that the data in the experimental class and control class are normally distributed, which means that the data is obtained in a normally distributed population. The further analysis used the t-test to compare students' mathematical problem-solving abilities in the experimental and control classes as shown in Table 6.

Table 6
Independent sample t test

Class	t value	Sig.
Experiment Control	2,199	0,032

Table 6 shows that the students' mathematical problem-solving abilities in the experimental class are statistically better than the control class, which means there is no difference in students' mathematical problem-solving abilities in the experimental and control classes. Further analysis was carried out to determine the effect of the application of contextual learning with ethnomathematics based on the level of thinking using ANCOVA in Table 7.

Table 7
Summary of the ANCOVA results

	Type III Sum of Squares	Df	Mean Square	F	P
Corrected Model	4758,441	2	2379,221	12,834	0,000
Intercept	24294,021	1	24294,021	131,042	0,000
Thinking Level	3579,175	1	3579,175	19,306	0,000
Class	1127,008	1	1127,008	6,079	0,017
Error	10567,292	57	185,391		
Total	266750,000	60			
Corrected Total	15325,733	59			

Table 7 shows that there is a linear relationship between the level of thinking and students' mathematical problem-solving abilities.Complex problems require several reasoning abilities to be used in appropriate situations. Mental operational development that is not ready to handle certain situations causes students to have difficulty obtaining an overview of appropriate problem solving. Students are often trapped in contextual illustrations based on their intuition because they have not reached the appropriate level of thinking to deal with specific problems. Furthermore, differences in treatment also influence the ability to solve mathematical problems without involving the thinking level. The value of problem-solving ability can change at an intercept without being affected by the level of thinking and behavior. Simultaneously, differences in thinking and treatment

levels affect students' mathematical problem-solving abilities. The coefficient of determination simultaneously is 0.31 which means that the difference in treatment by considering the covariate factor contributes 31% to the students' mathematical problem-solving abilities.

Attitudes of Local Culture Character Students

Local cultural character is an attitude that can emerge in ethnomathematics learning. Students are aware of the relationship between local culture and mathematics learning to foster a sense of acceptance and appreciation of mathematics related to the values prevailing in society. The observations about students' attitudes related to local cultural characters in the experimental class can be seen in Figure 1.

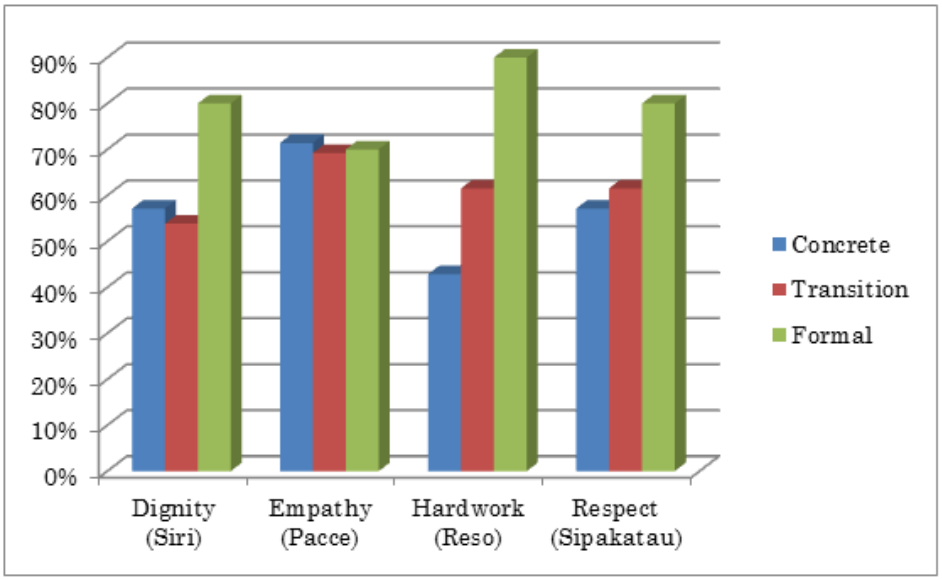

Figure 1. The character of the local culture in experimental class

The character of local culture is generally seen in contextual learning with ethnomathematics at every thinking level. The character of empathy is the most balanced character possessed by every student at each level. Instead, the character of hard work mostly arises from students who have a formal thinking level. Thus, empathy is a character that is commonly owned by students regardless of their thinking level while the character of hard work as an effort to find solutions to problem-solving is very dependent on their thinking abilities. Hard work can also be identified from students' efforts to find problem-solving strategies relevant to the context and ensure the accuracy of the solutions obtained. Correspondingly, students at the formal level have better integrity than students at the transition and concrete levels. Students at the formal level have relative confidence in the methods used, and feel reluctant to give the answers they get. However, mutual respect is shown by formal level students compared to transition and concrete level students. If there are different solutions, then most of the formal level students will try to provide alternative

solutions. In the learning process, formal level students are more obedient in following the instructions given, while concrete level students generally show a less cooperative attitude.

Skill Math Problem-Solving

Students' skills in solving mathematical problems are assessed by looking at indicators of problem-solving ability. A comparison of students' mathematical problem-solving skills based on differences in thinking levels in the experimental class can be seen in Figure 2.

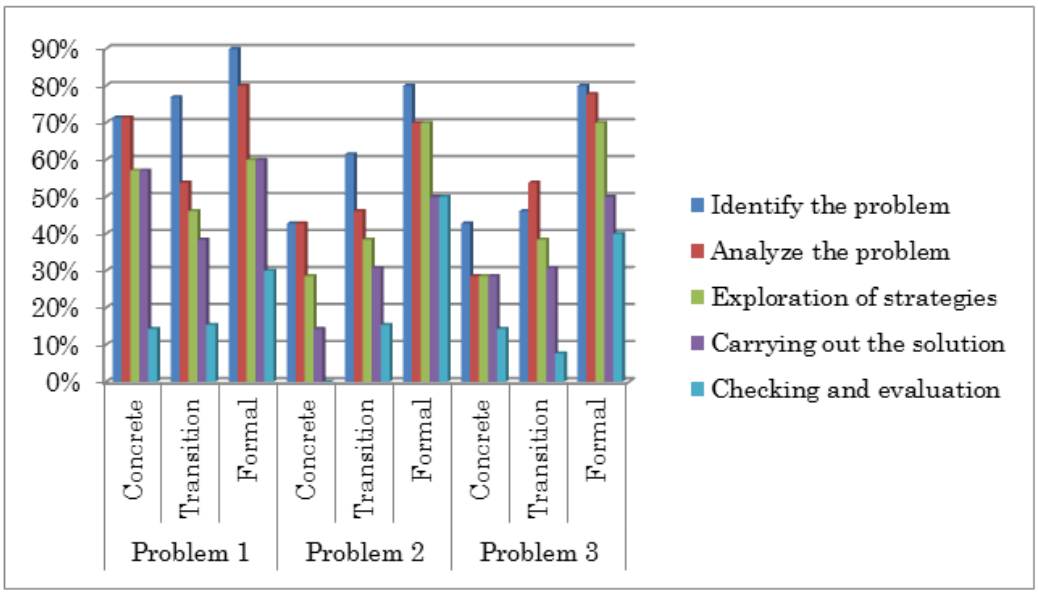

Figure 2. Students' mathematical problem-solving skills

Stages of problem solving by students seem to have a relationship with the complexity of the problems faced and the level of thinking ability. In problem 1, most students can understand the problem at each thinking level. However, students who are able to solve problem 1 are mostly solved by students with concrete and formal levels. It appears that transition level students make more mistakes in analyzing problems and implementing strategies. Students at the concrete level seem to have more difficulty solving problems 2 and 3. Instead, students at the formal level consistently show a performance of problem solving stages in problem 2 and 3 that is not much different than at problem 1. Thethinking level of students with several more complex reasoning abilities can be used to solve complicated problems. Formal level student solutions'characteristics show mathematical thinking processes that are more sophisticated than concrete and transition level students. Formal level students find it easier to use abstraction so that it is more flexible to apply various illustrations of diagrams, pictures, and mathematical symbols. Many concrete and transition level students still use intuition, rewrite sentences in questions, and understand them through reading.

Discussion

Contextual learning with ethnomathematics provides students with an opportunity to get to know more about the relationship between mathematical concepts that grow in society. They can make decisions with unique methods of solving problems. Students' negative perceptions of mathematics are reduced after applying contextual ethnomathematics learning as indicated by the increasing character of local cultural (Akib, 2016; Widada et al., 2018). Students take a higher role in the classroom by collecting data, devising solving strategies, and solving problems. An open attitude in accepting mathematical concepts becomes better with the emergence of various topics related to the context of everyday life (Imswatama & Lukman, 2018).

Integrating cultural contexts in various mathematical problems becomes a pleasant space for students. Contextual learning with ethnomathematics provides opportunities for students concrete thinking levels to understand the problem better. Problems related to daily experiences cause students' motivation to grow (Fouze & Amit, 2018). Raising various cultural contexts relevant to mathematics learning is an attempt to gain learning experience in mathematics from a different perspective without following strict rules (Muhtadi & Prahmana, 2017). The construction of mathematics learning is significantly important in fostering the ability to solve mathematical problems (Schoenfeld, 2016).

Modeling mathematical problems is an important skill and tool in solving mathematical problems. The success of problem-solving is very dependent on the accuracy of modeling the problem. Contextual learning with ethnomathematics provides space for students to think creatively developing problem-solving models by the existing context. This is in line with Supriadi's idea that contextual ethnomathematics learning with teaching materials that are tailored to the students needs contributes to the ability to model problems (Supriadi et al., 2014). The teacher develops anthropological perspectives related to the classroom learning process to provide opportunities for students to recognize various cultural traditions, linguistics, procedures, and mathematical practices (Rosa & Orey, 2018).

Contextual learning with ethnomathematics becomes a means for students to understand the relevance of mathematics in their lives. Knowledge is built by valuing various forms of cultural experience to empower students intellectually, socially, emotionally, and politically (Rosa & Orey, 2011). Ethnomathematics learning can reconstruct students' understanding of mathematics better regardless of their current level of thinking development. Students become more confident in the methods used independently and inspire a sense of respect for the local cultural character. Problem-solving becomes more varied and supports students in gaining a meaningful understanding of mathematics. Tasks that stimulate students 'curiosity with challenging problems are good ways to understand students' thought processes and provide potential interest in learning mathematics (Cheeseman, 2019). The significance of mathematics learning becomes a strong basis for maintaining thinking levels and increasing them at higher levels.

In general, thinking levels make a real difference in solving mathematical problems in the experimental and control classes. However, these differences have not been explored further, especially those related to reasoning and mental operations used when solving problems. This is because resources to trace students' thought sequences in detail require qualitative studies. However, a description of the differences in problem-solving can be seen in the skills demonstrated in each problem. The problem context adapted to the needs of this type of reasoning provides information that the more complex the problems form is the skills shown depend on the students thinking level.

Furthermore, students' mathematical problem solving skills at the transition level show relatively smaller differences than other thinking levels. The assumption arises that contextual learning with ethnomathematics does not significantly impact students' transition levels on mathematical problem solving skills. The problem solving ability of students at the transition level is not influenced by the learning approach used. It is possible that a number of reasoning skills have developed, but students at the transitional level are not strong enough to understand more complex problems (Nur & Rahman, 2013). The use of learning methods is not enough to help transition level students develop problem solving skills. Learning media that facilitate the ability to think concretely can be selected to optimize the transition level students (Karplus, 1977). Each student's problem-solving skills depend heavily on his thinking level which represents visual perception and multidimensional thinking, especially on geometric problems (Sezen & Bülbül, 2011). The more complex a problem can be imaged in a visual form, the more difficult it is to be able to perform appropriate mental operations. In addition, supporting factors in the problem solving processes such as complexity, problem gap space (Nur & Rahman, 2013), mental operations (Widada et al., 2018), language level (Akib, 2016), cultural understanding(Simamora & Saragih, 2019), and motivation for learning mathematics in cultural contexts (Nur & Dadi, 2018) are important parts for students to solve mathematical problems. The use of cultural context is important to provide better understanding support so that students are motivated to solve mathematical problems.

Conclusion

Mathematical concepts can't be separated from the cultural activities that grow in the community. Contextual learning with ethnomathematics provides space for students to gain learning experiences by discovering mathematical content in various cultural contexts in the environment. They can begin understanding mathematical concepts by utilizing real situations that involve their own identities. Problem solving becomes more realistic and can be managed based on the thinking development of each so that the learning process becomes more meaningful.In general, contextual learning with ethnomathematics influences students' mathematical problem-solving abilities based on their level of thinking. Local cultural characters appear in each indicator shown by each category of students' thinking level in the experimental class. Students with formal categories have better problem-solving skills than other levels of thinking. Recommendations regarding the

findings include, further analysis is needed regarding the average difference in students' mathematical problem-solving abilities in the transition category which is not much different from the concrete category. Factors outside ethnomathematics based contextual learning and thinking level categories have not been explored in depth. There may be other variables that affect students' mathematical problem-solving abilities relevant to this research study.

Acknowledgment

This research was carried out with the help of the BPPDN scholarship from doctoral programs from Kemristekdikti and Universitas Musamus.

Bibliography

Abdullah, A. S. (2017). Ethnomathematics In Perspective of Sundanese. *Journal on Mathematics Education*, *8*(1), 1–16. https://doi.org/10.22342/jme.8.1.3877

Akib, I. (2016). The Local Cultural Values In The Interaction of Matematics Learning at School. *IOSR Journal of Mathematics*, *12*(4), 24–28. https://doi.org/10.9790/5728-1204012428

Alangui, W. V. (2017). Ethnomathematics and Culturally Relevant Mathematics Education in the Philippines. In *Ethnomathematics and its Diverse Approaches for Mathematics Education* (pp. 183–208). Springer International Publishing.

Balamurugan. (2015). Ethnomathematics; An Approach for Learning Mathematics From Multicultural Perspectives. *International Journal of Modern Research and Reviews*, *3*(6), 716–720.

Cheeseman, J. (2019). Young children are natural inquirers: Posing and solving mathematical problems. *Waikato Journal of Education*, *24*(2), 11–22. https://doi.org/10.15663/wje.v24i2.664

Cheriani, Mahmud, A., Tahmir, S., Manda, D., & Dirawan, G. D. (2015). Problem-Based Learning – Buginese Cultural Knowledge Model — Case Study : Teaching Mathematics at Junior High School. *International Education Studies*, *8*(4), 104–110. https://doi.org/10.5539/ies.v8n4p104

Fah, L. Y. (2009). Logical thinking abilities among form 4 students in the interior division of Sabah, Malaysia. *Journal of Science and Mathematics Education in Southeast Asia*, *32*(2), 161–187.

Fouze, A. Q., & Amit, M. (2018). Development of Mathematical Thinking through Integration of Ethnomathematic Folklore Game in Math Instruction. *EURASIA Journal of Mathematics, Science and Technology Education*, *14*(2), 617–630. https://doi.org/10.12973/ejmste/80626

Imswatama, A., & Lukman, H. S. (2018). The Effectiveness of Mathematics Teaching Material Based on Ethnomathematics. *International Journal of Trends in Mathematics Education Research*, *1*(1), 35–38. https://doi.org/10.33122/ijtmer.v1i1.11

Karplus, R. (1977). Science Teaching and The Development of Reasoning. *Journal of Research In Science Teaching*, *14*(2), 169–175. https://doi.org/10.1002/tea.3660140212

Muhtadi, D., & Prahmana, R. C. I. (2017). Sundanese Ethnomathematics : Mathematical Activities In Estimating , Measuring , and Making. *Journal on Mathematics Education*,

8(2), 185–198. https://doi.org/10.22342/jme.8.2.4055.185-198

Naresh, N. (2015). The role of a critical ethnomathematics curriculum in transforming and empowering learners. *Revista Latinoamericana de Etnomatemática*, *8*(2), 450–471.

Nur, A. S., & Dadi, O. (2018). The Development of Curved Side Constructions Learning Media Involving Problem Solving Capability and Local Culture Wisdom. *Jurnal Pendidikan Indonesia*, *7*(2), 120–129. https://doi.org/10.23887/jpi-undiksha.v7i2.13742

Nur, A. S., & Rahman, A. (2013). Mathematics Problem Solving as a Medium to Develop a Formal Reasoning at Student of Junior High School. *Sainsmat*, *2*(1), 84–92. https://doi.org/10.2685/sainsmat217532013

Orey, D. C., & Rosa, M. (2006). Ethnomathematics: Cultural Assertions and Challenges Towards Pedagogical Action. *The Journal of Mathematics and Culture*, *6*(1), 57–78.

Roadrangka, V. (1983). The construction of a group assessment of logical thinking (GALT). Retrieved from: http://thaiscience.com

Rosa, M., & Orey, D. C. (2011). Ethnomathematics : the cultural aspects of mathematics Etnomatemática : os aspectos culturais da matemática. *Revista Latinoamericana de Etnomatemática*, *4*(2), 32–54.

Rosa, M., & Orey, D. C. (2018). The Anthropological Dimension on Ethnomodelling Research Based on Ethnomathematics and Modelling. *Journal of Archaeology and Anthropology*, *1*(1), 1–8.

Saragih, S., Napitupulu, E. E., & Fauzi, A. (2017). Developing Learning Model Based on Local Culture and Instrument for Mathematical Higher Order Thinking Ability. *International Education Studies*, *10*(6), 114–122. https://doi.org/10.5539/ies.v10n6p114

Schoenfeld, A. H. (2016). Learning to Think Mathematically : Problem Solving, Metacognition , and Sense Making in Mathematics. *Journal of Education*, *196*(2), 1–38. https://doi.org/10.1177/002205741619600202

Sezen, N., & Bülbül, A. (2011). A scale on logical thinking abilities. In *Procedia - Social and Behavioral Sciences* (Vol. 15, pp. 2476–2480). Elsevier B.V. https://doi.org/10.1016/j.sbspro.2011.04.131

Simamora, R. E., & Saragih, S. (2019). Improving Students ' Mathematical Problem Solving Ability and Self-Efficacy through Guided Discovery Learning in Local Culture Context. *International Electronic Journal of Mathematics Education*, *14*(1), 61–72. https://doi.org/10.12973/iejme/3966

Supriadi, Suryadi, D., Sumarmo, U., & Rakhmat, C. (2014). Developing Mathematical Modeling Ability Students Elementary School Teacher Education through Ethnomathematics-Based Contextual Learning. *International Journal of Education and Research*, *2*(8), 439–452.

Widada, W., Herawaty, D., & Lubis, A. N. M. T. (2018). Realistic mathematics learning based on the ethnomathematics in Bengkulu to improve students ' cognitive level. In *The 6th South East Asia Design Research International Conference (6th SEA-DR IC)* (pp. 1–8). IOP Conf. Series: Journal of Physics: Conf. Series.