Consideration of curriculum approaches of employing ethnomathematics in mathematics classroom

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Abstract. As mentioned by many researchers (e.g., [1,2,3]), students have a belief that learning mathematics is formal and not flexible. Students are required to have fundamental mathematics skills which not only focus on memorizing the formula but also make sense of it. Recently, ethnomathematics is one of the promising approaches to help the students to explore their culture to get the idea of the mathematical concept. Though this ethnomathematics is well-known enough, ethnomathematics in the classroom seems superficial and only is used for the introduction part in the mathematics concept. In this paper, researchers try to review previous studies to identify the research gap and consider a new curriculum approach to fill the gap. Several existing approaches will be examined to develop a mathematical concept by overcoming superficial nature. Strength and weakness of them are identified. As a part of the consideration, an example will be given to strengthening the proposed curriculum.

1. Introduction

In general, as reported by many researchers [1,2,3] students have difficulties to make sense of mathematics. It is because they cannot connect what they learn in the school and outside the school. Students tend to have the same belief that mathematics only deal with formula and not flexible with their world. Indonesia students as well have the same belief that makes them useful to run away with this subject. For students, mathematics only for people who like to do calculate and those whose expertise in this field is special while some of them who do not like to deal with that formula is less confident to be challenged related this subject.

The latest curriculum of Indonesia tried to overcome this issue by put focus on the improvement of students’ ability towards culture and students’ center approach [4,5] as well as emphasizing thematic system to combine all subject in elementary school level. But this system only works less than two years, and they come back to separate mathematics and physical education subjects from the thematic system. The reason for this issue behind is the mathematics have a huge domain that cannot be combined with others subject. Besides, in the reality mathematics in the thematic system still works on the formula and in the end, the students are emphasized to memorize the formula rather than understand the concept deeply. In this case, the pedagogy issue is the crucial part to teach mathematics in the classroom.

Following the focus in Indonesia curriculum, bring the culture to the curriculum context, ethnomathematics can be one of the promising approaches to help the students to explore their culture to get the idea of the mathematical concept as well as appreciate others culture as a multicultural country. However, the implementation of ethnomathematics approach used for the introduction part only that cause superficial in the mathematics classroom. To overcome the issue, researchers using qualitative
approach by review previous studies and analyze several existing approaches: problem posing-problem solving approach, open-ended approach and realistic mathematics education approach to fill the gap and strength the ethnomathematics as a proposed curriculum.

2. Development of ethnomathematics research

Investigating culture relate to the mathematical idea has been discussing for almost more than 30 years ago. This promoting culture idea by using the name of ethnomathematics was to begin by D’Ambrosio [6] and following by Bishop [7] with his idea in mathematical enculturation which focuses on six universal activity that can be found in any culture.

Exploring those cultures which are close to the students’ daily life make mathematics more meaningful for them. Several researchers had been conducting the ethnomathematics issue as a research activity which proposes by Gerdes [8] and D’Ambrosio [6] as a subject of study. However, those previous studies not pay attention to the mathematics education part rather than more relate to the anthropological issue. Even the issue of ethnomathematics used to be considered as a promising approach, but many researchers also argue the standpoint and position of this approach in the education especially in the mathematics education. Start from the 20th century, Bishop [7,9] and D’Ambrosio [6] promote an idea to integrate the ethnomathematics into the curriculum which can provide meaningful context in the introducing mathematics context to the students. In the continuing development of the ethnomathematics, Orey, and Rosa [10] consider this approach as an intersection of the three disciplines which are mathematics, cultural anthropology, and mathematical modelling. In the latest of their work, they promote ethno-modelling by considering culturally relevant pedagogy to create an opportunity for mathematics curriculum [11]. Although Orey and Rosa had been promoting the cultural pedagogy, by considering the difference between M(athematics) and m(a)thematics proposed by Bishop [7], the cultural pedagogy here more relate to the m which is more refer to the individual uses in daily life (procedures to count, to measure, etc).

Ascher [12] tries to bridge the relation between m and M in mathematics from the perspective of anthropologist and psychologist as well as D’Ambrosio [13] did. However, the m which relate to the culture only can be seen as an introductory part of the lesson and at the end of M which relate to the school mathematical goals only be seen as abstract for the students. Therefore, in this paper, researchers try to investigate the previous studies which have been integrating to employ ethnomathematics in the classroom.

3. Curriculum approach using ethnomathematics

According to the Adam, S [14], to emphasize the pedagogical issue of how to bring ethnomathematics into mathematics curriculum, there are five possibilities for an ethnomathematical curriculum can be identified as follows:

a. Ethnomathematical curriculum is as an approach which means ethnomathematics provides meaningful context for the students because its relation to students’ thinking about mathematics [9].

b. Ethnomathematics as an approach to see mathematics from the historical development as well as from the different cultures.

c. Ethnomathematics curriculum can be focused on children’s culture which means that mathematics should start from their world.

d. Ethnomathematical curriculum could set up the mathematics classroom into cultural context situation by considering different cultural values, beliefs and the way to learn specific theories.

e. Ethnomathematics curriculum can be developed by integrating mathematical concepts and practices to the students’ culture in order to help them understand how mathematical ideas develop and how to apply in their lives.

Additional to this, several possibilities approach by previous studies can be considered as a part of the development of ethnomathematics curriculum in the mathematics classroom.
3.1. Problem posing-problem solving approach
This approach has required the students to creative propose as well as solving the problem. Mahendra et al. [15] distinguish problem posing and problem-solving as: for problem posing, students require to redefine the problems given, and teachers need to facilitate them to solve the problem while for solving the problem logically and systematically are the critical points of problem-solving.

By learning how to pose the problem make the students develop their creativity based on their experience. If the students can pose their problem, they will improve the conceptual understanding by themselves then they will proceed smoothly in solving the problem.

3.2. Open-ended approach
Suryawan and Sariyasa [16] tried to integrate the ethnomathematics into an open-ended problem where the focus is on the teaching materials. In their finding, the insertion of ethnomathematics in to open-ended problem gives the students a new environment in learning mathematics by considering various ethnics and cultures.

Open-ended problem-based learning model facilitated the students to do problem-solving activities and use their reasoning to solve the problem. Open-ended problem stimulates students’ ability not only to pose and solve the problem but also to make a generalization and find the relation between the concepts [16]. By integrating the ethnomathematics to this open-ended problem, the problem given is coming from the cultural conflict that makes it closer to the students’ daily life.

3.3. Realistic Mathematics Education (RME) approach
The philosophy of the RME approach where mathematics must connect to reality and consider as a part of human activity [17] will make mathematics more meaningful for the students. The fact itself not only relate to the concrete situation but also it can be arising from the imaginary situation. Students need to be more active and reinvent by themselves by the guide of the teacher.

As mention by Gravemeijer [18], the model that develop by the students is the crucial part in the level of RME. The students are required to find the model of the situation given then using the model for generalization to reach formal mathematics. Various local instruction theories were developed by using the principal of RME as well which means this approach seems like to be the complement of the previous approaches.

4. Strength and weakness of problem solving-problem posing, open-ended approach, and realistic mathematics education approach
Based on those previous studies, the summary of the strength and weakness of those consideration curriculum approaches (problem posing-problem solving, open-ended and realistic mathematics education) are showing in Table 1.

The table shows that realistic mathematics education is an appropriate approach to be integrated with ethnomathematics compare to the other two approaches. It is because of the principle of this approach which put emphasize on students’ creation. Different type of students’ model can make them aware of another idea and point of view from a different angle. The same focus as well with ethnomathematics, the student comes together from the different cultural background and being put in the classroom which has variety type of students’ character, culture, etc. The importance of this approach is how to make a deal in the classroom to reach the same idea to achieve the objective of the lesson. This type of curriculum also has a positive impact as mention by Lipka, J [19] and Adam, S. [14] that students will be able to recognize mathematics as part of their life, make mathematics meaningful connection as well as deepen their understanding for all forms of mathematics.
### Table 1. Strength and weakness of those consideration curriculum approaches

| Approaches                              | Strength                                                                                                                                                                                                 | Weakness                                                                                                                                                                                                 |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Problem solving-problem posing       | 1. Students are able to develop their mathematical thinking and adaptive reasoning as well as motivated to challenges themselves during the teaching-learning process.                                              | 1. Students have difficulties imagine the problem.                                                                                                                                                         |
| 2. Open-ended problem                   | 2. Students are free to explain their answer because not only one single right answer; Motivated the low students to provide their answer; Students’ creativity can be found from this approach.            | 2. Teachers should be able to organize the class in facilitating all the students’ answer; A little bit difficult to generalize the answers.                                                               |
| 3. Realistic Mathematics Education      | 3. RME approach provides a clear understanding to students about the relationship between mathematics and daily life as well as the usefulness of mathematics in general for humans; Mathematics is a field of study that can be constructed and developed by students; How to solve a problem or the problem should not be single, and do not have to be the same with each other; The process of learning mathematics is the main concern and do so, they need to find out for themselves the mathematical concepts by guidance of the teacher. | 3. The test based contextual problem is not easy to be found for any mathematical topics; Learning process in RME more complicated than conventional method; The selection of props must be meticulous so that it can help the process of students’ way of thinking; Teacher finds the difficulty to make connection between other mathematics strands (integrated different mathematics strands). |

By integrate ethnomathematics and realistic mathematics education, the students will start their understanding from phenomena/situation either in the mathematical domain or specific domain. Any activities though relate to the culture or daily activity, consciously or unconsciously done in daily life promotes the activity within a culture [20]. Based on the Adam, S [14] as well consider what kind of ethnomathematics in the context of situational level which consists of mathematical activities from other culture and their own culture. This idea is also similar to Bishop [21] where accommodation approaches attempt to restructure the curriculum based on the children’s culture. Another important thing is the utilization of the model. To bridge the gap between informal and formal mathematics, this model can be an essential device to help the student.

#### 5. Consideration of example

One of the examples that can be found is related to the recent works of Peni [22] were using traditional games as one of the cultural activities and realistic mathematics education as a method to develop students’ understanding on the word problem. The result shows that having experience in
the situation of the game helps the students to imagine the problem, and then they will be able to
make the model and extend the model for the other mathematics domain. Another example can be
found in the pattern of traditional clothes such as batik and woven fabric. The variety of the plan
figures can be found, and at the end of generalization, the concept can be extended to the find the
characteristics as well.

6. Conclusion
In the conclusion of this research, Realistic Mathematics Education approach which has same focus
with ethnomathematics: mathematics as human activity [17,7,18] can be one of the reasons to
consider the new curriculum approach in the mathematics classroom. By consider Realistic
Mathematics Education approach as a method, we can employ ethnomathematics in each level to
reach the objective of mathematics curriculum education.

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