Ethnomathematics: Utilizing South Sumatra’s cultures to emphasize prospective teachers’ creativity in creating mathematical problems

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Abstract. This Study aims to describe prospective teachers’ creativity in producing mathematical problems based on South Sumatra’s Cultures. The subjects are 30 3rd-year mathematics study program students of Sriwijaya University. These students are divided to 8 groups of three or four. Each group assigned to create 2 mathematical problem from the same cultural context in two weeks. The results show that there is improvement for students’ fluency, flexibility, and elaboration aspect. Students are able to create more than one mathematical problems, proposes more than one resolution, and some of them are able to evaluate those alternatives. There is no significant improvement in the aspect of originality. The topic engaged with the culture tend to be uniform, with most groups employ the concept of geometry and transformation. Therefore, it is suggested to conduct further research on ethnomodeling.

1. Introduction
Possessing Higher Order Thinking Skills, like problem solving skill, is very important for student in globalization era [1]. It’s not only important for them in classroom activity, but also later in work and real life situation [2]. In Indonesia, students tend to have intermediate to poor Higher Order Thinking Skills [3]. PISA results imply that Indonesian students consistently have lower reasoning and problem solving skills compared to other countries [4]. One of many factors that cause this phenomenon is only few teachers employ problem based learning [5]. Although rapidly growing research on the benefit of problem solving instructional in past decade [1, 2, 6] and it is principally compulsive for Indonesian teachers to demonstrate it [7], direct learning seems to still dominate classroom instruction due to classic reasons, like limited time [5]. Furthermore, it is suspected that some teachers don’t have adequate ability to create and conduct a learning process using mathematical problem [7]. Therefore, it is urgent to prepare prospective mathematics teachers to have high competence to solve and create legitimate mathematical problems.

On the other hand, some research suggest that students’ poor performances is because they lost interest in learning mathematics [8]. They have inferior perception towards mathematics [9, 10], like mathematics is hard [9] and many say that mathematics has no significant role in their lives [10]. This kind of perception is an implication of a meaningless learning [9]. In order to make meaningful learning process, teachers must integrate mathematical concepts with students’ environment [11]. This strategy helps students to understand that mathematics is not just a collection abstract concepts, but moreover, has important use for their daily lives.
Employing traditional art and culture that existed around students is expected to help students have better interest and performance in learning mathematics and solving mathematical problem. Ethnomathematics is mathematics applied and developed in a particular society [12]. It is an idea of exploring “traditional group” mathematics concepts other than more popular Europe concepts [12, 13]. In practices, ethnomathematics enable teachers to integrate these ethnicities with well-known mathematics concepts [14]. Many researchers try to explore their cultural heritages and associate them with geometry, geometry transformation, or number pattern [10, 15, 16]. Benefits of learning with ethnomathematics are reducing abstraction of mathematics [17], appreciating other students that have different culture [18], and developing positive attitude towards mathematics [19].

Since it is arguably very important to improve student’s engagement in mathematics instruction as well as their problem solving skill, then mathematics teacher must have excellent creative thinking ability in order to produce high quality mathematical problems. Creative thinking ability is the highest ability of thinking skill that requires ones to analyze, to evaluate, to reason, and to be critical in order to create original product [20, 21]. Therefore, this research aims to describe how prospective mathematics teachers utilize South Sumatra’s traditional cultures as context for the problems. The quality of the problems and the solutions is evaluated to determine the creative thinking skill based on four criteria, namely fluency, flexibility, elaboration, and originality.

Table 1. Indicators of Creative Thinking

| Creative aspects | Criteria |
|------------------|----------|
| Fluency          | In term of creating mathematical problem, subjects are able to produce more than one problem with various mathematical concepts based on a single art/culture/building of Sumatra Selatan. The clarity of the problems must be well-formulate. The purpose of the problem is clear, whether it is open-ended, ill-structured, or well-structured. This is indicated by the consistency of the solution and conclusion offered towards the problem. |
| Flexibility      | This criteria emphasizes on the diversity of the solution. The solution derived from the problem is not solo, means subjects are able to demonstrate various mathematical concepts or approaches in order to solve the problem. |
| Elaboration      | The quality of the problem and solution must be self-evaluated by the subjects. Students are able to give further explanation and critic toward their work. For example the ability to explain the most effective solution. It’s also possible to point out contradictions, errors, obstacles, or limitations throughout the process of creating and solving the problem. |
| Originality      | The problem produced by the students must be original. But more importantly, based on their works, students are able to generate new mathematical concepts. This criteria includes, but not limited to, discovering mathematical concept or implementing existed mathematical concept in different approach. |

2. Method

This research is a descriptive quantitative research. The subjects for this research were 30 3rd-year prospective teachers of mathematics education study program, Universitas Sriwijaya. These subjects were chosen because they already completed most of the educational and mathematics courses, therefore minimize the possibility that the subjects find any obstacle towards determining what material or topic they decide to adapt as well as how they going to present the mathematical problems. These students were divided into 8 groups of 4, where each group created 2 mathematical problems with their resolutions based on one South Sumatra’s art or culture.

Subjects were given 2 weeks to complete the task with one problem must be finished for each week. After the first week, they presented the problem and resolution in front of the class, and other students evaluate them. This process allowed students to create better problem with more comprehensive resolution and possibly give them some idea to formulate next mathematical problem.

Besides that, the researchers also conducted desk evaluation to evaluate the developed mathematical problems based on the indicators of creative thinking given in Table 1. The ability will be divided into
three levels, low, intermediate, and high based on comprehensive evaluation. This process also allow
researchers to identify if there’s any significant improvement from the first to second meeting.

3. Result and Discussion
There were 30 subjects participated in this study with total of 16 mathematical problems and solutions
based on South Sumatra’s cultural context. The list of context and topic explored by student are shown
in Table 2.

| Group | Context (Art/Culture) | Week 1 Material | Topic | Week 2 Material | Topic |
|-------|-----------------------|-----------------|-------|-----------------|-------|
| 1     | Songket              | Transformation  | reflection | Geometry | area       |
| 2     | Batik with songket motif | Transformation | translation | Transformation | rotation |
| 3     | pagoda               | Geometry        | volume    | algebra       | number pattern |
| 4     | Oban Yadikon Rasan | Geometry   | volume    | Geometry | surface area |
| 5     | Batik                | Transformation  | translation | Transformation | transformation composition |
| 6     | Songket              | Transformation  | translation | Transformation | reflection |
| 7     | Limas House          | Geometry        | volume    | Social Arithmetic | cost |
| 8     | Mpek-mpek           | Geometry        | volume    | Integration   | volume |

Based on the desk evaluation and presentation, the level of creative thinking skill of each groups
can be seen in Table 3.

3.1. Fluency
Fluency emphasizes on student’s ability to create more than one problem with various mathematical
concept from a single cultural context of Sumatra Selatan [22, 23, 24]. Student’s ability of this aspect
only determined by the second week since they only obligate to make one problem each week. As seen
in Table 3, 62.5% of students have intermediate to high level of fluency. Lower students are able to
make more than one problem with one context. However, the material covered by those problem is the
same. For example group 6 who take Songket as the context basically has the same topic to be explored.
Compared to group 1 who successfully employed various concepts contained in a single context. They
are able to identify reflection and area of a plane as the topic of the problem they create from Songket.
For intermediate group, they create different problem with the same material but different topic. For
example group 5 chooses Batik as the context. They identify single transformation at the first week, then

![Research Procedure](image)

Figure 1. Research Procedure
the next week they identify composition transformation as the topic. The type of their problem is also clear and develop in difficulties level. The first meeting was well-structured problem and then the second week was open-ended problem. On the other hand, group 7 who is also classified as intermediate group, identify a completely different material and topic, but failed the consistency between the problem and the solution.

| Group | Context (Art/Culture) | Week 1 Fluency | Flexibility | Elaboration | Originality | Week 2 Fluency | Flexibility | Elaboration | Originality |
|-------|-----------------------|----------------|-------------|-------------|-------------|----------------|-------------|-------------|-------------|
| 1     | Songket               | 1              | 1           | 1           | 3           | 3              | 3           | 1           |
| 2     | Batik Songket         | 1              | 2           | 1           | 1           | 1              | 1           | 1           |
| 3     | Pagoda                | 1              | 1           | 1           | 1           | 3              | 1           | 1           |
| 4     | Oban Yadikon Rasan    | 1              | 1           | 1           | 1           | 2              | 1           | 1           |
| 5     | Batik                 | 1              | 1           | 1           | 1           | 2              | 2           | 1           |
| 6     | Songket               | 1              | 2           | 1           | 1           | 1              | 1           | 1           |
| 7     | Limas House           | 1              | 1           | 1           | 2           | 1              | 2           | 1           |
| 8     | Mpek-mpek             | 1              | 1           | 2           | 1           | 3              | 3           | 2           |
| %     | Low                   | 100            | 75          | 87.5        | 100         | 37.5           | 50          | 62.5        | 100         |
|       | Intermediate          | 0              | 0           | 0           | 0           | 37.5           | 25          | 25          | 25          |
|       | High                  | 0              | 0           | 0           | 0           | 37.5           | 25          | 12.5        | 0           |

3.2. Flexibility
For this aspect of creative thinking, there was improvement from the first week to the second week. Half of the group categorized as intermediate to high level. These groups are able to give more than one resolutions or approaches to solve the problem even when the problem is not an open ended problem [25, 26]. For instance group 1. This group gives three ways to solve the problem at the second meeting. They successfully employ different mathematical concepts, like trigonometry and geometry as shown in Figure 2. Group 8 also categorized as high level since they are able to employ geometry and integration concepts in order to find area of a dent sphere.

3.3. Elaboration
This aspect of creative thinking emphasize not only how complex the solution is, but also the ability to assess which solution is the most effective solution [20, 21, 25, 26]. This elaboration aimed to challenge students ability to evaluate the problems and their solutions, hence, it is highly suggested that they are able to state the contradictions, errors, obstacles, or limitations. Especially when we use real world context in a problem, it is very important to explain the limitation and assumption of real world condition that may affect the solution of the problem. Most groups (62.5%) settle with a “correct” solution. They didn’t try to elaborate why their answer fitted the most or identify if there’s any contradiction between premises. However, group 1 successfully identified the simplest way towards the solution. Their arguments extend to the statement that “there’s no particular standard of the most effective way to solve this problem. Because Cara 2, for example, may be effective for students once they already know the formula for a triangle with one angle and two sides given. However, Cara 3 is the most basic and common resolution and probably the most effective way to solve the problem especially for primary and secondary students”.
Figure 2. Problem and Resolution of Group 1

On the other hand, group 8 is able to point out the obstacle towards one solution and then gives alternative with slightly more complex concept but more comprehend solution as shown in Figure 3. However, there is still a big question whether the solution they offered is the correct one or not. The concept they use is integration, specifically disk formula. They started with the function of full circle, which means the area covered are both above and below x-axis. When they take full revolution (360°), it means that the volume is basically twice of the desired result. Furthermore, from Figure 2 and Figure 3, there is a sense of mathematical modeling enclosed. It can be seen from students’ work that they were able to generate specific function and rules to be applied in solving the problem [27].
3.4. Originality
The higher aspect of creative thinking is originality. This aspect emphasizes on novelty and produce original product [25]. In this case, students are expected to be able to discover new mathematical concept based of philosophy of that particular culture or implementing existed mathematical concept in different approach. Unfortunately, from two meetings, there is no indication that students fulfil the criteria of originality.

3.5. Overall performance
Note that in Table 3, most of the materials explored by the students are transformation and geometry. Some group even apply the same material for each week. This uniformity is potentially happens for...
many reason. The first factor is lack of observation [28]. In order to successfully create diverse problems, one must take time to explore many literature and existed problems to see if there’s any idea that they can generate from those readings. The tendency of Indonesian students is to wait until the day before due date to work on the task [29]. This behavior will not only make the students have lack of creativity, but also the quality of the problem [28]. Most of the work done when they finish creating the resolution. They don’t take enough time look back at the consistency of the solution towards the question. That’s why some of the solution don’t have any alternatives as comparison to assess which solution is the easiest to be applied.

The second possibility is lack of experience [7]. As explained before, the subject choses for this study is 3rd year students of mathematics education with assumption that they already completed most of the mathematics as well as educational courses. However, many classroom hold cooperative learning as the method. This method is good but sometimes some students will depend too much toward more comprehend students. Since this task is also a group task, there is huge possibility that this behavior is carried away. Their lack of contribution in the discussion make the idea will only come from one individual and therefore lack of variation in terms of the material and the solution.

The third possibility is the teacher didn’t teach them to be creative [30]. Ideally, developing creative thinking in classroom activity will only happen if the teacher allow the students to be creative by comprehensive instructional plan, media, and material [7]. However, due to classic reason of limited time and focusing on national examination, teachers tend to give their students routine problems that usually occur in national exam. This patterns causes losing of opportunity to train and demonstrate how creative students are. In this case, the behavior effect prospective mathematics teachers in their creativity to create high quality and diverse problems. Once they become a teacher, this cycle will be endless.

On the other hand, generally, there is improvement in the aspect of fluency, flexibility, and elaboration. Ethnomathematics allows students to develop their investigation skill by assessing and selecting appropriate mathematical concept towards a contextual culture [21, 31]. The same improvement also observed on flexibility aspect where students were encouraged to consider alternative solutions towards a problem [31]. Lastly, students’ elaboration skill also increases. It’s because in creating a problem they have to consider every single aspects and throughout the process, students will gain critical thinking, to question every decisions and steps they make [31, 32].

4. Conclusion

From the result, it is suggested that through mathematical problem making, with the use of South Sumatra’s culture as the context, students’ creative thinking skill improved. Students’ fluency improves by 62.5% while both flexibility and elaboration improve by 25% classically. Many factors predicted to explain this result, such as investigation process in making the problem, continuous thinking to find the solution and alternatives, and the role of the culture itself. Furthermore, there’s occurrence of ethnomodeling throughout the process. However, this prediction needs to be further examined in order to find empirical proof. On the other hand, there is no improvement in the aspect of originality. Students are not able to generate any new knowledge or theory. This does make sense, since they only have two weeks to propose the problem. Hence, it is important to engage students’ thesis with this study, not only to improve their creative thinking skill, but also preserve traditional knowledge. Moreover, classically, the topics of the problems seem to be uniform. It is important for students to do more observations and readings, in order to gain more experience. Therefore, once they become mathematics teacher, they can create better, more various, and more comprehensive mathematical problems.

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