**Developing of mathematics learning tools of flat side spaces using guided discovery learning method in the reasoning ability of eight grade junior high school students**

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**Abstract.** This study aims to develop mathematics learning tools namely lesson plans and student worksheets with guided discovery learning to the material of flat side spaces based on the reasoning ability of eighth grade junior high school students. This study also aims to describe the quality of the learning tools in terms of validity, practicality and effectiveness. This type of research used in this study is use the model of Research and Development (R&D) with ADDIE type. The instrument used in this study was a learning device assessment sheet, observation sheet of the learning implementation, student questionnaire response and test of reasoning ability. The results of this study are learning tools with the quality as follows, the lesson plans validation obtained a score of 4.16 with the criteria ‘Valid’, while the students worksheets obtained a score of 4.2025 with the criteria of ‘Very Valid’. The observation sheet of the learning implementation obtained 90% with the criteria ‘Very Practical’ while the student questionnaire responses obtained a score of 4.4 with the criteria ‘Very Good’. The reasoning ability tests obtained a percentage of completeness of 85.34% with the criteria ‘Very Good‘.

**1. Introduction**

Mathematics is formed as a result of human thought related to ideas, processes, and reasoning. According to the National Council of Teacher of Mathematics (NCTM) curriculum standards, the main purpose of learning mathematics is to encourage student’s belief that mathematics can be reasoned, increase student's sensitivity to mathematics, and trust in student's thinking abilities. Geometry is one of the studies that students must study and master. The flat sided spaces is one of four mathematics materials that must be achieved by junior high school students. According to the results of the absorption of the National Examination Mathematics subject at the Junior High School level in the 2018/2019 school year, it is known that student's mastery of geometry is still below that of other materials.

The material of flat side spaces contains a lot of contexts for finding the formula so that it is very approachable with the guided discovery learning method. The guided discovery learning method guides students to find their own mathematical formulas in accordance with the instructions given by the teacher, by finding themselves students can better understand step by step so that they can be better understood and remembered. Reasoning ability is one of the abilities that needs to be developed in mathematics learning. Students who have good reasoning skills will easily understand mathematical material. The ability to reason is not only needed by students to solve problems and draw conclusions in life problems. " Therefore, students are required to have the ability to reason.

The results of the Trends in International Mathematical and Science Study (TIMSS) achievement of the reasoning ability of Indonesian students in 2007 scored 394, whereas in 2011 it got a score of 386. The score of reasoning ability of Indonesian students is still low and far below the established international average of 500 , even the achievement ability of Indonesian students's adoption in 2011 decreased compared to 2007. Likewise in 2015 showed the mathematical achievements of Indonesian students ranked 44 out of 49 countries (IEA, 2016). Based on the release of the 2018 PISA results held by the OECD, Indonesia's score at 2018 PISA was apparently still below the organization's average. The results for mathematical ability are only around 28% that have reached level 2 cognitive abilities where the minimum OECD standard is 76%. Reasoning ability is at the level of analysis. The reasoning ability is in level 4 abilities and Indonesian students have not been able to reach that cognitive level.

Therefore it is necessary to develop learning tools in the form of Lesson Plan and Worksheets for material of flat side spaces with a Guided Discovery Learning approach oriented on reasoning ability.

**2. Research method**

This type of research is a type of development research, which is a study to develop a product. The product produced from this research is a mathematics learning kit consisting of Worksheets and Lesson Plan which are oriented towards reasoning ability for junior high school students in class VIII semester II.

This research was conducted at 2 Wates Junior High School which is located in Bendungan Village, Wates District, Kulon Progo Regency, Special Region of Yogyakarta. The research will be carried out in the 2019/2020 school year starting on March 18 to April 24, 2020. Subjects in this study were students of class VIII B of State Junior High School 2 Wates in the 2019/2020 school year.

This study uses an R&D (Research & Development) model with ADDIE type. ADDIE development model is a learning design model based on an effective and efficient system approach and an interactive process that is the results of the evaluation of each phase can bring the development of learning to the next phase. The final result of a phase is the initial product for the next phase. The ADDIE development model consists of 5 stages, namely: (1) Analyze; (2) Design; (3) Development; (4) Implementation; (5) Evaluate.

**3. Result and Discussion**

The development model used in developing mathematics learning tools in this research is to use the R&D (Research & Development) model with the ADDIE type. The ADDIE development model consists of 5 stages, namely: (1) analyze (analysis); (2) design (design); (3) develop (development); (4) implement (implementation); (5) evaluate (Reyzal Ibrahim, 2011).

1. Analysis Phase

Requirement Analysis

Based on the results of interviews with mathematics subject teachers and observations of mathematics learning in schools it was found that the need for learning tools in schools is still minimal. Teachers do not have lesson plan and worksheets that support the implementation of learning. Teachers do not have time to make these learning tools due to the tight schedule, so that in implementing learning the teacher does not use lesson plans. In addition to learning tools, choosing the right learning method is also very necessary. At the intended school, the learning methods used by teachers are still conventional. Learning in schools is still dominated by teachers. Students are activeless in learning.

Curriculum Analysis

Curriculum analysis includes the selection of Core Competencies, Basic Competencies and Competency Achievement Indicators of flat sided spaces that is in accordance with the latest 2013 Revised Curriculum.

Analysis of Student Characteristics

Analysis of student characteristics is an analysis of the character of students in learning in school. This is done by learning observation. Based on the results of observations of learning, the average character of class VIII B students at 2 Wates Junior High School tends to be activeless, the classroom conditions tend to be calm, the teacher gives an explanation from the beginning to the end by writing on the board and only to take notes. Students are activeless if invited by the teacher to interact, asked to progress to do even difficult, students tend to lack confidence in their abilities.

1. Design Stage

In the planning stage, the researcher designed the learning tools, namely lesson plan and worksheets , supporting instruments such as the reasoning ability test instrument, lesson plan and worksheets assessment sheet, the observation sheet of the implementation of learning, and the student questionnaire responses.

1. Development Stage

At the development stage researchers began to develop learning tools and supporting instruments that had been designed at the design stage.

1. Implementation Phase

The product trial was conducted at 2 Wates Junior High School which is located at Jalan Wahid Hasyim No. 10 Bendungan, Wates, Kulon Progo, Yogyakarta. The research product trial was conducted on 32 students in 8th grade Wates Middle School VIII B for 7 meetings. Details of the implementation schedule of learning device trials can be seen in the following table.

Table 1. Learning Device Trial Schedule

|  |  |  |
| --- | --- | --- |
| Meeting to- | Activity | Date and time |
| 1 | Learning with student’s worksheet 1 | Wednesday, 18 March 2020 |
| 2 | Learning with student’s worksheet 1 | Thursday, 19 March 2020 |
| 3 | Learning with student’s worksheet 2 | Thursday, 2 April 2020 |
| 4 | Learning with student’s worksheet 3 | Thursday, 9 April 2020 |
| 5 | Learning with student’s worksheet 4 | Monday, 13 April 2020 |
| 6 | Learning with student’s worksheet 5 and 6 | Friday, 17 April 2020 |
| 7 | Reasoning ability test | Thursday, 23 April 2020 |

Learning takes place in two different types of learning, namely face-to-face learning in the classroom and online learning through Whatsapp groups. Face-to-face learning in classrooms is conducted at the first and second meetings, then the third to the seventh meeting is held online through the Whatsapp group.

Face-to-face learning begins with the opening activities, apperception, motivation and delivery of learning objectives, then the next lesson the teacher distributes worksheets to each student, the teacher introduces first that during learning of flat sided spaces the worksheets will be the main source of learning, then the teacher guide students in filling the worksheets. Learning is done through discussion together, the teacher provides a stimulus and then students who respond by filling in every activity displayed on the worksheets, at the end of the worksheets there is always a Competency Test containing 5 questions that facilitate students to test their understanding of the material being learned . At the end of the teacher's learning together students make conclusions about the subject matter they have learned, equating concepts and reinforcing concepts found using the help of instructional media.

The second learning is, online learning system. Learning continued with an online system because schools were closed by the government due to the Covid-19 outbreak. The learning opens with opening activities and attendance, then the teacher sends a worksheets file to the Whatsapp group of students, in the group there is a discussion together. Besides worksheets students are also given assignments, the term of collecting assignments is 1 week. Online learning is done flexibly, in addition to discussion through the Whatsapp group the teacher also facilitates personal guidance for students who want to ask questions via private chat with the teacher.

1. **Evaluation Stage**

**Validity Analysis of Learning Devices**

The validity of the learning device can be seen from the score of the learning device assessment developed, namely the lesson plan, worksheets, and the reasoning ability test instrument. The results of the lesson plan assessment by the lecturer obtained an average score of 4.08 included in the "Valid" category while the assessment results by the teacher obtained an average score of 4.24 included in the "Very Valid" category. Worksheets assessment results by lecturers obtained an average score of 4.03 included in the category of "Valid" while the assessment results by teachers obtained an average score of 4.375 included in the category of "Very Valid". The results of assessing the ability of reasoning tests by lecturers obtained an average score of 3.67 included in the category of "Valid" while the results of the assessment by the teacher obtained an average score of 4.0 included in the "Valid" category. Based on the results of the assessment by lecturers and teachers it can be concluded that the three learning tools are declared valid for use.

**Practical Analysis of Learning Devices**

The practicality of the learning device can be seen from the results of the student response questionnaire and observation sheet of the implementation of learning.

1. Distribution of Student Response Questionnaire

Questionnaire responses from students were distributed in the form of an online questionnaire through Google form at the end of learning. The results of filling out the student questionnaire received an average value of 4.4 in the very practical category. Therefore, it can be concluded that the worksheets developed is practically used in learning.

1. Fill out the Learning Observation Sheet

This observation was carried out to determine the practicality of the developed learning device and to know the feasibility of learning with the guided discovery learning method. The results of overall observations summarized in the following table:

Table 2. Observation Results of Learning Implementation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number | Date and time | Meeting to- | Percentage | Criteria |
| 1 | Wednesday, 18 March 2020 | 1 | 92% | Very Practical |
| 2 | Thursday, 19 March 2020 | 2 | 88% | Very Practical |
| 3 | Thursday, 2 April 2020 | 3 | 78% | Practical |
| 4 | Thursday, 9 April 2020 | 4 | 82% | Practical |
| 5 | Monday, 13 April 2020 | 5 | 82% | Practical |
| 6 | Friday, 17 April 2020 | 6 | 82% | Practical |

According to the results of the table it can be seen that the implementation and management of learning has been going well as expected. Learning management includes the implementation of the guided discovery method steps. Therefore, research products are said to be practical with an average percentage of 84% with practical criteria.

Based on the results of the scores and percentages obtained from the two instruments, it can be concluded that the developed learning device is declared practical in learning.

**Analysis of the Effectiveness of Learning Devices**

The effectiveness of the learning device can be seen from the results of student's reasoning ability tests. The reasoning ability test was carried out at the 7th meeting. Researchers conducted a test of learning outcomes on Thursday, April 23, 2020, which was attended by all students of class VIII B of 2 Wates Junior High School with a total of 32 students.

The results of the learning outcomes test are 29 students who score above the KKM and 3 students score below the KKM with the KKM score of 75. The average student score is 85.34. Based on the results of the learning outcomes test it is known that the percentage of classical learning completeness for 2 Wates Junior High School is 93.75%. This shows that the classical learning completeness for junior high school is in very good criteria. Therefore, it can be concluded that the learning tools developed are effectively used in the learning process.

**4. Conclusion**

Based on the results of this study the following conclusions can be drawn:

1. The process of developing learning tools is carried out in accordance with ADDIE steps as a reference in developing learning tools in the form of Worksheets and Lesson plan guided development learning is a ADDIE type development model (Analysis, Design, Development or Production , Implementation or Delivery and Evaluation). The device development process includes identifying needs, formulating objectives, developing materials, developing evaluation tools, producing, validating, and finally revising.
2. The quality of learning tools is measured from the results of validity, practicality and effectiveness. Validity test is based on the assessment of expert lecturers and junior high school mathematics teachers. Practicality test based on the results of the student response questionnaire and observation sheet of the feasibility of learning obtained very good category. The effectiveness test was obtained based on the results of the reasoning ability test obtained very good criteria. Based on the results of product validation, practicality analysis and effectiveness analysis that has been done, it can be concluded that the learning tools have good quality.

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