Primary School Pre-Service Teacher's Perspectives on Cultural Needs in Developing Culture-Based Mathematics' Learning Materials

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Abstract: An integrated concept of culture should be understood by students of primary mathematics teaching education program before they implement culture-based learning in primary schools. This study aims to recognize and analyze students' perspectives on the concept of culture. Both of recognition and analysis are done in order to determine students' needs in the framework of developing culture-based teaching materials in the Department of Primary Teacher Education (PGSD). This study adopts an integrated concept of culture that contains three aspects, namely values, contexts and artifacts. Data were obtained from 278 PGSD students (respondents) who have passed the course of primary mathematics education. Date were obtained through two instruments, questionnaire and lessons' implementation plans (RPP). Data then analyzed in quantitative (for questionnaire) and qualitative (Critical Discourse Analysis for the RPPs) modes. Opinions of students were positive in general towards the need for culture-based teaching materials, where they realize that culture is a part of real life that mathematics tries to solve its problems. Very few of the students still believe in separation between culture and mathematics. Results also show that students rarely experience culture-based learning and rarely get involved in cultural activity during their course.

1 INTRODUCTION

What will be envisioned in our minds when we hear the word 'culture'? what will people around us, like pre-service teacher students, say about it?. As we were preparing this study, one of our interviewee said: "the culture has begun to be forgotten, especially in a modern environment".

Technological developments in this era of rapid globalization, not only provide many facilities for human life, but also a direct or indirect negative impact for the world of education and exceed it to the world of citizenship and belonging. In Indonesia nowadays, 84% of citizens have cell-phones. Moreover, with the vast presence of smart phones, it is familiar now to see children, and even babies, play with gadgets. The more children are exposed to globalized entertainment floods, with American settings in general, through TVs and gadgets; the less they have chances to know about their communities, environments and actually culture! Culture, in our point of view, is not limited to traditional things, culture is that general context of psychological, social and material surrounding us, yesterday, tomorrow and of course today.

The abundance of Indonesian children from their noble culture and their low ability to solve story problems becomes urgent duty for educators, especially mathematics educators at the primary school level. Primary school children who are, cognitively, in concrete operational phase, should be able to build new concepts in mathematics that are learnt meaningfully. Being meaningful means well-connected to their selves, natural, social and material environments surroundings them. Being meaningful may be realized by getting back to know, explore, and preserve those settings that constitute together Indonesian culture. Thus, learning mathematics is not just learning to count, but also conserve the noble culture of the nation.

Based on the results of discussions the researcher had with mathematics education specialists from Michigan State University, learning mathematics in primary schools should not abandon the existing culture in the student environment. Culture here, not only limited to the art, dance or food that is traditional, but also on the daily events that exist in the student environment. Mathematics learning that relates to the problems around students will help the students in facing the problems they encounter.

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Students of PGSD (Department of Education for Primary School Teacher in Yogyakarta State University, Indonesia), as prospective primary school teachers, should be empowered to teach mathematics that pay more attention to the cultural values of the nation and reconnect students to their environments.

Empowering pre-service teachers to teach such culture-based mathematics should start with infusing curricula in PGSD with cultural aspects, especially the integrated concept of culture. Integrated concept of culture becomes an urgent need because, as we were preparing our recent study, most PGSD students appeared to have partial concepts of it.

2 CULTURE IN MATHEMATICS EDUCATION

2.1 The Meaning of Culture

Robert Kohls in Wintergerst (2011) states that "Culture is an integrated system of learned behavior patterns that are characteristic of any given society. Culture refers to the total way of life of particular groups of people. It includes everything that a group of people thinks, says, does, and makes. Its systems of attitudes and feeling. Culture is learned and transmitted from generation to generation". In this regard, Wintergerst notices that culture can be seen from different disciplinary perspectives. For example, anthropologists view culture as the perspective of human studies. Sociologists view culture as social relationships between people and their groups. Psychologists view culture as a phenomenon related to mind and behavior. Meanwhile, linguists focus, primarily, on language practice. To be briefly stated, "Culture is a universal fact of human life".

Saifer (2011), goes in the same current as states that: "culture can be defined as a way of life that relates to socially transmitted habits, customs, traditions, and beliefs that characterize a particular group of people at a particular time". Culture influences the way people learn, solve problems, and teach". Therefore, learning mathematics in primary school, as a learning and teaching activity, cannot be isolated from the existing culture in the student and teacher environment. Actually, school math aims to help students overcome the problems they encounter in their environment using mathematical methods. Some of the following figures clarify the cultural significance of mathematics in primary school.

K.H. Dewantara (2013) states that culture is the fruit of human civilization or human mind. In Bahasa Indonesia, the word civilization means 'peradaban'. Peradaban comes from the root 'adab', which means 'virtue of total nature of human mind'. The researcher proposes the phrase 'total nature of human mind' because that is the way Malay language represents 'mind'. Mind in Malay culture is 'budi', budi is not limited to cognitive functions of mind, but exceeds it to the emotional, wills, and even supernatural functions. To sum it up, culture in Indonesian perspective is related to civilization, and total existence experience of man.

According to Dewantara (2013), "all cultures are orderly, beautiful, useful, sublime, giving a sense of peace, happy, happy, and so on. Culture is the result of the struggle of human life". Dewantara even tries to explain culture by dividing it into elements, based on man's mind functions. According to Dewantara, human mind encompasses all the movements of mind, taste, and will, so that culture can be divided into entities of thought (e.g. science, education and teaching, philosophy), entities of feeling (e.g. all noble character, customs, justice, religion, arts, temples, batik, wicker, wayang and so on), and entities of will (e.g. agriculture, shipping, buildings, etc.). Culture never has an everlasting existence, but is constantly changing because of the changing nature and the age. Sometimes culture generally benefits human civilization. Other times, culture may instead endanger civilization and even life! Therefore, we may always sustain a sort of critical thought that enables us to adapt our culture to the ever-changing demands of contexts surrounding us.

In line with the opinion of K.H. Dewantara, Honigmann in Koentjaraningrat (1990) states that there are three forms of culture, namely ideas, activities, and artifacts. Following is a brief explanation of that trilogy of culture.

- Culture as ideas, values and norms.
- Culture as patterned activities or actions in the community, also called the social system. This social system consists of human activities that interact with each other and are concrete, happening around us every day, observable, photographed and documented.
- Culture as artifacts, objects of human works. This type of culture is also called the physical culture so that the most concrete, can be objects that can be touched, seen, and photographed.

Another famous author that tries to construct the concept of culture is Lev Vygotsky (1896-1934), a Russian psychologist, as he proposes Cognitive-Construction theory. Theory of cognitive-

Construction assumes the active role of learners (students) in building their own knowledge. Vygotsky improves Piaget's ideas, as he specifically looks at how social interactions and collaborations proceed in learner's learning. Piaget argues that the development of one's character has an end point and consists of four major growth periods. Those periods are, in order, (1) sensorimotor, (2) preoperational, (3) concrete operations, and (4) formal operations.

In the contrary, Vygotsky believes that character's development is a life-long process that is too complex to be defined gradually (Driscoll, 1994). Learning process will occur efficiently and effectively if learners learn cooperatively with their friends in a supportive and guided environment, accompanied by a more capable person or an adult, such as a teacher. The theory formulated by Vygotsky includes (1) culture, (2) language, and (3) the zone of proximal development (ZPD).

Vygotsky argues that the culture and social environment of a child is paramount in influencing the formation of their knowledge. Children learn through songs, languages, arts, and games, as culture affects the learning process. A person's mind must be understood from the social and cultural background and history. Besides, Vygotsky agrees with Piaget as emphasizing the importance of an individual's active role in constructing his knowledge. In addition to culture, language also plays an important role in the process of cognitive development of children. There is a clear relationship between language development and cognitive development of children.

The third component in Vygotsky's theory is 'Zone of Proximal Development' (ZPD). In this regard, Vygotsky states that "what children can do with help today will be able to do it on their own tomorrow" (Vygotsky, p.81, 1978). ZPD implies that a child learns by building or collecting his own knowledge, and in the same time affected by social context around her. This opinion is supported by Bruner, co-founder of constructivist theory. Bruner's theoretical framework is based on the theme that learners build ideas or concepts based on new existing knowledge. Learning is an active process. Aspects of the process include selection and transformation of information, decision making, generate hypotheses, and the meaning-making of information and experience.

Bruner postulates three stages of intellectual development, (1) the enactive stage, (2) the iconic stage, and (3) the symbolic stage. At an enactive stage, children learn an active knowledge by using concrete objects or through real and contextual situations. In the iconic stage, children learn and gain knowledge through images or graphs that are images of the manipulated objects. Children do not directly interact with real objects as in the enactive stage. At a symbolic stage, the child learns in the form of abstract symbols used according to the agreement of the people in the field concerned, either verbal symbols (e.g. letters, words, and sentences), mathematical symbols, or symbols / other abstract symbols.

The three-stages of learning proposed above by Bruner are more clarified by four stages of learning by Fruedenthal. Fruedenthal is the founder of Realistic Mathematics Education (RME), which includes concrete mathematics, concrete models, mathematical models, and formal mathematics. RME is closely related to culture-based learning, because it's philosophical foundation (Freudenthal (2002)), assumes that Mathematics should be connected to reality and should be seen as living activity, hence it relates to cultural elements. As Moritz (2011) argues that a mathematician must have mastered the technical framework in which they are placed.

Based on previous opinions of famous researcher mentioned above, the meaning of culture in learning mathematics can be explained as follows in figure 1.

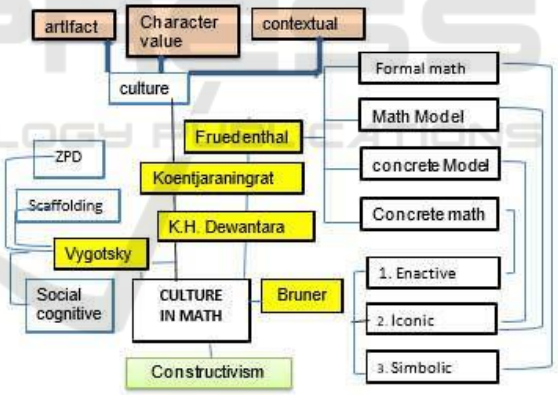

Figure 1: Concept map of culture based mathematics learning.

2.2 Implementation of Culture-Based Mathematics Learning

Albanese (2015) found that the potential of working with ethno mathematical micro projects about other signs of cultural identity and to begin with, the curriculum of primary education may be the most accessible to work with. Cimen (2014) argue that mathematics can be relative among cultural perspectives and social groups, so it can be developed as a result of various activities based on practices and experiences of these cultural groups. Based on

previous discussion about the meaning of culture, this article adopts the point of view that culture-based mathematics learning is that kind of learning that links mathematics with the cultural trilogy, namely value/character, social context, and artifact. Here is an example of primary mathematics learning based on that element. In this context, Ghislaine Guedet (2016) argues that children should learn by applying hands-on material and concrete activities. In line with this, Trinick et al (2016) argue that students need to be involved in critical reflections on the processes by which practices and knowledge come to be valued. Therefore, it is important to make the students active in learning and involve the culture that exists in their environment.

2.2.1 Values/Character in the Learning of the Sum of Two Integers

The learning of the summing of two integers using black and white buttons, where black buttons are negative and white buttons are positive. If associated with the culture that exists in Indonesia, then black (magic) is usually indicates evil, while the white indicates good character.

Summing operations of integers may be done by involving white-black or white-red analogues (metaphors), as teacher shows students concrete materials that represent each one. Besides, summing operations of integers may be useful in cultivation of good values in student personality. Four types of summations are explained below (table 1) alongside suggested ways to realize that cultivation.

Table 1: Cultivation values by utilizing four types of integers' summation operations.

No.	Type of summing integers	Metaphores of integers in cultivating values	Examples
1	Summing two positive integers.	Good deed added to another good deed result in more good deeds.	3 + 4 = 7
2	Summing two negative integers	Wrong deed added to another wrong deed result in more wrong deeds.	-3 + (-5) = -8
3	positive integer plus negative integer	The type of result (positive or negative) is determined by considering which actions are more numerous (if the wrong deed is bigger, so the result will be negative and if the good deed is bigger, so the result will be positive).	1 + (-3) = -2 7 + (-3) = 4
4	negative integer plus positive integer	The type of result (positive or negative) is determined by considering which actions are more numerous (if the good deed is bigger, so the result will be positive)	-4 + 6 = 2

Moreover (as in (Rahayu Condro Murti, 2014)) those operations of integers' summation may be utilized in cultivation religious values as follows. (1) two positive integers: as a servant of God, a student should do good deeds as much as possible, so as to save as much reward as possible, (2) two negative integers: a servant of God should not do evil, because it will always be recorded as a sin that will increase continuously if added to other evil, (3) and (4) summing negative and positive integers, gives meaning that a student, as a human being, may do good or wrong deeds, but he should always try to do more (add) good deeds (positive integers), so that when his deeds are to be weighed in the hereafter, good deeds will ultimately exceed the wrong ones (negative integers).

2.2.2 Contextualizing Two Natural Numbers Multiplication

Students usually face the concept of two natural numbers multiplication in everyday life. The following figure 2 is an example of a multiplicity of two natural numbers. This example in figure 2 is introducing the concept to second grade students of primary school.

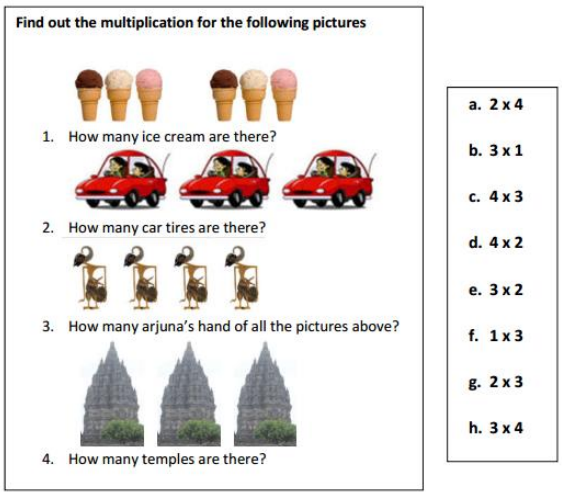

Figure 2: Introducing the concept of two natural numbers multiplication.

Multiplication of two numbers or other number operations can also be found in the existing buying and selling activities in the modern market (mall) and traditional markets, such as the following floating markets (figure 3), where floating markets are special trait of archipelagic nature of Indonesia.

Figure 3: Floating markets in archipelagic Indonesia.

2.2.3 Primary Mathematics at Prambanan Temple (Artifact)

Learning primary mathematics may carried out in cultural artifacts context. One of famous Indonesian culture artifacts is Hindu Temple of Prambanan, which is located in the heritage city of Yogyakarta. Within that huge temple complex, many of primary mathematics may be done. Starting from number learning to geometry learning, from simple to more complex forms. For example, students may be asked to count the number of statues in the entire temple, the number of stairs in the entire temple, the number of corners on the entire temple, the number of doors on the entire temple, the summits of the entire temple, the number of animals' figures in the temple relief, the number of hands' figures on a certain statue, … etc.

Moreover, primary mathematics can be done through the location map of temple, the scale of the temple size (length and width) or the scale of the temple distance from a certain place (figure 4). In Prambanan, there are a lot of shapes, either flat or space shapes. Students may learn primary geometry by calculating various dimensions of space shapes existing in the building, such as the area of the temple, the width of the stairs, and so on.

Figure 4: Measuring one temple (standard and nonstandard length unit).

3 PGSD STUDENTS' PERSPECTIVES ON CULTURE CONCEPT IN PRIMARY MATHEMATICS LEARNING

3.1 PGSD Students' Perspective on Culture Concept Based on Questionnaire

This study defines PGSD students' perspectives as opinions of PGSD students on 'culture' concept within the process of developing culture-based primary mathematics learning materials. Those students are 278 respondents who have passed the course of mathematics education. Those students were asked questions around the importance of learning culture-based primary mathematics.

Researcher distributes questionnaires in the form of statements related to the development of cultural-based teaching materials. Applied questionnaire is based on the trilogy of cultural elements, namely value / character, social context, and artifacts (each contains 6 statements). Respondents fill questionnaire by giving check mark "√" according to their experience, on score with 4 scales. Here is the result of data analysis from the questionnaire.

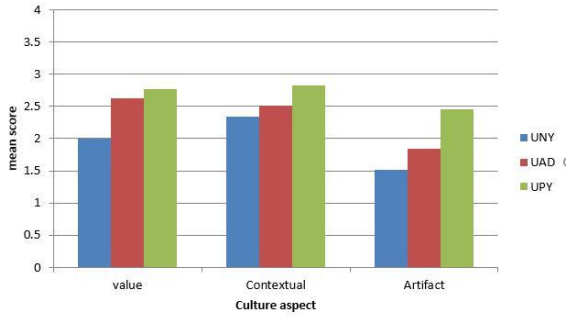

Figure 5: Culture aspect mean score of student.

Based on the figure 5 above, primary mathematics learning PGSD students experienced fells in the rare category (score 2). On the "value" aspect, the average score is 2.266, which means that PGSD students experience is rarely related to values/character. On the "contextual" aspect, the average score is 2.559, it also means that students' experience is rarely associated with contextualized mathematics learning. Nevertheless, this contextual aspect is the highest score compared to the other two cultural aspects. The "artifact" mean score is the lowest cultural aspect (1.938) in the student experience of the primary school mathematics lectures.

3.2 PGSD Students' Perspectives on Culture Concept Based on Fairclough's Framework of Critical Discourse Analysis (CDA)

Fairclough (1995) argues that language analysis can reveal the structure of relations and ideology that underlies a discourse. This language analysis can be done in 3 levels, namely at the level of the text itself, at the level of discourse practice, and at the socio-cultural level. In this paper the CDA is conducted only at the level of the text itself which analyzes the answers of the students about whether the development of the primary mathematics teaching materials needs to be carried out or not. Students were also asked to mention their opinions backed by sufficient reasons. Researcher, also, analyzes students' opinions as shown from their lessons' implementation plans (RPP). Following the results of both analyses in detail. Answers and RPPs are analyzed to extract students' representations of the concept of 'culture'.

3.2.1 CDA of Students' Answers

276 students (out of 278) declared the need to develop cultural-based primary mathematics teaching materials. Remembering that students' culture-based learning experience in PGSD, in the course of 'Mathematics Education', is rare, so such finding does make sense. Such finding also indicates that the students already have an awareness of the importance of linking the learning of mathematics with culture. Ylva Jannok Nutti (2013) found that cultural-based mathematics learning at Sami's school were mainly challenged by external obstacles, for example lack of textbooks that prevented culture-based implementation. Other researcher, Chahine and Kinuthia (2013) was successfully used the Zulu culture called Beadwork and Basketery in developing mathematical knowledge of students and disseminating Zulu cultural values to their students. Therefore, teaching materials that provide examples of cultural-based mathematics learning in elementary schools become important to develop Here's the CDA of 10 students' opinions on the concept of 'culture' (Table 2).

Table 2: CDA of 10 students' opinions endorsing the importance of culture-based mathematics teaching materials.

No	Students' Answers	Representations of 'Culture'
1	Yes, so children do not forget the culture and history it has	Culture as a monuments of the ancestors
2	Yes, because humans will definitely need a culture in their life in the future, and better can be taught from primary school	There is separation between man and culture, whereas the existence of culture because of human being
3	Yes, culture is a real part of human life. The mathematical substance that students have to master will become more plausible and more easily mastered if they are integrated with mathematics learning.	Paying attention to the contextual aspect of culture, and aware that culture is an integral part of human life.
4	Yes, cultural-based mathematics learning is a form of contextualization of matter because culture exists because of human existence itself.	Paying attention to the contextual aspect, also understands the integrated nature of the relation between human and culture; culture exists because of human existence
5	Yes, because in the future PGSD graduates will live in the middle of a cultured society, if from the time of	The life of a cultured society becomes the spirit of cultural-based mathematics learning

No	Students' Answers	Representations of 'Culture'
	education PGSD students already know the mathematics based culture then in the future PGSD students will have the ability and skills of math and supported by a strong cultural identity.	
6	Yes, the cultural aspects that are integrated in mathematics learning, will make the material more meaningful and become more easily understood by the students	Mathematical meaning-making occurs by relating it to the cultural aspect
7	Yes, if you can do lessons based on culture, you may love culture itself.	Using the expression 'love' of culture shows culture as a traditional entity.
8	Yes, mathematics need to be associated with positive values so as to strengthen the student's character. Artifacts and contextual help students learn mathematics that is close to everyday life,	This answer shows understanding culture as a whole; values, contextual and artifacts.
9	Yes, because during this course learning mathematics rarely pays attention to the values of education, (we are) only motivated to complete the achievement of cognitive competence of the course	This answer shows awareness of the importance of strengthening values' education. However, it is limited to value aspect of culture concept.
10	Yes, for the mathematical material to be closer to the student environment, the material is not abstract and easily understood by the student	Shows culture as a social context

As for two of the 278 respondents who declared no need to do the development of teaching materials of cultural-based mathematics education, their answers are explained and critically analyzed below (table 3).

Table 3: CDA of 2 students' opinions opposing the importance of culture-based mathematics teaching materials.

No	Students' Answers	Representations of 'Culture'
1	It is not necessary, because the mathematical point is not the focus of culture	The notion that math is not the focus of culture, suggests the separation between culture and mathematics, although mathematics is a representation of the real world, where culture actually exists. This proves that the student has not yet understood the meaning of culture. He still thinks culture is only related to historical or traditional entities.
2	No, because there are other courses that cover that area (cultural values)	Culture is represented as a course that is just enough to be introduced to students, separating math from culture, and shows vague conception of culture.

3.2.2 CDA of Students' RPPs

Out of 278 respondents, 10 RPPs were taken from their work while attending lectures on primary mathematics education. RPP analysis is done by considering the RPP as a whole and by looking for the trilogy of culture in it, namely value / character, contextual, and artifacts. Of the 10 RPPs, only one RPP raises the trilogy of culture. However, within that RPP, the aspect of values is not explicit. It is implicit in apperception, and it has not yet emerged in the core activities or lessons learned. The contextual aspect is also implicit within apperception, although it should arise in the core activities of learning. As Ernest (2016) argues in a broad sense, mathematics is always related to human's life, both individually and socially. Thus, contextual learning becomes important. Furthermore, Boris Reliable and Janette Bobis (2004) stated that teaching mathematics should relate mathematics to real life situation. Artifacts that are presented have not involved traditional. The other Nine RPPs focus more on formal mathematics learning and learning mathematics using mathematical symbols. Such an orientation of focusing in formal mathematics does not match the characteristics of primary students who are still in concrete operational stage. Below (table 4) is an

explanation of the CDA results of the only one RPP that reflects the trilogy of culture.

Table 4: CDA of the only one student's rpp that represents the trilogy of culture (values, contexts and artifacts).

Culture's aspect	Analysis of RPP
Value	Value of justice is implied in the story of sharing that is relevant to the mathematical material.
Contextual	Apperception given in the form of stories about the relationship of children with parents.
Artifacts	Practicing uses star paper to explain the multiplicity of counting.

Learning mathematics involving culture is not just clarifying the concept but also can make students more interested in math. In line with the research results from Yusuf et al (2010) that this might even encourage our younger ones who dread mathematics to have more interest in the subject.

4 CONCLUSIONS

Pre-service primary mathematics teacher students' opinions on the concept of culture were analyzed in the framework of preparing culture-based teaching materials. Generally speaking, students showed awareness of the need to develop such materials, as culture is a part of real life that mathematics tries to solve its problems. Only few students thought that there is no need for such development. However, in their experience, students still rarely involve the trilogy of culture concept (values, contexts and artifacts) in their on-campus learning. That rareness was shown with the average score for the value aspect being 2.466, the contextual aspect 2.559, and the artefact aspect 1.938. All three scores fall into the "rare" category. Therefore, it is important for educators, especially in PGSD to develop their culture-based lectures.

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