A study of local culture utilization on the higher order thinking skills - categorized items

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Abstract. This research was classified into exploration research to determine the usefulness of local culture elements in order to be applied to the items categorized into higher order thinking skills. This research focused on obtaining the example of Mathematics items categorized into higher order thinking skills covering local culture elements as well as the Mathematical topic. The technique of collecting data was conducted based on the principles in ethnographic such as observation, interview, documentation and field notes. The result showed that the HOTS-categorized items and the examples of items utilizing local culture product like motif batik covered the elements of similarity and congruency. Stimulus on local culture could be in the form of text, picture, game, motif or pattern, graphic, table, art craft or other pieces of information from students’ cultures.

1. Introduction

In 2018, Ministry of Industry of the Republic of Indonesia released ten national priorities in an initiative Making Indonesia 4.0. One of which was planning to reorganize educational curriculum by emphasizing on the STEAM (Science, Technology, Engineering, the Arts, and Mathematics) which harmonizing the national education curriculum with the needs of industry in the future [1]. Education and culture cannot be separated because they are intact, comprehensive, and basically needed for every human. The reinforcement of character education has the function to encounter the influence of industry modernization in the educational field because it begins undermining the value of national culture. The interest of society is still relatively low in enjoying the art in which the percentage of painting arts is at 0.86%, plastic arts at 0.54%, and craft arts or craft at 2.17% [2]. The educational purpose is not in the right way anymore because of the lack of student’s awareness to show the identity and cultural values of the nation that can be upheld highly as the characteristics of national education.

Especially for culture, Indonesia has certain characteristics adhering on every individual as well as on group which inherited from generation to generation. A study of culture linking with mathematics covers all fields related to numbers, symbols, graphics, probability, game strategies, and puzzles, changing and modeling [3]. The anthropologist's research gradually suggested that mathematics is the product of human development [4]. Local culture is identified through vocabularies, codes, symbols, ways of thinking and particular activities that characterize the civilization in an area.

Concerning cultural integration towards mathematics learning in school, Abi [5] highlighted that the learners do not need to imagine what they have never experienced, meanwhile they are expected to understand and comprehend because they have done and looked every day and they have even been involved in creating. In education, the teacher delivers not only the knowledge but also the values of
local wisdom in students’ environment [6]. The characteristic of mathematical thinking has been influenced by extensive human diversity such as language, religion, moral, and economics-social-politics [7]. Bishop [8] stated that mathematics today must be understood as cultural knowledge in which all cultures produce language, religious belief, ritual, and food production technique so that it seems that all human cultures produce mathematics. Thus, every cultural group has its own way in learning mathematics like calculating, using numbers, and classifying the object that exists in the surrounding.

The development of mathematics was firstly inseparable from direct observation of the surrounding environment. For instance, a process in measuring, modeling and giving argumentation. The knowledge is factually becoming a basis in constructing the higher knowledge on the further stages. In assessing learning, the teacher is required to assess factual knowledge, concept understanding, computation ability, proper technique application, and practice skill in conducting and communicating statistics [9]. Things to do in understanding the fact are linking, categorizing, manipulating, and using the fact in a new situation to solve the problem [10]. The teacher also needs to interpret and validate the result of the assessment, both from the teacher’s judgment and from external assessment [11]. Mathematics items in school and students’ daily lives are clearly different so that local culture utilization needs to be applied to bridge the students in linking mathematics in both dimensions.

The items covering the elements of Higher Order Thinking Skills (HOTS) are the kinds of standard items constructed internationally. One of the international tests was held in Indonesia as a sample by the Organization for Economic Cooperation and Development (OECD). OECD held the international test Programme for International Student Assessment (PISA) in 2015 about students’ ability in Mathematics and it was stated that Indonesia was in the low order at average value 386 [12]. PISA [13] was used by governments to monitor the performance of their educational systems. The standard test encouraging higher order thinking skills provides an overview of student’s achievement from a country and becomes an external challenge in order to be able to compete in the industrial revolution 4.0.

Ministry of Education [14] elaborated the stages to ensure the quality of the standardized tests, such as determining the purpose of the test, determining the reference to be used, constructing the table of a specification and selecting the items from the existing items collection. HOTS has different levels. The level of students’ abilities and skills in remembering, understanding, and applying is categorized as Lower Order Thinking Skills (LOTS) while analyzing, evaluating, and creating are classified as Higher Order Thinking Skills (HOTS) [15]. Anderson & Krathwohl [15] revised Bloom’s taxonomy by differing the knowledge dimension with the cognitive process dimension. Budiman’s research [16] resulted in items products to measure the higher order thinking skills of students in Junior High School that are valid and reliable. The product results in the items of higher order thinking skills that are still in the form of mathematics items, not in the form of cultural context yet.

According to several studies that have been conducted, it is identified that there is still limited utilization of local culture towards the items categorized HOTS as assessing material. Cultural integration towards mathematics learning has been undertaken, however, the fulfillment of the items covering local culture elements is still limited. This research was focused on how to create the HOTS-categorized items by utilizing local culture as a stimulus for students in solving the problem. Accordingly, the question proposed in this research was how to utilize local culture towards HOTS-categorized items in order to stimulate students in solving mathematics problems. This was also related to the material of mathematics learning correlated contextually. HOTS-categorized items are not fully classified as difficult items, but the kinds of items that involve logical reasoning in a particular context of the problems. The teacher gives HOTS-categorized items to students on the basis of the purpose of learning. Thus, it is necessary to examine local culture utilization on the HOTS-categorized items.

2. Method
The research design used in this study was exploration research in which the information was explored deeply [17]. The procedure of research was conducted from July to September 2018 focusing on obtaining the example of Mathemathic items categorized into higher order thinking skills covering local culture elements as well as the Mathematical topic. Further, qualitative descriptive was used in
this exploration research in explaining and obtaining the whole information extensively and deeply [18].

On the other hand, the approach of this research used ethnographic research to obtain description and analysis comprehensively based on the phenomena in the field of research [17]. In data collection technique, the limitation of research was selected based on ethnographic principles such as observation, interview, documentation, and field notes. Especially for sources of data, it used primary and secondary data. Primary data was obtained from interview result with the teachers from three Senior High Schools in Karanganyar regency related to HOTS-categorized Mathematical topics. While, secondary data was extracted from notes or documentation of learning module, guidance book of writing the instrument of HOTS-categorized items, socio-cultural book 2015, ten Mathematical journals with a cultural approach, and eleven journals of HOTS-categorized items.

3. Results and Discussion

The results of local culture utilization on the HOTS-categorized items were extracted from several stages. Relating to the development of higher order thinking items, [19] proposed eight stages, they were reviewing the literature, developing the operational definition, determining (construction, dimension, and indicator), setting the grid, preparing the items, analyzing the readability and field trial, and analyzing the data. Based on these stages, this research chose the stages that were adapted to the local culture utilization of HOTS-categorized items as follows.

3.1. Theoretical review

This study aimed at examining local culture utilization towards the mathematics items categorized into HOTS. The utilization of culture and mathematics [20] proposed the ethnomathematics concept that means as the mathematics practiced among the culture that can be identified in groups, such as national-ethnic society, labor group, children of a certain age, and professional class. A particular culture is developed based on the history, technique, and ideas to learn how to work using measurement, calculation, conclusion, comparison, classification and ability to model the natural and social environment in which we use those aspects to explain and understand the phenomenon or mathematics [21]. Local culture is defined as all groups identified having knowledge about the regional culture that has particular characteristics.

Batik is the example of the original culture of Indonesia that is well-known in the world. Pattern or motif in batik has the shape or character based on a certain regional culture. Especially in Karanganyar area, there is a famous batik that has been involved in international market namely Girilayu batik [22]. Look at Figure 1, the written batik motif of Girilayu has the elements of mathematics in similarity and congruency.

![Figure 1. The application of similarity and congruency in the motif of Girilayu batik](image)

Figure 1 is one of motif examples of Girilayu batik in which there are still many other motifs that can be identified having the elements of mathematics. Another batik having mathematics elements can be found in Semen Rama batik from Yogyakarta [23] that can be seen more detail in Figure 2.
Reflection

Figure 2. The application of geometry transformation in motif of *Semen Rama batik*

Figure 2 describes the application of geometry transformation in the motif of *Semen Rama batik*. Making this motif can be done by applying reflection of several ornaments using y-axis in the Cartesian coordinate system [23]. To facilitate the students in finding the concepts of mathematics in the design of *batik* can be done by creating the learning design using the design of *batik* as the starting point in drawing *batik* motifs and introducing concept transformation in design learning [23]. This is because mathematics is the study of structure organized from undefined to defined elements, to the axiom or postulate and eventually to the theorem [23]. The values contained in mathematics learning include practice and usage, discipline, culture, social, moral, aesthetic (art/beauty), and recreation value (entertainment) [17]. Therefore, *batik* motifs are one example of the use of local culture in HOTS-categorized items. Other local cultures that utilize mathematics concept can be seen from the temples that can be found in Java.

Level of students' abilities or skills in Analyzing (C4), Evaluating (C5), and Creating (C6) is categorized into Higher Order thinking Skills or abbreviated HOTS [15]. The way of thinking in Analyzing (C4), Evaluating (C5), and Creating (C6) the knowledge skill is higher than that in Remembering (C1), Understanding (C2), and Applying (C3). All things considered, utilizing various local culture is like using a *batik* motif on the HOTS-categorized items. Besides that, the traditional games utilizing mathematics concept are marbles, *engklek*, and *congklak* that can be learning and assessing material in probability theory.

3.2. Operation definition development

The next stage in this research was developing the operational definition from local culture on the variable of arranging the HOTS instrument. The operational definition of local culture covered the resulting product of Indonesian culture, art, and several games containing the elements of mathematics. The operational definition of HOTS is derived from the definition that has been obtained, such as analyzing, evaluating, and creating skills. The operational definition consists of critical and creative thinking skill then developed an indicator [19]. Critical thinking is the ability to evaluate several things like product, idea, and one’s argument [24]. Based on this statement, critical thinking can be defined as the ability in analyzing and evaluating. To think critically, it is needed to involve the thinking ability independently and produce own thoughts or products [24]. This showed that creative thinking is the highest ability at the stage of creating or resulting in the product.

3.3. Determination of constructs, dimensions, and indicators

Developing mathematical activities include mathematical concepts in cultural products in an area in the form of traditional equipment, art, the fabric of *batik* motif, and traditional game. HOTS items measure on metacognitive dimension, so it does not only measure the factual, conceptual, and procedural dimension [25]. Metacognitive dimension describes the ability in connecting several different concepts, interpreting, solving the problems, choosing a problem-solving strategy, finding a new method, arguing, and making the right decision [25]. HOTS cover critical, logical, reflective, metacognitive, and creative thinking [26]. Higher order thinking skills on the metacognitive dimension require critical and creative thinking to solve the problems given.

The indicators of critical thinking are having basic ability, giving the explanation, concluding assumption, questioning the concept, analyzing the concept, synthesizing the relation of the concepts,
determining the result of assumption, using a proper and balanced concept, finding the source of problem, estimating the causes of problem, collecting the information for problem solving, finding several alternative solutions, choosing the alternative or best solution, and evaluating the decision [19]. Indicators of creative thinking are rejecting standard technique, optimizing knowledge, having high motivation and broad interest, having forward orientation or optimism, having interest in challenge/new idea, thinking freely, being dynamic, developing a concept, modifying concept, experiencing trial and error, having an original and new idea [19]. In arranging HOTS items, the indicators use stimulus. Stimulus is interesting and contextual, which means encouraging the curiosity to solve the problem. Cultural utilization becomes an interesting stimulus if applied in the mathematics items of HOTS-categorized. Stimulus in local culture can be in the form of text, picture, motif or pattern, graphic, table, or other pieces of information from students' local culture.

3.4. The items preparation

The items were taken from the institutions that had been tested for the efficacy and accuracy. It could be seen that in Figure 3, the items were at the cognitive level of logical reasoning which was higher order thinking skills. To answer the items on logical reasoning level the students need to be able to remember, understand, and apply the factual, conceptual, and procedural knowledge and also have high logic and reasoning in solving the contextual problems [25]. Mathematics units usually begin with a description of a situation that might be encountered in real life in the form of words and pictures and possibly symbols (e.g. a map for a journey, authentic tables of data, plans for a house), a formula to calculate something practical and a series of questions requiring students to use this information [13]. The characteristics of HOTS items varied greatly from the difficult problem cannot be handled by students, complete the items using several methods, and also have the novelty rather than just a conventional procedure. Thus, HOTS items needed stimulus to attract and impress the students in solving problems.

3.5. HOTS-categorized items and analysis of local culture utilization

Figure 3 shows that the items of reasoning level on the linear equation system of three variables material [25]. Figure 3 contained the problem of a factory that produces several kinds of shoes and will deliver the products to several shops.

Figure 3 explains that based on the result of stimulus analysis of local culture was the type of shoes needed to be changed into batik motif of Girilayu from Karanganyar, batik motif of Semen Rama from Yogyakarta, and the batik of Tegal. For this reason, the question would be changed into a factory
produces three kinds of batik motif: batik motif of Solo, batik of Jepara, and batik of Tegal. The batik will be delivered to boutique A and boutique B with the details as follows, for any pair of shoes was changed into many pieces of batik. In fact, there were several batik motifs that could be an inspiration for a teacher in introducing regional culture in each HOTS-categorized item. Local culture utilization on the HOTS-categorized items of mathematics could be found in some topics like linear equation system, a linear program, probability, and geometry. These topics contained a lot of local culture elements that could be taken and formed as a stimulus in assessing activity. Cultural-based students’ activities in the process of tahu takwa making had the purpose to introduce Kediri culture to students that tahu takwa making could be calculated using the math [27]. Therefore, batik motifs are one example of local cultural products that can be used in HOTS category. Look at Figure 4, in PISA [28] released Mathematics item in Figure 4 having conifer tree theme that shapes the square pattern to protect the apple tree from the wind. Then, the picture of pattern 1 show if there is only one apple tree, so there will be eight conifer trees surrounding it and the number of both trees will increase in the next pattern.

Figure 4. PISA Items [28] of HOTS-categorized

Figure 5. The example of the items adopted items for Senior High School.

Figure 4 explains that the teacher could ask students that if there is a value in which the number of an apple tree is equal with conifer tree, to determine the stages to solve this mathematical problem. Students would answer this question used a critical ability that is analyzing the elements known in the item. Students with problem-solving, critical thinking and decision-making activity would help them in increasing higher order thinking skills [29]. Furthermore, Figure 5 was an item sample in the guidance of writing HOTS items for Sekolah Menengah Atas (SMA)/Senior High School. HOTS items writing for SMA was an item sample from PISA items that utilized plant diversity in Indonesia. Based on the results of interviews with secondary school teachers in Karanganyar, regarding teaching materials that utilize local culture are systems of linear equations, linear programs, probability, and geometry.

In the completing process, students were required to think in a high level that needed critical thinking ability and creativity. Alangui [30] argued that the development of Mathematics Education that is culturally relevant for native students is only able to succeed and be effective if it is done in a broader educational program context. In creative thinking ability towards that question, the students could construct the result of concept analysis so that they could create a new formula in each pattern, then completed the question problem.

According to previous research, it was only found the HOTS-categorized items without associating it with the local culture utilization. Therefore, when the teacher would measure higher order thinking skills, could utilize local culture on the items arranged as a stimulus for students. The following is the presentment of HOTS-categorized items that utilize local culture as a stimulus for students in solving
the problem. (1) A batik craftsman gets an order to make the newest motif by using a basic pattern (see in Figure 6).

![Motif Zone](image)

**Figure 6.** the example of a basic pattern in make motif *batik*.

The provisions required in making *batik* was each pattern was square with size 20 cm x 8 cm. The white area had minimal wide in 100 cm² and had the same width of motif zone on each white side. Help the craftsman to make a Mathematical model that can be used to determine the width of the motif zone on each white side! (2) A batik factory will produce Girilayu batik with the production cost of Rp 3,750,000,00 for one month. The production results during that period were successfully sold and produced three remaining pieces of batik. If the selling price of Girilayu batik is Rp 3,600,000,00 and the profit of each batik is Rp 50,000,00, so the number of batiks sold is.

4. Conclusion
The elements of cultural utilization can be a stimulus for students so that it can be applied to the HOTS-categorized items of mathematics. Stimulus on the local culture can be in the form of text, picture, game, motif or pattern, graphic, table, craft product or other pieces of information from students’ cultures. It means that it can encourage the curiosity and motivation in solving the problem. Learning materials that utilize local culture are the linear equation system, the linear program, probability, and geometry. The results are the HOTS-categorized items and the examples of items utilizing local culture product like motif *batik* covered the elements of similarity and congruency. Therefore, the result would be the foundation or the best reason for the researcher to design higher order thinking skills-categorized items and implement the design local culture in mathematics learning process to solve the problems on future research.

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