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Development of Learning Tools through the Wankat-Oreovocz Strategy to Improve Mathematical Problem Solving Ability of Junior High School Students

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Abstract

This study aims to produce quality teaching materials developed based on the Wankat-Oreovocz Strategy and to analyze the improvement of students' mathematical problem solving abilities who are taught using the Wankat-Oreovocz Strategy. This research is a development research using the Thiagarajan 4-D development model (define, design, develop, dessiminate). The learning tools developed were Student Books, Student Worksheets and tests of mathematical problem solving abilities. The trial of learning tools based on the Wankat-Oreovocz Strategy was carried out three times to obtain a quality device. Based on the results of the analysis, the learning device using the Wankat-Oreovocz Strategy has good quality at the disseminate stage and the ability to solve mathematical problems learned using the Wankat-Oreovocz Strategy increases at the disseminate stage. The results of data analysis indicate that the Wankat-Oreovocz Strategy Learning tool can improve students' mathematical problem solving abilities.

Keywords: *4-D Development Model; Mathematical Problem Solving Ability; Wankat-Oreovocz Strategy*

Introduction

Mathematics is a subject that has a very important role in education. Almost all fields of study require mathematics. Therefore, everyone must study mathematics so that it can be used as a means of solving problems in everyday life. Mathematics is an important subject because mathematics is very useful and very useful in life. Mathematics can also be integrated with various scientific disciplines such as science, social sciences, arts, health and physical education (Milaturrahmah, 2017).

Basically, learning mathematics cannot be separated from the problem because someone's success or failure in mathematics is marked by the ability to solve the problems they face. Problem-solving abilities are important for students to solve a problem, both elementary, middle and high school students (Marsaulina, 2019). This is because problem solving skills are the main goal of learning mathematics. As expressed by Ozturk and Guven (2016) that "problem solving skills have an important place among the main objectives of the curriculum".

Although problem solving skills are the main goal in learning mathematics, many students have difficulty solving these math problems. As said Tambychik, et al. (2010) that "many students reported experiencing difficulties in mathematics, especially in solving mathematical problems". The low ability of students' mathematical problem solving can also be seen from the results of research on the analysis of mathematical problem solving difficulties among elementary school students in Thailand conducted by Phonapichat, et al. (2013) that "most students do not have math problem solving skills. This proves to be one of the reasons why overall achievement in mathematics is considered quite low". This can also be seen from the results of research by Utami and Wutsqa (2017) which found that "389 students who were subjected to research had problem solving abilities in low criteria. The factors that cause this situation include students who do not understand the information on the questions, students are less able to make mathematical models, and students are not careful in solving the questions. Fitria, et al (2018) stated in the results of their research that "students' mathematical problem solving abilities are still low, this can be seen from the percentage of students who cannot understand the problem and re-examine the problems given by the teacher. Overall students' problem solving abilities, especially in mathematics, are in low qualifications.

Given the importance of mathematical problem-solving abilities that students must master after studying mathematics and the facts that show low mathematical problem solving abilities, steps are needed to improve students' mathematical problem solving abilities. To solve this problem, teachers are required to be able to find ways to optimize students' mathematical problem solving abilities. One way is to develop learning tools using the Wankat-Oreovocz Strategy. The importance of learning tools in learning activities is also supported by research by Nwike (2013) that students who learn using teaching materials are better than those who learn without teaching materials. Oliyinka's (2016) research states that students who are taught using learning devices have better scores than students who are taught without learning devices. It is therefore recommended that teaching materials be used in teaching because they have a positive impact on student performance.

Literature Review

Mathematical Problem Solving Ability

Krulik and Rudnick (1987) define "problem solving is a skill and understanding that is obtained previously to meet the demands of an unknown situation. Lesh and Zawojewski (2007) define mathematical problem solving as a process of interpreting a situation mathematically which usually involves several repeated cycles to express, test, and revise mathematical interpretations and sort, integrate, modify, revise or organize groups of mathematical concepts from various topics in in math. Meanwhile, according to Szetela and Nicol (1992), "problem solving is the process of dealing with new situations, formulating new situations, formulating relationships between given facts, identifying goals, and exploring possible strategies to achieve goals". According to Schoenfeld (1985) there are 5 stages in solving problems, namely Analysis (analyzing), Design (designing), Exploration (exploring).

Implementation (implementing), and Verification (verification). Meanwhile, according to Krulik and Rudnik (1988: 26) introducing five stages of problem solving as a Heuristic. The five steps are read (read), explore (explore), select a strategy (choose a strategy), solve (complete), and look back and extend (look back and develop). Meanwhile, Charles, Lester, and O'Daffer (1987) suggested that there are three stages of problem solving in mathematics, namely (1) understanding the problem (understanding the problem); (2) solving the problem (solving problems); (3) answering the problem (answering questions). The three stages of problem solving are mostly based on the steps to solve the problem of the pattern (Barmby, 2014; Rachmadtullah, et al ,2018 ; Sumantri, et al 2016, Saputra, et al 2019;Saputra et al 2020; Rachmadtullah et al 2019; Syofyan,et al 2019; Supriatna et al 2019; Rachmadtullah et al 2019; Siregar et al, 2019;Rasmitadila et al, 2018). Based on the description above, it can be concluded that mathematical

problem solving abilities are the abilities students have in solving mathematical problems by paying attention to the process of finding answers based on three stages of problem solving in mathematics, namely (1) Understanding the problem; (2) planning problem solving; (3) Resolving problems.

Wankat-Oreovocz Strategy

The Wankat-Oreovocz strategy is a problem-solving learning strategy developed by Phillip C. Wankat and Frank S. Oreovocz. According to Haverdi (2013) the Wankat-Oreovocz Strategy is a learning strategy that can increase motivation, self-confidence and train students' logical thinking to analyze a problem at hand, and be able to develop problem-solving skills. Wulandari et al, (2015) said that "the Wankat-Oreovocz Learning strategy is a learning strategy that can increase motivation, student self-confidence in asking questions and train logical thinking to analyze the problems at hand, and be able to develop student activities and abilities. in determining the answer to solve the problem ". Learning with the Wankat-Oreovocz strategy in the learning process motivates students to ask or answer questions about the problem to be solved and to be able to think logically to solve a problem. In addition, solving the Wankat-Oreovocz problem also helps students in analyzing problems and guides students to solve problems systematically.

Meanwhile, according to Wena (2011) the Wankat-Oreovocz Learning Strategy is a way of learning which is done by training students to face various problems to be solved alone or collectively. According to Andrayani (2015) the purpose of using the Wankat-Oreovocz learning strategy is to (1) provide broad opportunities for students to gain new understanding of mathematics; (2) provide broad opportunities for students to be able to find relationships, analyze patterns, find appropriate methods so that all students can be optimally involved in the implementation of learning; (3) students have great opportunities in developing the problem solving process they face. Linuhung (2014) reveals that the characteristic feature of the Wankat-Oreovocz strategy is giving motivation because the key to success is a large motivation that grows in students.

Research Method

This research is a development research. This study uses the Thiagarajan, Semmel and Semmel development model which is also often referred to as 4-D, which includes four stages, namely Define, Design, Develop and Disseminate. The tools developed were student books, student worksheets, and tests of students' mathematical problem solving abilities. Nieveen (1999) states that to determine the quality of learning device development, three assessment criteria are needed, namely effectiveness, practicality, and effectiveness. The validity process is carried out by experts or experts in accordance with their field of study. Feedback from the validator becomes material for revising learning tools developed using the Wankat-Oreovocz Strategy. While practicality can be seen from the opinion of experts or the response of experts that the tools developed can be used and the implementation of the learning tools is at least in good criteria, namely $80 \leq k < 90$. Furthermore, to see the effectiveness of using learning tools, it is measured from (1) classical student learning completeness, namely at least 85% of students who take learning to get a score of ≥ 70 on the mathematical problem-solving ability test; (2) achievement of learning objectives with criteria $75\% \leq T \leq 100\%$; (3) at least 80% of students gave positive responses to the components of the learning tools developed; (4) the minimum learning time is the same as the usual learning carried out at the school. This research was conducted at State of Junior High School 1 Manyak Payed which is one of the first secondary schools in Aceh, Indonesia. The subjects in this study were students of class VIII-2, VIII-3 and VIII-4. To analyze the increase in students 'mathematical problem solving abilities, data were obtained from the results of the students' pre-test and post-test. The improvement of students' mathematical problem solving abilities can be obtained from the N-Gain test.

Results and Discussion

In this study, the development of learning tools using the Wankat-Oreovocz Strategy has met the criteria for being effective at the develop stage. Furthermore, at the disseminate stage, devices that meet the effective criteria are called the final draft. The final draft was retried into a different class, namely class VIII-4. The results of the development of learning tools using the Thiagarajan 4-D model are explained as follows:

Stage 1 – Define

In the final stage, the researcher looks for information about student characteristics including cognitive development, academic background, social and economic life background. Furthermore, based on observations of learning materials, there are several weaknesses in the learning tools used by the teacher, such as in the student book that has not provided contextual problems, and the teacher does not use student worksheets as support for learning activities. Furthermore, in the learning process the teacher still uses direct learning during the learning process, and the teacher is also not used to motivating students to solve the problems given. This results in students appearing less active during the learning process.

Stage 2 – Design

At this stage, the researcher determines the appropriate and appropriate media to present the material. The choice of media is adjusted to the learning objectives, student characteristics, teaching and learning strategies, and the ability of teachers to use media. Then the researcher also chooses a format for designing the content and learning resources in accordance with the principles, characteristics, and steps that are in accordance with the learning strategy used. Furthermore, the initial design of the learning tools in this study included student books, student worksheets and tests of mathematical problem solving abilities. The design of the learning device and the resulting mathematical problem solving ability test instrument is called Draft I

Stage 3 – Develop

At this stage, the draft I which has been revised by the experts is tested in a class outside the research subject. The aim is to see the weaknesses in draft I so that it can be revised and perfecting the learning tools developed. Expert validation shows that all learning devices meet valid criteria, with the average student book validation being 4.31 and student worksheets being 4.24. All items of the student's mathematical problem-solving ability test met the valid criteria and could be used. The reliability of the instrument was used to determine the test results. After the calculation, the reliability of the mathematical problem solving ability test was 0.409 (sufficient category).

After the learning device developed has met the validity criteria, the learning device in the form of draft II is tested in the subject and place of research, hereinafter referred to as the I trial. , so that improvements are needed to produce learning tools that meet all the defined effective criteria. The revision is based on the findings of the weaknesses of the learning device, namely that the sentences in the student books are less understood by students. After the revision is complete, a second experiment is carried out to determine the effectiveness of the learning device and to improve mathematical problem solving abilities.

Stage 4 – Disseminate

At the disseminate stage, learning tools that have been tested and revised and have produced effective learning tools are called the final draft. Furthermore, the final draft was tried out on a small scale in the same school with different classes.

Result of Trial I

From the results of the first trial data analysis, it is known that the learning tools developed have not been effective, this is because there are still a number of indicators of effectiveness that have not been achieved, namely the percentage of classical completeness that is achieved is 67%, which means that it has not met the classical completeness criteria. other than that, only item number 3 reached the criteria to achieve the learning objectives of at least 75%. While the indicator of effectiveness that has been met in the first trial is the achievement of learning time, namely the learning time used during the first trial is the same as ordinary learning and student responses, namely students respond positively to the components of the Wankat-Oreovocz Strategy learning system developed. Based on the results of this analysis, it is necessary to revise several components of the learning tools developed in order to obtain quality learning tools for the Wankat-Oreovocz Strategy and to improve students' mathematical problem solving abilities.

Result of Trial II

After conducting trial I on draft II, further improvements were made to produce learning tools that meet all the predetermined effective criteria. The revision results in draft II produce draft III which is then tested on grade VIII-3 students. Based on the results of data analysis, the learning tools developed using the Wankat-Oreovocz Strategy have met the criteria for effectiveness. This is indicated by the percentage of classical completeness that is achieved is 87%, which means that it has met the classical completeness criteria, besides that the achievement of learning objectives has reached the criteria to achieve the learning objectives of at least 75%. While the achievement of learning time, namely the learning time used during the second trial was the same as ordinary learning and student responses, namely students responded positively to the components of the Wankat-Oreovocz Strategy learning system developed. Based on the results of the analysis from trial II, it is known that the learning tools developed have met all the criteria for being effective, then the learning tools become the final draft. Furthermore, the final draft was tried out to class VIII-4 with the results of the analysis found that the learning tools developed had met all the criteria for being effective. Results of the Analysis of the Improvement of Students' Mathematical Problem Solving Ability

The description of the analysis of the increase in students' mathematical problem solving abilities using the Wankat-Oreovocz Strategy learning tool at each stage can be shown in table 1.

Table 2. Description of Results of Mathematical Problem Solving Ability

Informasi	***Posttest*** **Trial I**	***Posttest*** **Trial II**	***Posttest Stage Disseminate***
the highest score	80,00	90,00	96,67
Lowest Value	46,67	56,67	63,33
Average	69,44	78,11	83,11

Based on Table 2 regarding the results of the analysis of the increase in students' mathematical problem solving abilities in the first experiment, the second experiment and the distribution stage, it shows that the average posttest results in trial 1 were 69.44, increasing to 78.11 in Trial 2 and at the

deissemination stage increased again to 83.11. In addition, the improvement of students 'mathematical problem solving abilities can also be seen based on the N-Gain calculation of the results of students' mathematical problem solving abilities in trial 1, trial 2 and the distribution stage shown in table 2. below.

Table 3. Summary of N-Gain Results Metematical Problem Solving Ability

Trial 1	Trial II	Stage Disseminate
0,20	0,37	0,50

Based on Table 3, it can be seen that in trial 1, trial 2 and the spread stage increased from 0.20 to 0.37 and the distribution stage increased to 0.50. This shows that students' mathematical problem solving abilities using learning tools developed with the Wankat-Oreovocz strategy have increased at the disseminate stage. Based on the results of previous research and the support of the above research, it shows that learning with the Wankat-Oreovocz strategy is significantly better in improving students' mathematical problem solving abilities. Based on this, it can be concluded that the learning tools developed using the Wankat-Oreovocz Strategy have a positive impact on improving students' mathematical problem solving abilities.

Conclusions

Based on the results of the analysis in this study, it can be concluded that the learning device using the Wankat-Oreovocz Strategy has met the criteria of being effective and the ability to solve mathematical problems has increased. This study shows that the learning device using the Wankat-Oreovocz Strategy is something that needs to be considered in an effort to maximize students' mathematical problem solving abilities.

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