

Local Wisdom as an Ethnomathematics Learning Approach (A study on Regency Local Wisdom)

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Abstract. Mathematics learning experiences a paradigm shift in its development. It is followed by various mathematics learning approaches including ethnomathematical approach. Ethnomathematical approach integrates the characters and cultural literacy in mathematics learning. Therefore, it is able to instill the mathematics concepts through the cultural practice which is implemented in the learning process. One of it is conducted through the exploration of regency local wisdom that has a role in developing ethnomathematical. This study implements the concepts of regency local wisdom which is able to be adopted in ethnomathematical learning. This study is qualitative research in which the researcher observes the local wisdom of Bojonegoro regency, East Java, Indonesia. The data obtained is related with the rational stories behind the culture. Based on observation results, Bojonegoro local wisdom such as *Oklik*, *Tengul* dance, and *Khayangan Api* story can be integrated in mathematics learning. Understanding the local wisdom stories can potentially bring out the values of it and connect culture with mathematics. Those stories can be implemented in mathematics learning by providing HOTS (higher order thinking skill) questions which are relevant to the learning materials.

Key words: Local wisdom; Ethnomathematics; approach

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INTRODUCTION

The development of mathematics learning methods is very diverse. Moreover, the developments of technology, digital, social, and culture can be the elements of mathematics learning process. Related to cultural element in learning, it can be implemented out of science subjects (Mohammed & Kinyó, 2022). However, the implementation of cultural element in mathematics learning is not commonly used. Several researchs reveal that the use of cultural element in learning can improve students' awareness to preserve the surrounding cultures. According to (Utami & Sayuti, 2020), one activity related to students' situation is learning materials from indigenous communities. To compile these learning materials, the teacher needs to be adaptive, innovative, and creative to suit the students' environment, including the conditions and circumstances of the facilities.

Ethnomathematics is mathematics learning which includes culture. (Lubis et al., 2021) state that ethnomathematics and mathematical literacy are the two main ideas about knowing mathematics in the world. The ethnomathematics emphasizes the competence of people developed in different cultur groups in their daily lives. Moreover, (Niken, 2020) says that Ethnomathematics from a culture can then be

used in learning mathematics in schools. The use of ethnomathematics in class teaches students to connect culture and mathematics. Another study related to ethnomathematics is carried out by (Lubis et al., 2022), who state that the local wisdom is oriented to socio-scientific issues to improve conceptual knowledge and environmental literacy. Furthermore, (Nursyahidah et al., 2018) argue that mathematics that grows and develops in certain cultures that also view mathematics as a cultural product is called ethnomathematics..

Based on those opinions, it can be said that Ethnomathematics is an approach to integrate culture and mathematics learning process. In addition, the cultural objects relate to the geometry of mathematics (Gunawan et al., 2021). Those objects can be adjusted for ethnomathematics learning especially in the material of geometry. This study brings cultural elements in mathematics learning approach viewed from different point of view in previous researchs. This study utilizes rational stories behind the emerging culture. Those stories can be used as materials of mathematics learning, e.g. in creating HOTS (higher order thinking skill) questions (Retnowati, 2022).

Moreover, this study utilizes cultures in the students' local wisdom. Local wisdom is the original culture of a regency which is very close

to the society. Local wisdom becomes the focus of this study because it is close to the students' life. When the culture is integrated in the ethno mathematics-based questions, students are supposed to study the culture in it indirectly (Umbara et al., 2021). In this integration process, observations of the stories behind the culture are conducted to identify the problems which can be presented mathematically. These problems are not only in forms of essay questions, it is also related to the higher order thinking skill (HOTS). It is because there are stories behind culture (local wisdom) which have not been presented in form of mathematical questions. In line with (Widada et al., 2019) who state that ethnomathematics makes local culture a starting point for learning mathematics

The problems of students' local wisdom are presented to help them in solving it. According to (Sumirattana et al., 2017), in terms of developing

METHOD

Research Design

This study is qualitative research to analyze several cultural local wisdom and identify its mathematical forms. The mathematical forms are to utilize stories behind cultural local wisdom to relate it with the mathematical problems.

Data Collection

Identifying local wisdom culture uses observations and interviews with several important characters in the culture. Observation is carried out by reviewing the literatures from various sources. Then, interview is carried out to the important characters in the culture to obtain additional information related to the background of the culture. It aims to achieve more detail information and identify the mathematical elements which can be presented in form of questions. It is provided to the students, so they are able to find the process of problem solving.

Moreover, interview aims to study more about the results of literature review. The researchers confirm it by providing several questions including: 1) the beginning story of the culture, 2) the process of forming the culture or art, and 3) rational things relating to culture and existing mathematical process. This study is carried out to investigate the cultural elements mathematically in Bojonegoro regency, East Java, Indonesia.

Data Analyzis

The data is analyzed using qualitative research procedures. It is carried out by interpreting data

and increasing mathematical literacy, teachers have an important role to play in facilitating students' mathematics learning experiences so that they can better apply mathematics in their real lives. Furthermore, (Olivares et al., 2020) say that problem solving is more than one way to define a problem. The literature agrees that facing a problem means that we cannot use a previously given path, experience, or method to find the solution. Therefore, Ethnomathematics problem solving based on local wisdom can be more studied to investigate the process of problem solving itself.

Based on this, the purpose of the research is to integrate local wisdom-based culture with mathematics learning. This integration of culture and mathematics can be realized in the problems of higher thinking skill. This study implements the concepts of regency local wisdom which is able to be adopted in ethnomathematical learning. and mathematical elements of cultural local wisdom. It is also related to the rational stories behind the culture. The result of analyzis is used to improve the mathematical problems in form of HOTS questions.

RESULTS AND DISCUSSION

Culture and Mathematical Elements

The ethnomathematics approach is found in many life aspects. People's habits and daily lifes are the things which become the basis of a culture. In fact, local wisdom is mostly an icon of a regency. It needs to increase the student's sense of belonging the local wisdom. It can be carried out in mathematics learning process Based on the results of literature review related to Bojonegoro local wisdom, observation, and interview with important characters, the researchers choose 3 local wisdom to be discussed and identified its mathematical elements. Those local wisdom are *Oklik*, *Tengul* dance, and *Kayangan Api*. It is described as follows:

Oklik

Oklik is one of local wisdom at Bojonegoro which continues to be preserved. According to (Anggraeni et al., 2022), it emerged based on a story of a disease that attacked Sobontoro village in Bojonegoro; it was called *pagebluk* [plague]. Moreover, it is stated that *oklik* was started when the local people did night patrol to overcome the disease by playing this musical instrument of *oklik*.

Oklik derives from the word "*klik klok klik klok*". It is the sounds of bamboo musical

instrument. It has 4 rhythms, namely *kinthel arang*, *kinthel kerep*, *gedog*, and *klur*. When it is played together, it creates the *oklik*. Furthermore, *oklik* is a musical art made of bamboo that has different sizes, so it produces different tones. The process of creating this musical instrument goes through several stages, including selecting materials, cutting it, keeping it dry to produce appropriate tone.

The researchers explore the stories related to



Figure 1. Bamboo Trees

Source: Researchers' document

In figure 1, it shows the basic materials needed to make *oklik*. Based on the explanations of interviewee, the first step to make it is to choose bamboo with different sizes to create various sounds. Moreover, he explains that bamboo (Javanese: *pring*) mostly grows at Bojonegoro Regency. Even in the villages, most of people's backyards are covered with it; it is called *pring ori* or *greng*.

The next step is to dry the selected materials,

the beginning of *oklik* creation by conducting interviews. Based on the review results, the researchers conduct an interview with one of the activists of *oklik*. It was conducted on 4th september 2022 to investigate the steps of creating it. The researchers asked about the history of *oklik* and its development. In addition, the researchers also asked about the way to make it. The materials needed were bamboo which could be viewed in figure 1 and figure 2.



Figure 2. Materials of *Oklik*

so it can produce louder sounds. It can be viewed in figure 2. When the bamboo is dry, it is cut into each segment. Then it is examined to explore different sounds. Based on the interview result, it takes a long time to dry it up in order to create appropriate sounds. It requires expert's sound sensitivity and accuracy.

In table 1, there are several mathematics elements taken from the history of *oklik*. It is described as follows:

Table 1. *Oklik* Local Wisdom using Ethnomathematics Approach

Local Wisdom	Mathematics Elements	The Grids of Questions
<i>Oklik</i> is viewed from the rhythm pattern	There are 4 rhythm patterns in <i>Oklik</i>	HOTS questions are related to <i>Oklik</i> 's rhythm patterns
<i>Oklik</i> is viewed from the stages in creating music instruments	Creating music instruments is started from choosing materials, making and choosing tones	HOTS questions are related to time allotment and materials needed in creating <i>oklik</i> (in the course of linear programming)

Table 1 can be more developed by making instruments of questions to investigate the process of problem solving using *oklik*-based ethno mathematics problems. The instruments are started by providing information for students related to *oklik*. Moreover, it can be developed to be questions which are viewed from the elements of *oklik* music instrument or the process of creating *oklik*.

Thengul Dance

Thengul dance is one of iconic dances in Bojonegoro regency which is developed since 1992. It is explained that *Thengul* derived from the word "*Metheteng*" and "*Methungul*". *Metheteng* means 'stiff and serious'. *Methungul* means 'to appear'. Based on this meaning, the movements of *Thengul* dancer look stiff. *Thengul* dance is inspired by the performance of *Thengul* puppet. This dance is played by at least 7 dancers with distinctive makeup characteristics that are

different from other dances. Their movements are also different. It is presented by paying attention to the *gamelan* music, open and closed stage settings, dancer's make-up, dancer's dresscode, lighting and the floor patterns. The movements are based on the movements of *thengul* puppet. Its *gamelan* music uses *pelok* and scenario. The floor patterns in *thengul* dance include single or mass

patterns.

The previous descriptions of *thengul* dance can describe that its uniqueness can be viewed from various points of view. Its uniqueness becomes a basis to develop the instruments of ethnomathematics questions which will be provided for students. The performance of *thengul* dance can be viewed in figure 3.



Figure 3. *Thengul* dancer
Source : Instagram @disbudparbojonegoro

Developing instruments can be done in forms of questions related to the history of *thengul*

dance which can be viewed in table 2.

Table 2. *Thengul* dance as Bojonegoro local wisdom using ethno mathematics approach

Local Wisdom	Mathematical Elements	The Grids of Questions
<i>Thengul</i> dance is viewed from the patterns of movements and floor	The movements; single and mass floor patterns	HOTS questions related to single and mass floor patterns
<i>Thengul</i> dance is viewed from dancer's uniqueness and its number	The number of dancers who are needed in performing dance	HOTS questions related to optimize the number of dancers and the preparation of dance performance.

Table 2 can be more developed by making instruments of questions which contain ethno mathematics problems related to *thengul* dance viewed from the floor patterns, dancer's movements, and its uniqueness. The elements of culture and mathematics can be integrated in the questions. In this case, the students' literacy about culture and mathematics can be developed indirectly.

Khayangan Api Story

As *oklik* and *thengul* dance, *kayangan api* is one of iconic culture in Bojonegoro regency. It is located in Ngasem as one of sub-districts in Bojonegoro. It is tourist destination in a forest area which combines the natural phenomena in form of gas burst that can be seen as fire burst that never goes out (Insani et al., 2020).

Khayangan api provides interesting story

to be understood based on the literature review and interview result with the caretaker of it. The interview was conducted on 3rd September 2022. Its historical story was told that it began when *Empu Supo* left his village to go to a forest. There, he continued his work to make heirlooms for the Majapahit Kingdom. Some people knew it because of the appearance of fire which floated at the triangular point in the entrance that was well known as the tree of love. At this time, it is known as eternal fire and called *Khayangan Api* (Lestari et al., 2022).

Apart from its historical stories and accompanying natural phenomena, *Khayangan Api* is currently a tourist destination that is still in demand by the surrounding community and outsiders. The *Khayangan Api* can be viewed in figure 4.

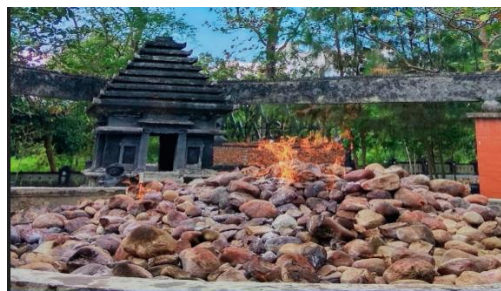


Figure 4. Khayangan Api

Source : Instagram @disbudparbojonegoro

In figure 4, it can be viewed the location of the

eternal fire. There are piles of stones arranged in certain formation of eternal fire area. Furthermore, there are many buildings in its surroundings which have values and meanings. One of it is called *Sasana Khayangan Api*. It is built with open design which has 4 main pillars facing the cardinal directions. It has a function as a pavilion which is used for certain ritual events (Subadyo, 2017).

Based on those explanations, the researchers identify the elements of mathematics which can be explored from *Khayangan Api*. It can be viewed in table 3.

Table 3. Local Wisdom of *Khayangan Api* using Ethnomathematics Approach

Local Wisdom	Mathematical Elements	The Grids of Questions
The point of view on the history of <i>Khayangan Api</i>	Optimizing the time allotment in making heirlooms	HOTS questions related to optimize the time allotment in making heirlooms
The point of view on the buildings' characteristics in <i>Khayangan Api</i> and its tour operation	The shape of buildings. Minimizing the operational costs of tourism	HOTS questions related to the shape of building and the minimization of tourism operational costs

Table 3 can be a reference in developing the instruments in form of essay questions to investigate the process of solving ethnomathematics problems related to the local wisdom of *Khayangan Api*. The instruments can be developed based on the stories' point of view, the shape of buildings, and tourism management. The instruments have to refer to the students' problem solving processes.

Creating Instruments

It explains the examples of instruments which can be made based on the mathematical elements in each local wisdom. The instruments are also based on the initial material of linear programming course i.e. Common Patterns of Linear Programming. The followings are the examples of instruments which integrate the culture and mathematics elements.

Oklik is one of musical arts developed in Bojonegoro regency, East Java, Indonesia. It starts from the emergence of a disease called "Pagebluk". Oklik utilizes the tools made from bamboo which are beaten. It has four basic tones used to create musical instruments. The process of making oklik is divided into several stages, namely choosing materials, cutting it, drying it up, and selecting tones. The drying process and tone selections are the longest process in producing it. A craftsman needs 2 weeks to make it started from the beginning process to the finishing process. When there will be a cultural festival in August, craftsmen usually get increased orders. As in August last month, craftsmen received orders to make two types of oklik musical instruments. The process of making it can be viewed in table 5.

Table 5. Process of Creating Oklik

Types of musical instruments	Cutting (day)	Drying up (day)	Selecting tones (day)	Total of craftsmen	Profit (Rp)
Oklik 1	1	2	5	4	80000
Oklik 2	1	2	6	6	100000

How many musical instruments can the craftsmen make maximum?

The integration of culture and mathematics elements in that example of instrument can be

viewed from the ethnomathematics problems provided in it. The brief story about *oklik* musical instrument in the beginning of it is as a part of cultural literacy for students. The mathematical

element of it is the optimization of time and revenue on the process of making oklik as part of linear programming materials. Indeed, this instrument needs further study until it is ready to be used as an instrument for further research.

The above instrument also provides new things about ethnomathematics in which several previous studies have mostly linked cultural elements in mathematics from the point of view of geometry. It takes an ethnomathematics point of view from different side, namely a brief story of local wisdom made in algebraic HOTS questions. In addition, it can be used by students to investigate the process of solving ethnomathematics problems.

CONCLUSION

The aim of this study is to integrate the elements of local wisdom and mathematics. Based on the results and discussion, there are several local wisdom in Bojonegoro regency, East Java, Indonesia which can be developed as ethnomathematics learning approach. This approach can be more developed specifically in the instruments of HOTS questions of ethnomathematics problems. The story's point of view behind the culture and the mathematics value in it can indirectly lead to cultural literacy and students' processes in solving ethnomathematics problems. In this case, the researchers will conduct ethno mathematics instruments' development based on local wisdom which is more valid and reliable to investigate the problem solving process. In line with (Nur et al., 2020) who state that the integration of contextual approaches with ethnomathematics can use direct learning to enhance mathematical problem-solving abilities and accommodate various students thinking levels development.

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