The efforts to develop the geometry teaching and learning tools based on acehnese culture through problem based learning in junior high school students

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Abstract. The implementation of mathematics teaching and learning based on the 2013 curriculum in Indonesia requires teachers to develop their own tools. The tools must be designed thoroughly and systematically so that the teaching and learning will be interactive, inspiring, fun, challenging and efficient. The teaching and learning should also motivate the students to actively participate and provide enough space for innovation, creativity, and independence according to their talents, interests, and physical development. However, considering Indonesia’s geographical differences, the teacher needs to develop the learning tools adapted to students’ cultural backgrounds. This study aims to conduct the needs assessment to develop teaching and learning tools on geometry based on Acehnese culture, including the lesson plan, student worksheet, mathematics test, and teaching materials through problem-based learning. This study employed the Dick and Carey model that was conducted for only seven out of ten stages. The observation was carried out at SMPN 1 Meureudu, Aceh. The results are Prototype 1 consisting of the lesson plan, student worksheet, test result, and teaching material by integrating Acehnese culture into the curved side geometry.

1. Introduction
One of the readiness of professional teachers in implementing the 2013 curriculum in Indonesia is to develop their own learning tools. The importance of teachers developing these tools aims to (1) improve the quality of teaching and learning, (2) develop teacher professionalism and (3) accountability of teachers in internal and external quality assurance [1]. Therefore, teachers’ knowledge is needed to design learning tools properly so that they can facilitate classroom learning.

Based on the observations of researchers at several schools in Aceh, mathematics teachers generally have not designed learning tools properly yet. One reason is that the teachers have not considered the cultural background of the students and the learning model used. Even though the teachers already have the tools, some teachers used the tools based on the results of downloading from the internet or copying from colleagues. Some teachers have not designed their own learning tools carried out solely as administrative items. In fact, teachers rarely refer to the learning tools that they already have for the implementation in the classroom. As a result, the learning process becomes less focused because the learning objectives are not in accordance with the expected indicators. Moreover, the condition of students has diverse backgrounds. Therefore, mathematics teachers should consider the condition of the students' background and use the appropriate learning model in preparing or developing the learning tools.
Several studies have developed mathematical learning tools by applying certain learning models. [2] has developed the tools of problem-based learning (PBL) model on quadrilateral and triangle material. The study aims to determine the validity and practicality of the tools used. [3] have developed mathematical learning tools on geometry material based on realistic, valid, practical and effective. However, the two studies focused more on the learning model used but did not consider the background of students or the cultural context of students. Meanwhile, although it has developed valid, practical and effective learning tools by integrating cultural values in mathematics learning [4], the model used is realistic for the material about linear equations and inequality. Moreover, the study did not use the problem-based learning (PBL) model and the material used was other than geometry. In fact, geometry is one of the abstract mathematical material which often causes difficulties for students in studying it [5,6,7,8], especially in junior high school. Therefore, it takes the effort of the teacher to adjust the geometry learning tools used by considering culture in the context of everyday life by using a problem-based learning model.

The real world is used as a tool and source in studying mathematics [9]. This is given that the results of mathematical knowledge are obtained from social interactions where relevant ideas, facts, concepts, principles, and skills are obtained as a result of the cultural context [10] and [11]. Problem-solving in the context of everyday life aims to make students accustomed to facing similar problems and applying a mathematical procedure in a new context. Differences in the background must adjust according to the place of residence of students, the context used is obtained through the use of things that are close or experienced by students, so that the experience gained becomes meaningful and impressed. An important component of cultural education is relevant because it proposes that the teacher needs to contextualize mathematics learning by connecting mathematical and cultural content and real-life to student experience [12]. Therefore, there needs to be a renewal in the mathematics education system in schools by integrating culture into mathematics learning activities that are more specific to the local culture, especially Aceh. This is motivated by the implementation of the Aceh curriculum based on the 2015 Aceh Qanun number 9 and Aceh is the place where researchers conducted the needs assessment.

The mathematical concept that comes from the experience of everyday life is a system of knowledge that is developed to solve the problems associated with numbers, relationships, and space in everyday life [13]. Therefore, curriculum design and teaching mathematics should include a cultural experience of students to achieve the goal of equality in mathematics. Use of solving problems relevant to the culture as an alternative to learning [14]. The use of the local context can help students understand mathematical phenomena from the perspective of their own life experience and it makes the mathematics much more interesting and useful for all students [15]. Therefore, researchers conducted development research on geometry to develop the teaching and learning tools based on Acehnese culture through the Problem Based Learning model in junior high school students.

2. Method
This research is development research that uses the Dick and Carey model. The subjects were students of class IX SMP 1 Meureudu, Aceh. The instruments used in this study were the learning objectives analysis sheets, the learning analysis sheets, the students' initial achievement, and character analysis sheet, and the 2013 curriculum analysis sheet. The data analysis used is a descriptive analysis which consists of seven stages namely identify an instructional goal, conduct an instructional analysis, identify entry behaviors and characteristics, write performance objectives, develop criterion-references test items, develop an instructional strategy, and develop and/or select instruction.

3. Results and Discussion
This research has resulted in seven stages of the development of geometry learning tools based on Acehnese culture consisting of learning implementation plans, student worksheets, learning outcomes tests and teaching materials through the Problem Based Learning (PBL) model using models Dick and Carey. The results in the first stage were obtained from activities to identify learning objectives,
formulation of learning objectives can be developed both from the formulation of learning objectives that already exist in the syllabus and from the results of performance analysis. The results obtained from the identification of points 3.7 and 4.7 Basic Competence (KD 3.7 and KD 4.7) are found in the 2013 curriculum. The learning objective is that the students understand geometric concepts, especially curved side space buildings, so students can relate them to mathematical problem solving differently.

The results in the second stage were obtained from the activity of analyzing learning carried out to determine the needs of the learning tools developed. Table 1 are excerpts of questions raised by researchers related to the research objectives.

Table 1. Several research questions related to the application of problem-based learning.

| Questions                                                                 |
|--------------------------------------------------------------------------|
| 1. How does the problem solving ability of students involved in solving mathematics problems? |
| 2. Are students often posed with non-routine questions?                   |
| 3. What did you prepare and do before teaching?                           |
| 4. Have you ever studied learning tools with PBL based on Acehnese culture? |
| 5. What are the obstacles for you to design the Acehnese-based PBL learning tool? |
| 6. What inspiration can be taken from existing tools?                     |
| 7. What changes have been made to overcome weaknesses in existing tools?  |

The results obtained from this stage are that teachers are still limited in preparing learning tools that are based on Acehnese culture because they are still guided by existing textbooks and require a long time to design them. There are still limited teaching and learning tools that can develop students' mathematical problem-solving abilities and meet valid, effective criteria [17] [18]. Thus, if learning tools are available to solve problems by integrating culture, the teacher will try to implement them in learning, given the importance of preserving the culture that is increasingly forgotten by students.

The results in the third stage were obtained from the activity of identifying behavior and the initial character of the student. The researchers analyze the character of students in SMPN 1 Meureudu especially in the class that will be used as the test subject, namely class IX. Learners' initial ability to a particular subject will influence how and what they will learn [19]. The results of the identification of the prerequisite abilities of students were obtained before taking part in learning the material to construct a curved side space with the PBL model. Students have an attitude of cooperation and responsibility in groups. Students have an attitude of confidence when using a flat wake formula in solving problems of waking up space. Although the material of flat shapes and flat wake formula have been learned in classes VII and VIII, they still need more detailed apperception.

The results in the fourth stage were obtained from formulating learning objectives conducted after knowing the limits of learners' ability of the material to construct curved sides. The results can be continued with the aim of knowing the ability that must be possessed by students after participating in learning using the learning tools developed. The process of formulating learning objectives begins with clarifying learning objectives according to the learning domain, namely attitudes, knowledge, and skills. The learning objectives that students will achieve after learning with the tools developed, namely participants learn about the types of constructs of curved side spaces. Next, students are able to distinguish from building flat side spaces, are able to use surface formulas and volumes to build curved side spaces independently, and are able to solve everyday problems using the concept.

The results in the fifth stage are obtained from developing the assessment of instruments. The results were that after formulating learning objectives and the test formulation, then the researchers developed the test needed to measure students abilities that are appropriate to the learning objectives (can be seen at Table 2). The format of the students' worksheet preparation refers to the Ministry of National Education Year 2008 which consists of stages of curriculum analysis, namely by analyzing basic competencies and teaching materials, compiling a map of students worksheet needs, determining students worksheet titles, and assessing students worksheet. The results of the development at this
stage are students worksheet questions and learning outcomes tests. The questions at the students' worksheet are informal questions that lead students to achieve formal, namely finding the concept of constructing curved side space through problems. While the test questions are non-routine that have various ways of solving.

Table 2. One example of the context in an Acehnese culture-based and problem-based learning test

| One example of the context in Acehnese culture | One example problem of context in Acehnese culture |
|-----------------------------------------------|--------------------------------------------------|
| 

Krong Pade made of woven bamboo/reed. It can be filled up to 3.5 tons of dry rice. The inside is covered with pandan leaves. It is usually placed under the Acehnese house, or in other buildings that are specifically made to resemble a hall around the house. (Source: Museum of Aceh) | Anwar will make a Krong Pade with a height of 1.5 meters and a centerline on the base of 1 meter. Estimate how many of woven bamboo/reed does Anwar need to make it? |

The results in the sixth stage are obtained from developing learning strategies. This is based on information from the previous five steps. The next step is to identify strategies for use in learning. The results of this stage are the researchers determine the learning strategy that will be applied in order to achieve the learning objectives that are expected to be achieved by students. Teachers are required to be able to choose a learning model that can spur the spirit of each student to actively get involved in his learning experience [20]. The forms of learning strategies that can be used in implementing learning activities are pre-learning activities, presentation of learning materials, and follow-up activities of learning activities. The learning strategy used is learning using the Problem Based Learning (PBL) model. PBL is a learning approach in which students are faced with authentic (real) problems so that they are expected to develop their own knowledge, develop high-level skills and inquiry, empower students, and enhance their self-confidence [21]. Initial draft lesson plans through PBL based on Acehnese culture which refers to the Permendikbud standard process no. 22 of 2016 concerning the SMP/MTs curriculum. The format for drafting the students' worksheets refers to Permendikbud no. 22 Year 2016 which consists of several components, namely the identity unit of learning, subject identity or theme / sub-theme, class / semester, subject matter, time allocation, basic competencies, indicators of achievement of competencies, learning objectives, learning materials, learning methods, learning resources, learning steps and assessment of learning outcomes.

The results in the seventh stage are obtained from developing learning materials. Basic competencies related to the material to construct curved side spaces which are the references in developing this device are KD 3.7, which is generalizing surface area and volume of various curved side spaces (tubes, cones and balls) and KD 4.7, which is to solve a contextual problem related to the surface area and volume of the curved side space (tubes, cones and spheres) and a combination of several curved side spaces. The format of preparation of teaching materials refers to the Ministry of National Education Year 2008 which consists of evaluation components which include the feasibility of content, language, and presentation. Figure 1a, 1b, and 1c are some of Acehnese's cultural contexts related to the construction of curved side spaces that can be used as geometry problems.
Based on the various development steps that have been described, one important component needed in designing subjects is identifying students’ initial abilities. As stated by [22] that initial ability has a lower position compared to the ability or new knowledge in learning where the initial ability is a prerequisite that must be possessed by students before entering into learning towards the next higher material. [23] found that students will be boring when learning is always repeated by teachers and students who do not have a strong initial knowledge base will find it difficult to master the lesson. In addition, teachers will have the ability of meta pedagogical skills when preparing the learning process [24]. Therefore, teachers must make student characteristics related to their initial abilities as a basis for designing, developing, and implementing learning programs.

The use of local cultural contexts can help students understand mathematical phenomena from the perspective of their own life experiences. This makes mathematics much more interesting and useful for all students [15]. This was confirmed by [9] who suggested that the real world be used as a tool and source in teaching and learning mathematics. It is clear that learning related to the circumstances surrounding students is very helpful for students in understanding the problem. This is reinforced by [25] that the integration of cultural values that exist in the surrounding community in learning influences behavior, and has an important role in the development of individual understanding including mathematics learning.

Teachers as implementers of learning need to analyze the curriculum by looking at the material and use of the context of everyday life that is appropriate in its use. Problem-solving in the context of
everyday life aims to make students accustomed to facing similar problems and apply mathematical procedures in new contexts creatively. The context used is obtained through the use of things that are close or ever experienced by students, so the experience gained becomes meaningful and impressed. As research [26], the use of some stationery such as pencils and rulers as scaffolding efforts by teachers to students has been able to encourage students to design a triangle. This condition will certainly be very good if the teacher uses other learning contexts that are around student culture, such as bamboo, leaves, wood, and others as an effort to provide scaffolding by the teacher which will make students’ understanding better.

4. Conclusion
This research has produced the findings related to the efforts to develop the geometry of teaching and learning tools based on Acehnese culture through problem-based learning in junior high school students. Some of the important findings include (1) KD 3.7 and KD 4.7 issued in the 2013 curriculum are very suitable to be followed up in order to develop cultural-based mathematics learning tools, (2) Aceh-based cultural learning tools are very necessary in learning mathematics in Aceh (3) The initial ability of students is still lacking in understanding the prerequisites of geometry material so that contextual problems are needed to bridge student understanding, (4) The assessment instruments need to be arranged related to the cultural context, (5) The learning objectives to be achieved from the results of the development of the device are students can solve problems geometry of building the curved side space using the Aceh cultural context, (6) PBL learning strategies using the Aceh cultural context is very suitable to be applied in relation to the material of the curved tube, cone and ball sides as geometry learning material in Aceh.

Among all the development efforts that have been made, the stage of developing learning material is the most dominant and essential stage. Of course, this is because the creation of a device based on the breadth of material that must be achieved and must adjust to the learning model to be implemented and assessed. Therefore, future research needs to incorporate as many cultural elements as possible in order to develop a more complete set of geometric learning so that the geometric concept is embedded earlier in the context of student culture. The development of geometrical learning tools based on Acehnese culture or other cultures through the PBL model on SMP needs to be further followed to determine the validity and effectiveness.

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