Students’ worksheet on circular cylinder topic using GeoGebra software through Discovery Learning model

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Abstract. Students’ worksheet is a sheet that contains material, descriptions, work steps, and exercises to help students comprehend and discover the concept of learning materials. But in fact, students’ worksheets do not work well in schools yet. Students’ worksheets only contain materials and exercises, not including the components of good students’ worksheets. Therefore, it is necessary to develop students’ worksheets which could help students to find their own concepts. This study aims to develop valid and practical students’ worksheets based on discovery learning model employing GeoGebra in the topic of circular cylinder. This study was held at Year 9 on junior high school. The study is developmental research with ADDIE model, which consists of 5 steps: analysis, design, development, implementation, and evaluation. The research used validity and practicality instruments to assess students’ worksheet. The validity instrument includes the assessment sheets for student worksheet and practical instrument includes student and teacher response questionnaires. The results showed that the students’ worksheet fulfilled criteria (1) valid within the average score 4.5 of 5 for students’ worksheets; and (2) practical with student response questionnaire average score of 88% and teacher response questionnaire average score 4.5 of 5.

1. Introduction
Understanding mathematical concepts are, indeed, certainly inseparable from a teacher guiding learning in order to encourage students’ understanding of a concept. Recently, students’ understanding of the concept in constructing a circular cylinder is still not reaching the competency of the learning. Students face the difficulty in solving problem posing by the teachers because of students’ misconception in constructing cylinder [1]. Lack of conceptual understanding for students who have low mathematics achievement is caused by some factors, such as the teacher-centred approach used in mathematics leaning [2]. Indonesian mathematics teachers tend to use oral speaking in their teaching, such as speaking 25 words for each of the students’ word. The reality showed that the teacher-centred was commonly used of many learning methods in Indonesian classroom [3]. Moreover, students were not active in mathematics classroom learning and their understanding of mathematical concepts was still relatively low because teachers use poor constructed students’ worksheets [4].

A student worksheet is a sheet of learning activities carried out by students. Student worksheet consists of instructions, information, and steps to solve a problem in reaching the students’ competencies by some activities in order to develop students’ thinking and students' understanding of the concepts. The students’ worksheets that have been used so far was not created by the teachers, but
it was purchased from the publisher. In terms of its performance, the students’ worksheets used by students in the school contains a few clues to direct work to students and only contains material and questions that have not accommodated students' needs for learning. The use of student worksheets in teaching and learning could provide a great opportunity for students to express their abilities and skills to do their own in developing their thinking processes. For this case, the teacher needs to design students’ worksheets that can improve students’ understanding of the concept and should choose the suitable learning model as well. A model that has been applied by most Indonesian teachers is discovery learning.

In a learning process employing discovery learning, the teacher not only presents the lessons by its final form but also expects students to be able to organize the learning themselves. By using discovery learning, it is expected that students able to understand the concepts, meanings, and relationships by an intuitive process and finally arrive at a conclusion [5]. Curriculum 2013 presents the topic of circular cylinder by using one of many technological devices such as mathematics software. The availability of mathematics software will help students in the learning process [6]. Teaching mathematics using the software is much better, and the most important thing is such learning make fun for both students and teachers [7].

One of the mathematic software that is suitable for the learning circular cylinder is GeoGebra. GeoGebra is a mathematic software system that integrates the possibility of dynamic geometry and computer algebra in one tool for mathematics education [8]. GeoGebra is able to make abstract concepts to concrete. Mathematical software can help students and teachers to do calculations, analyse data, explore mathematical concepts in order to improve understanding in mathematics [9]. That discovery activity guided students to make a conclusion and the answers for student’s worksheets were correct and matched the worksheets [10]. The previous study of Rahaju and Wijayanti [10] produced valid and practical worksheets for junior and senior high school students but did not use GeoGebra. Based on the explanation, the research was conducted to produce students’ worksheets on circular cylinder topic using GeoGebra software through Discovery Learning model.

2. Research method
Research and development design with the ADDIE (Analyse, Design, Development, Implementation, and Evaluation) model was used in this research. However, this study was limited to the develop stage. The Analysis phase is the pre-planning stage. At this stage, the researchers analysed the need for new learning devices to be developed by analysing students, the curriculum, the needs of students, and the existing of learning devices. In the Design phase, the researchers developed the students’ worksheets based on discovery learning model by using GeoGebra and selected the format of the learning materials. The initial design of student’ worksheet will be compiled with the results of curriculum analysis, needs analysis, and existing learning tools.

The next phase is Development. After the product was designed, there is a need to determine the validity aspects of the product. The product was validated by expert lecturers and mathematics subject teachers. If the product did not meet the valid criteria, then the product should be revised. The next step is the Implementation phase. In the stage, a test to the learning devices that have been developed was conducted. The results of this stage are data used to measure the practicality of learning devices.

The subjects of this study were Year 9 students of Ulumul Quran Langsa. The instrument used to measure validity is the validity assessment sheet of the students’ worksheets. The instrument measuring the validity of students’ worksheets prepared based on the requirements of good student worksheets including the feasibility of content, the feasibility of presentation, the feasibility of language, and the appropriateness of graphics. Meanwhile, the instruments used to measure practicality are questionnaires about students’ responses and teacher’s responses.

The data used in this study consists of both qualitative and quantitative data. Qualitative data includes suggestions, input, and comments from expert lecturers, students, and teachers. Quantitative data includes the assessment results of students’ worksheets by expert lecturers, the students’ and teachers responses questionnaires, and the observation sheet about the learning implementation by an
observer. Quantitative data analysis includes validity and practicality analysis. Qualitative data in this study were analysed descriptively qualitative and used as a basis for revising products.

The average score of validation results by the mathematics experts and educational practitioner was classified into five criteria according to [11] as presented in Table 1. The results of the expert validation in the form of a validator's comments on the students’ worksheets developed and used as input to revise the learning device.

| Interval Score | Criteria  |
|----------------|-----------|
| $\bar{x} > 4.20$ | Very Good |
| $3.4 < \bar{x} \leq 4.20$ | Good |
| $2.6 < \bar{x} \leq 3.4$ | Fair |
| $1.8 < \bar{x} \leq 2.6$ | Poor |
| $\bar{x} \leq 1.8$ | Very Poor |

The data of the questionnaire of students responses and teacher responses and the observation sheet about learning implementation were analysed with the same steps as the analysis of students’ worksheets validity assessment sheets that refer to table 1.

3. Research results and discussion
The product developed in this research was students’ worksheets based on DL model assisted by GeoGebra on circular cylinder concepts. The product was developed by following the ADDIE procedure, which included the analysis, design, development, implementation, and evaluation stages.

3.1 Result of the analysis stage
Activities in the analysis phase are curriculum analysis, needs analysis, analysis of student characteristics and availability analysis of learning devices. After conducting observations in several secondary schools, it was known that the curriculum used in the school was Curriculum 2013. Therefore the developed tools were adjusted to the competencies. Educators need to prepare perfectly the student worksheet before the teaching-learning process. A good student worksheet covers all components and is based on organizing principles.

The students’ worksheet developed was adjusted to the characteristics of the research subjects; the 30 Year 9 students of junior high school. Activities conducted during the phase was analysing the characteristics of students by observing students’ classroom learning activities. Based on the results of these observations, the researchers gathered information about the characteristics of students. Therefore, the researchers found that it was a need to have students’ worksheets that cover all components of good worksheets, that is in accordance with the principles of preparation and have the ability to help students in developing their creative thinking skills, so that students can understand mathematical concepts well.

3.2 Results of the design stage
The design phase aims to design the product and the instruments used to test the quality of the product. The product developed in this research was the students’ worksheets. The activities carried out at this stage were the selection of formats and the initial design of the students’ worksheet. Figure 1 presents part of the developed students’ worksheets.
The activities were designed to assist students in finding the concept of the surface area of a circular cylinder. By using GeoGebra, students can clearly see the elements of the circular cylinder.

3.3 Results of the development stage

The product was developed based on product design or framework that has been compiled at the design stage. The product that has been developed was then be validated by expert lecturers or validators using instruments that have been previously validated. The activities of validating product aim to determine the feasibility and quality of the products produced before being implemented in the teaching and learning activities. Furthermore, the students’ worksheets produced was revised according to the inputs and directions from the validators. The results of the students’ worksheets validation analysis by the learning expert validators and practitioners are presented in Table 2.

| Validator | Score |
|-----------|-------|
| V1        | 4.9   |
| V2        | 3.8   |
| V3        | 4.7   |
| V4        | 4.7   |

The average score is 4.5. Based on table 2, the results of the students’ worksheets validation analysis reached an average score of 4.5 (very good category), which are in the valid criteria. It means that the students’ worksheets are feasible to be used in the learning process. Based on the results of the analysis of the validity assessment of students’ worksheets, it can be concluded that the developed students’ worksheets met valid qualifications. This shows that the developed...
students’ worksheets met the content validity because all the materials contained in the students’ worksheets were in accordance with the current curriculum. The worksheets also fulfill the construct validity criteria, that is, all the components in the students’ worksheet are interrelated.

Based on the comments from the validators, it was found that in the developed students’ worksheets, there were still some shortcomings. Some validators suggested simplifying the use of GeoGebra because complicated usage steps can cause the learning atmosphere to be bored. Therefore the instructions for using GeoGebra must be clear. The instructions in the students’ worksheets should be shorter and clearer in order to achieve the expected objectives. The images in the students’ worksheets must be interesting and often seen by students because of the drawing in the students’ worksheets function as a help for students to solve problems. Contextual questions in the students’ worksheets must be easy to understand and no multiple interpretations.

The practicality of learning materials is measured based on the results of student response questionnaires, teacher response questionnaires, and learning implementation feasibility sheets. The results of the analysis of student response questionnaires are shown in table 3.

Table 3. Student response questionnaire results.

|        | Positive | Negative |
|--------|----------|----------|
|        | 88%      | 12%      |

Based on table 3, the percentage of students’ positive responses to learning reached 88% (very good category). It indicates that students responded positively to learning using the developed learning materials. This means that the learning materials developed can be implemented well. However, when the researcher asked for comments from several students, it was found that some students had difficulty resolving the contextual problems given. It was not because they did not understand the concept of constructing curved side spaces, but because the students were difficult to find the cube root of numbers in the questions. The results of the analysis of teachers’ response questionnaires are shown in table 4.

Table 4. Teacher response questionnaire results.

| Teacher | Mean Score |
|---------|------------|
| Teacher 1 | 4.4        |
| Teacher 2 | 4.6        |
| Average  | 4.5        |

Based on table 4, the teachers’ response to learning devices that have been used in learning shows an average score of 4.5 (very good category). The teachers’ response that the learning process employing the developed learning materials is in a very practical category. It means that the learning materials can be implemented properly and are easy to use in the teaching practices.

Based on the explanation above, the students’ worksheets on circular cylinder topic using GeoGebra software through discovery learning model developed are in the valid and practical categories. Good students’ worksheets can help students be more creative [11] and the use of software GeoGebra can help the learning process [9].

4. Conclusion

Students’ worksheets developed for the Year 9 students in the topic of circular cylinder concept have gone through every stage of the ADDIE development model, up to the development stage. All validators have provided an assessment of every aspect of the students’ worksheets. It can be concluded that the developed students’ worksheets with the discovery learning model assisted by GeoGebra software that has met the validity and practical criteria to be used in Year 9 of junior high school.
Students’ worksheets with the discovery learning model assisted by GeoGebra that has been developed are expected to be used as a learning resource by students and teachers in schools that have the same characteristics as the school in this study. The development of learning materials with different approaches and materials can be done with the same procedure as in this study.

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