Development of learning devices with the PBL model using the Pythagoras theorem of RME approach

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Abstract. This study aims to produce a Mathematics Learning Tool with Problem-Based Learning Model Using a Realistic Mathematical Approach in Pythagorean Theorem lesson for 8th-grade students of SMP Negeri 1 Tomohon that met valid, practical, and effective criteria. The study employs the ADDIE model of research and development to design and develop learning instruments involved, lesson plan, student's worksheet, a test of learning outcome. Descriptive analysis results in that the development of the problem-based learning model using the realistic mathematical approach produced good learning tools because it met valid criteria based on expert opinion, the teacher's ability to carry out learning was good, students were active during the learning process, students gave positive responses to learning. The developed test of learning outcome meets the criteria of validity, practicality, and effectiveness. It is concluded that the problem-based learning model using a realistic mathematical approach was effective in teaching the Pythagorean Theorem topic to 8th graders of SMP Negeri 1 Tomohon.

1. Introduction
Education is an effort that is consciously designed to help a person or group of people in developing a knowledge as well as a view of life and life attitudes and life skills both individually and socially. Education is a process that is very important to educate students.

In the world of education, schools have a learning process that has teaching and learning activities by being a teacher and educator, namely teachers and those who receive education or teaching are students, namely students. This education must be able to equip the students themselves with knowledge and skills.

Mathematics is one of the subjects taught at every level of education, because mathematics is a basic science in supporting science and technology, which requires an understanding of mathematics. In mathematics, every concept is related or connected to other concepts. Schools have a very big share in this through the learning process of mathematics in the classroom.

Learning is an activity that involves various components, including: students, teachers, curriculum, educational facilities and infrastructure. The teacher is a very influential component in the learning process, which has responsibility and is very decisive in achieving the success of education.

Mathematics learning problems faced today are influenced by several factors and sources of problems, including the substance of the mathematics curriculum material, learning models, supporting facilities for learning activities, the presence of students and their environment, and the mathematics teacher itself. All of these things will have an impact on student learning outcomes. A good teaching and learning process will contribute to student learning outcomes.
In learning mathematics there are also various kinds of problems that are very often encountered by teachers, for example in the process of learning mathematics, there are some students who show that it is still difficult to do math calculation problems indicated by the learning outcomes achieved are still below average, and have an effect on the results. learning accomplished.

Another problem encountered by students is that some students are not able to work on more complicated questions, they can only work on questions that are slightly similar to the example questions that have been given. Another problem is that during exams, the learning outcomes obtained by some students are not the expected learning outcomes. Some students get learning outcomes that can be said to be below average. Learners have difficulty achieving expected learning outcomes.

Through observations made by the author at SMP Negeri 1 Tomohon, it is known that student learning outcomes in general have not reached the minimum completeness criteria of less than 75. One of the subjects that have not reached learning completeness is the material of the Pythagorean theorem. There are still students who experience difficulties in learning mathematics on the subject of the Pythagorean theorem.

With the problems encountered in learning mathematics, teachers and educators must always be able to provide learning opportunities to students by involving students effectively in the learning process. The number of theories and research results from educational experts show that learning will be successful if students participate actively in the learning process. learning that has to do with the environment or student life, can make students remember more about the learning.

Teaching preparation is one measure of a teacher's success. Failure in planning is tantamount to planning failure. This implies how important it is to prepare learning through the development of learning tools.

Learning tools are important to develop because learning tools are a form of preparation made by teachers before they carry out the learning process. The learning tools are the lesson plan, student worksheets and learning outcomes test.

Along with the development of learning tools, of course a quality and quality learning process cannot be separated from a method or approach. The method or approach used in carrying out the learning process will also greatly determine the comfort and interest of students in learning. The learning approach must make students play an active role in developing their own abilities, and be able to create experiences for them.

One model that can be used for the development of learning tools to improve student learning outcomes is to use the Problem Based Learning (PBL) model. The PBL model is a learning model that creates a more creative and fun classroom atmosphere.

And if coupled with a realistic mathematics learning approach (RML), learning will be more interesting by using contextual problems or problems raised from student life that can be easily understood by students.

These models and approaches can be used in class VIII material of the Pythagorean Theorem. The Pythagorean Theorem can be formulated, namely For every right triangle, the square of the length of the hypotenuse is equal to the sum of the squares of the length of the right side.

2. Problem formulation

How are the results of the development of mathematics learning tools with problem-based learning models using a realistic mathematics approach in the Pythagorean Theorem material for grade VIII students of SMP Negeri 1 Tomohon who meet the valid, practical, and effective criteria?

3. Research method

This research method includes research and development (Research and Development). According to Sugiono [1] research and development is a research method used to produce certain products and test the effectiveness of these products.
Nana Syaodih Sukmata defines research and development as a research approach to produce existing products. Research and Development aims to produce a new product through a development process [2].

The products produced in this study were learning tools in the form of lesson plans, worksheets, and learning outcomes test using the PBL model with the RME Pythagorean Theorem approach to grade VIII students at SMP Negeri 1 Tomohon. of various types or development research designs, researchers chose to use the ADDIE model development research.

4. Research results
Description of the Process and Results of Learning Device Development The results of this study are (1) Learning Tool Plan, (2) Student Activity Sheets, (3) Learning Outcomes Test. In this study, student activity sheets and learning outcomes test were packaged in an attractive manner and provided a variety of colors and images, the use of language that was easy to understand so that it made students enthusiastic in learning and doing it, systematically presented material according to the students' conceptual understanding ability.

At this stage the researcher develops products in the form of learning tool plan, student activity sheets, and learning outcomes test with a problem-based learning model and a realistic mathematics learning approach. The following is a description of the implementation and research results by following the stages of the ADDIE development model described as follows:

4.1. Analysis stage description (analysis)
At the analysis stage in this research includes needs analysis, curriculum analysis, and analysis of student characteristics.

4.1.1. Needs analysis. In this study, needs analysis was carried out by collecting important information related to the problems that occurred in mathematics learning for grade VIII students of SMP Negeri 1 Tomohon. The results of this analysis were obtained through observation and interviews.

Based on the results of observations and interviews, it was found that the teacher's role was still very dominant in learning mathematics in the classroom. Teachers still have difficulty finding learning tools that can facilitate this.

Therefore, it is necessary to make an effort to overcome these problems, namely developing learning tools that are in accordance with the Pythagorean Theorem material.

4.1.2. Curriculum analysis. Analysis is useful for knowing the curriculum used in schools, knowing core competencies and basic competencies, and knowing the existing material in mathematics lessons with reference to the 2013 Curriculum. From the curriculum, it was found that the core competencies and basic competencies for the Pythagorean Theorem material are (1) KI-1 (Spiritual): Respect and appreciate the teachings of the religion it adheres to, (2) KI-3 (Social): Respect and live up to honest behavior, discipline, responsibility, care (tolerance, mutual cooperation), polite, self-confidence, in interacting effectively with the social and natural environment within the reach of the association and its existence, (3) KI-3 (Knowledge): Understanding knowledge (factual, conceptual, and procedural) based on curiosity about science, technology, art, culture related to phenomena and visible events, (4) KI 4 (Skills): Trying, processing, and presenting in a concrete realm (using, outline, arrange, modify, and create) and the abstract realm (writing, reading, counting, drawing, and composing) according to what is learned in school and other sources in the same perspective or theory. Meanwhile, basic competencies: (1) Explain and prove the Pythagorean theorem and Pythagorean triples and (2) Solve problems related to the Pythagorean theorem and Pythagorean triples.

4.1.3. Analysis of student characteristics. The analysis of student characteristics aims to determine the characteristics of class VIII students of SMP Negeri 1 Tomohon such as ordinary children, children who are fun, or children who are difficult to adjust. Analyzes were carried out during the study.
From the results of the analysis, it was found that grade VIII students had various abilities. Based on some of the characteristics of these students, a learning device is needed to overcome existing problems and to generate motivation and activeness in learning mathematics in the classroom.

Therefore, researchers developed learning tools with the PBL model and the RME approach because in the PBL model, students can unite their respective opinions in order to deepen their knowledge.

4.2. Design stage (design)
This design stage is also known as making a design. The learning approach used is RME. The learning model chosen in each lesson plan is PBL. The teaching material used by researchers is the Pythagorean Theorem. At this stage, researchers began designing lesson plans, worksheets, and learning outcomes test with the PBL model with the RME approach.

4.3. Development stage (development)
The development stage is the stage of realizing the design of learning devices. At this stage, the researcher began to make learning tools with the PBL model with the RME approach in accordance with the structure that had been designed at the design stage.

4.3.1. Learning tool plan development. Learning Tool Plan is a guide for teachers in implementing learning. Learning is carried out using the PBL model with the RME approach.

The lesson plans developed must refer to components such as: school identity, subject identity, class or semester, subject matter, time allocation, learning objectives, core competencies, basic competencies, competency achievement indicators, subject matter, learning methods, steps learning, learning media, learning resources, and assessment of learning outcomes.

In this study, there were two learning tool plans compiled, namely learning tool plan 1 and learning tool plan 2. Each lesson plan was designed for one meeting.

4.3.2. Development of student activity sheets. In this study, 2 student activity sheets were compiled, namely student activity sheets 1 and student activity sheets 2. Each student activity sheets was designed for one meeting.

Student activity sheets development is carried out according to the predetermined design. The result of the development of the student activity sheets is the Pythagorean Theorem mathematics worksheets with the PBL model with the RME approach for grade VIII students of SMP Negeri 1 Tomohon. The developed worksheets have components that make it easier for students to understand the material being taught.

4.4. Learning outcomes test development
In this study, the learning outcomes test composed of 1 learning outcomes test. Learning outcomes test development is carried out according to the predetermined initial design. From learning outcomes test is designed for one meeting.

4.5. Expert assessment or validator
This expert assessment is carried out to determine the validity and feasibility of the learning tools developed in the form of lesson plans, worksheets, and learning outcomes test. The learning tool plan, student activity sheets, and learning outcomes test that have been approved by the supervisor are then validated by the validator, namely expert lecturers. Expert validation, namely the assessment of learning tool plan, student activity sheets and learning outcomes test using assessment instruments for learning tool plan, student activity sheets, and learning outcomes test in the form of a questionnaire for expert lecturers.

Product Trial Results Testing is included in the implementation activities carried out after the learning device is declared feasible to be tested with revisions by expert lecturers. Researchers get the
data used to determine the quality of the lesson plans, worksheets, and learning outcomes test developed. An explanation of the data obtained from the discussion and trial results is described as follows.

Practicality data Practicality data were obtained from teacher assessments, student responses and learning implementation. The explanation of the data is (1) The teacher assessment data was carried out by a mathematics teacher who taught in class VIII SMP Negeri 1 Tomohon. The assessment is obtained through the provision of an assessment sheet in the form of an assessment of the learning tool plan, student activity sheets, and learning outcomes test developed: learning tool plan, student activity sheets and learning outcomes test developed are rated very well. Based on these criteria, it can be concluded that the lesson plans, worksheets and learning outcomes test developed are practically based on teacher assessments.

Student assessment data Student assessment data were obtained from 28 students in class VIII SMP Negeri 1 Tomohon. This assessment is obtained after students carry out mathematics learning using the developed student activity sheets and learning outcomes test.

4.6. Learning implementation data
During the implementation of learning, observations were made to determine the implementation of the learning steps in the lesson plans developed.

Data effectiveness efficacy data obtained from the results of achievement tests conducted in akhir pembelajaran mathematics. The test questions given to students are post-test questions, which consist of two description questions.

4.7. Product revision
Based on the stages that have been carried out, also obtained some suggestions regarding the learning tools being developed. Researchers evaluate the developed lesson plans, worksheets and learning outcomes test. This is done to correct the rrp, student activity sheets and learning outcomes test errors encountered by researchers during the trial.

4.8. Revised learning tool plan
After conducting an expert assessment of the lesson plans developed, there are several suggestions that need to be revised so that the lesson plans developed are suitable for use in mathematics learning. Revision of student activity sheets and learning outcomes test after conducting an expert assessment of the worksheets and learning outcomes test developed, there are several suggestions that need to be revised, namely in writing so that the developed worksheets and lesson plans are suitable for use in mathematics learning.

4.9. Final product study
Based on the research results described above, products in the form of a Learning Implementation Plan, Student Activity Sheets and Learning Outcomes Test with PBL models and RME approaches are obtained that are valid, practical, and effective.

The steps for preparing and developing the lesson plan and worksheets are carried out with a predetermined development model, namely ADDIE: (1) conducting an analysis which includes: (a) needs analysis: analyzing the need to determine the basic problems faced in mathematics learning on the Pythagorean Theorem material, (b) curriculum analysis: analyzing the subject matter of class VIII SMP Negeri 1 Tomohon, (c) analyzing student characteristics: analyzing the condition of students at SMP Negeri 1 Tomohon based on the results of interviews with mathematics teachers at the SMP; (2) the design of the learning tool plan, student activity sheets and learning outcomes test which includes: (a) the design of the learning tool plan, student activity sheets and learning outcomes test: two learning tool plans are made according to process standards, while the worksheets are made based on material or content aspects, process standards, construction requirements, and technical requirements, (b) the design of the assessment instrument, namely the researcher compiling the teaching material assessment instrument as a tool to measure the feasibility of the lesson plans, worksheets and learning outcomes test.
produced; (3) development of lesson plans, worksheets and learning outcomes test includes: (a) development of research instruments in the form of validation sheets filled out by lecturers, practical assessment sheets filled out by teachers and students, learning observation sheets filled out by observers, and pre-test and post questions. -test to measure the effectiveness of the product, (b) development of learning tool plan according to design at the design stage, (c) development of worksheets and learning outcomes test according to design at the design stage; (4) implementation of learning tool plan and student activity sheets: conducted in July 2020 and (5) evaluation of the learning tool plan, student activity sheets and learning outcomes test: learning tool plan, student activity sheets and learning outcomes test are evaluated regarding their validity, practicality, and effectiveness.

4.10. Implementation Phase (Implementation)

4.10.1. Device trials. After the learning device is declared feasible by the expert, the learning device can be implemented, which can be used in learning activities. The results of this trial will be used as a reference for revising the learning tools developed.

Product trials were carried out at SMP Negeri 1 Tomohon with the research subjects of grade VIII students. In implementing learning, the use of devices in their learning activities can be done in groups. The group was selected heterogeneously and consisted of 2 people. In addition to working on discussion activities, group student activities, they also carry out student activities together and discuss if there are students in the group who are experiencing difficulties. In this lesson, it appears that students are interested and motivated to be able to solve problems that exist in the student activity sheets and learning outcomes test. This can be seen when students have difficulty completing student activity sheets and learning outcomes test, students will ask the teacher about solutions or ways they have to take to be able to solve the difficulties they are facing.

After students get their conclusions and write them on the answer sheet, the teacher reinforces the conclusions that the students have obtained by first asking one of the students to convey the results of the conclusions they have obtained. With the conclusion that has been strengthened by the teacher, students can better understand the material they are learning.

4.10.2. Product revision products. that have been tested are then revised again based on input or suggestions from student response questionnaires after using learning products.

4.11. Evaluation stage (evaluation)

The final stage of the ADDIE development model is the evaluation stage. The evaluation was carried out by the researcher by analyzing the research data obtained, namely the analysis of the validity of the tools from expert lecturers and teachers.

Student response data to learning activities to determine student responses or responses to the learning tools developed.

4.12. Data analysis and discussion

The data analysis of the trial results is intended to be the response of students to learning activities and learning outcomes tests. The analysis of the data on the test results of the Pythagorean Theorem learning tools developed includes analysis of the validity, analysis of practicality, and analysis of the effectiveness of the learning device.

4.12.1. Analysis of the validity of the learning tools learning. Implementation Plan, the three validators gave a good and very good assessment so that it met the valid criteria. The student worksheet of the three validators gave a good and very good assessment so that it met the valid criteria.
The learning outcomes test three validators’ provided a good and very good assessment so that it met the valid criteria for content validity, was very understandable for language and question writing, and could be used without revision.

4.12.2. Analysis of student response questionnaires. Based on data from student response questionnaires that have been filled in by 28 students after participating in learning activities for the Pythagorean Theorem material with the Problem Based Learning model using the Realistic Mathematics Learning Approach, the following results are obtained.

For example, are you interested in participating in the next learning activity that you are currently participating in? and the answer is all interested. The language used in the student activity sheets & learning outcomes test all answers well, and the appearance (writing, pictures, location of the pictures) contained in the student activity sheets & learning outcomes test also answers all well.

4.12.3. Analysis of teacher ability to manage learning. Based on the criteria for teacher ability described in chapter III, the ability of teachers to manage learning in the first to second meetings reaches the “GOOD” category, which is located at intervals of 3.50 TKG < 4.50. The ability of the teacher to manage learning has reached a good category, so this learning device has not undergone revision based on the observation of the ability to manage learning.

4.12.4. Analysis of the effectiveness of learning devices. that the number of students who succeeded in achieving completeness was because there were 24 students or 86%. Based on the assessment criteria, it can be said that the device developed meets the effective category.

5. Conclusion

- A learning tool has been developed with the PBL model using the RME approach in the Pythagorean Theorem material for grade VIII students of SMP Negeri 1 Tomohon which is found to meet the criteria of being valid, practical, and effective;
- The validity of the tools based on the PBL model using the RME approach is shown by the validation results of the validators against the tools;
- The practicality of the tools based on the PBL model with the RME approach is shown from the observations.

References

[1] Sugiono 2012 Metode Kuantitatif, Kualitatif dan R&D (Bandung: Alfabeta)
[2] Nana Syaodih Sukma Dinata 2005 Landasan Psikologi Proses Pendidikan (Bandung: PT, Remaja Rosda Karya) pp. 142