Problem Solving test

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Development of mathematical problem solving tests for junior high school students

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Instrument is one of the things that must be prepared by a researcher. To measure the ability to solve mathematical problems in students, a research instrument related to problem solving is needed in order to obtain a valid and standardized instrument. This study aims to obtain a mathematical problem-solving test on a valid and practical triangle and rectangular material. The stages used in this research are developed, which is the third stage of 4-D. The development phase includes two steps, namely, expert judgment and development testing. The instrument used in the study was a validation sheet used by the validator to measure each item of problem-solving test items. Data analysis techniques used the Aiken method for expert judgment and descriptive qualitative for development testing. The results showed that the mathematical problem-solving test instrument has an Aiken V index of more than 0.532, so it can be concluded that the mathematical problem-solving test instrument is valid and practical and can be used to measure students' ability to solve mathematical problems. In connection with these results, this research instrument can be used to obtain data about the ability to solve mathematical problems in flat plane geometry material for junior high school students.

Keywords: Problem-Solving; Instrument Research; Geometry,

Introduction

The instrument is one of the tools used to obtain data in research (Onwuegbuzie et al., 2010; Wotruba & Wright, 1975). Both in quantitative research and qualitative research, the existence of an instrument becomes an important one and must be available because it aims to obtain the research data needed (Borgman, 2012; Drost, 2011; Taherdoost, 2018). Although in qualitative research, the main research instrument used is the researcher himself, but the existence of instruments such as test and non-test instruments is very helpful for researchers to obtain data (Girard & Cohn, 2016; Reeves & Marbach-Ad, 2016). One instrument that can be used to measure students' cognitive abilities is a mathematical problem-solving test (Jacobse & Harskamp, 2012) (Jacobse & Harskamp, 2012; Nguyễn & Nguyễn, 2017; Tanujaya et al., 2017). This test generally aims to obtain the ability of students to solve mathematical problems.

Mathematical problem-solving tests become urgent and essential needs in the context of the fulfillment of mathematical education research instruments and mathematical learning outcomes instruments. This need is very reasonable because it relates to efforts to improve students' mathematical problem-solving abilities as one of the main goals of learning mathematics. In line with the policy of the Ministry of Education and Culture of the Republic of Indonesia regarding the obligation to accustom students at school to be given Higher Order Thinking Skills questions (Widana et al., 2019), the development of mathematical problem-solving ability tests becomes an activity that is highly relevant to the policy.

The ability to solve problems in mathematics is one of the skills that students need to have. Because the problem-solving ability can be the basis of students in terms of maintaining their opinions rationally and logically (National Council of Teachers of Mathematics, 2000), so students can build their thinking in solving the problem being faced (Wahyu Hidayat et al., 2018). With the ability to solve mathematical problems, it is expected to train students in understanding problems, planning strategies for solving problems, solving problems through planning, and checking the results that have been resolved (W Hidayat et al., 2019; W Hidayat & Aripin, 2019; W Hidayat & Sariningsih, 2018). But the reality in the field, teachers tend to still have difficulty in designing the learning process from planning to evaluation. In contrast, the expected learning objectives are a series of results, starting from the plan to the assessment. One solution to solve these problems is to arrange and develop teaching materials in the form of learning instruments that can improve students' mathematical problem-solving abilities

(Hendriana, Prahmana, et al., 2019; Hendriana, Putra, et al., 2019; Rohaeti et al., 2019). Thus the development of test instruments related to students' mathematical problem-solving abilities is an urgent matter for research.

Based on these objectives in this study is to obtain a valid and practical mathematical problem-solving test instrument. Students 'ability to solve problems refers to Polya's problem-solving procedures, namely understanding the problem, planning to solve the problem, carrying out the plan, and checking the students' answers (Polya, 2004). The test developed in this study is a test on geometry material, especially on triangles and quadrilateral material used in seventh-grade students of junior high school. It is hoped that the goal of learning geometry, namely developing the ability to apply geometry through modelling and problem-solving in a real-world context, can be achieved (S Maarif et al., 2019; Samsul Maarif et al., 2018).

Method

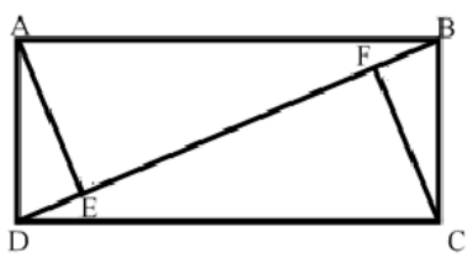
This study uses the develop stages in R&D research, where the develop stage is third after the define and design stages (Thiagarajan et al., 1974). Two stages must be carried out at the develop stage, namely expert judgment and development testing (Thiagarajan et al., 1974). The purpose of these two stages is to see the validity of the mathematical problem-solving test instruments for junior high school students. The expert assessment step is carried out to assess the feasibility of a research product, in this case, the instrument of problem-solving tests, whereas the development testing aims to test the readability of problem-solving test instruments, where the instrument readability is seen from linguistic aspects such as ambiguous or not.

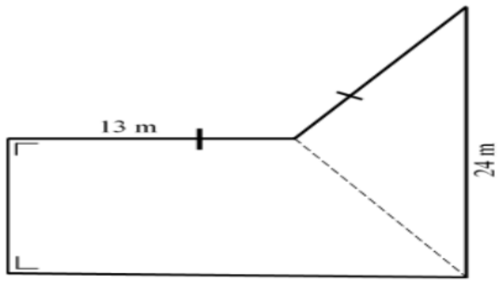
The subjects used in this study are very dependent on the develop stages used. In the expert assessment stage, subjects were used as many as 14 people taken by purposive sampling. Then they were referred to as validators. The validator consisted of

4 experts in the field of Mathematics Education, and 10 people came from education practitioners (junior high school teachers). At the develop subject stage, as many as 15 students were used purposively.

The instrument used in this study was a validation sheet used to measure the validity of the problem-solving test instrument. The validation sheet covers material aspects, construction aspects, and language aspects. The problem-solving test that will be validated can be seen in Table 1.

Table 1. Test of mathematical problem solving

No	Problem
1	A parallelogram ABCD, P and Q lies on BD so AP and CQ perpendicular BD. If it's long a AD = 13 cm, BD = 25 cm and wide area of parallelogram is 125 cm2, count length of PQ!
2	 Rectangle ABCD, like in the picture. If length AB = 8 cm and BC = 6 cm, then calculate the length of the track AEFC
3	ABCD is square with the lengths of the sides are 2 cm. E is a midpoint CD, F is the midpoint AD, G is the cut point of BF with AC, and H is the cut point of BE with AC. Determine the area EDFGH!

No	Problem
4	A square picture frame is rotated 45^0, with the axis of intersection of the diagonal-diagonals. If the length of the square side is 1 cm, determine the area of the incision between the photo frame before and after rotating
5	 Mr. Ali has a plot of land shaped like the picture on the side. Determine the land area of Mr. Ali!

The data analysis technique used is adjusted to the stage of the research used, namely at the expert assessment stage the Aiken method is used to determine the index of content validity or the content validity index of mathematical problem-solving test instruments (L. H. Aiken & Patrician, 2000; L R Aiken, 1999; Lewis R Aiken, 1980, 1999), while in the development testing phase it is done descriptively.

Result

In the expert judgment section , This study only uses the develop stage, which is part of the 4-D research and development phase (Thiagarajan et al., 1974). The develop stage is the third stage after the defined and design stages. The stage of develop is the foundation of a researcher to carry out the dissemination stage.

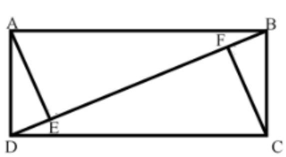
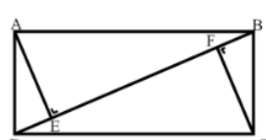
The results of the expert's assessment in assessing 5 problem-solving problems in each aspect can be seen in Table 2.

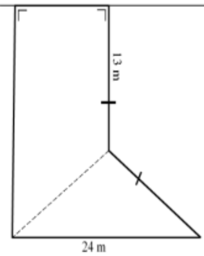
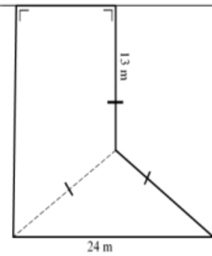
Table 2. Validity Summary (V) Aiken

Aspect	Validity Item	Item Number				
		1	2	3	4	5
A	A1	0.881	0.952	0.976	0.976	0.905
	A2	0.786	0.976	0.881	0.881	0.929
B	B1	0.857	0.976	0.786	0.736	0.881
	B2	0.786	0.976	0.786	0.952	0.976
C	C1	0.952	0.881	0.881	0.905	0.952
	C2	0.786	0.976	0.881	0.857	0.857

In the developmental testing step one of the goals is to see the readability of the mathematical problem solving test instrument. The readability of problem solving test instruments is seen from the linguistic aspects such as the meaning of ambiguous mathematical problems or not. The final goal in this development stage is to obtain a problem solving test instrument that can be used to measure the ability to solve mathematical problems in junior high school students. From the results of the development testing conducted on 15 students taken purposively, several notes were obtained, as shown in Table 3.

Table 3. Revised summary of problem-solving problems

Number of problem	Problem Before Repairing	Problem after Repairing	Information
2			Improvements to the image, added a right symbol

Number of problem	Problem Before Repairing	Problem after Repairing	Information
5			Improvements to Pictures

Discussion

Whether or not a mathematical problem solving test instrument can be seen from the results of the content validity index (Pardimin et al., 2018). The validity index obtained is compared with the product moment correlation index for N a number of validators in $\alpha = 5\%$. Because the study used a validator of 14 people, the product moment correlation index was (rxy) = 0,532. So, if an index of content validity is obtained (V) more than 0.532, the mathematical problem solving test instrument is declared good and can be used to measure students' ability to solve mathematical problems. But if the content validity index (V) is obtained less than or equal to 0.532, the mathematical problem solving test instrument needs to be improved.

From Table 2, it is obtained that each validation item has a content validity index (V) of more than 0.738. So it can be concluded that the mathematical problem solving test instrument is expressed both in terms of mathematics, construction, and language.

Content validity is a degree of measurement that reflects the expected content domain (Allen & Yen, 2001; Gay, 1990; Kimberlin & Winterstein, 2008). Content validity is important for cognitive tests, such as achievement tests and problem-solving skills. So before the test is used to obtain data about the cognitive abilities of the respondent, a researcher needs to do a validity test based on the content first. This is done so that a test instrument can reflect the students' true cognitive abilities. Some things that a researcher can use to enhance a content validity include identifying materials that have been given along with their instructional objectives, making a grid of test questions to be tested, compiling test questions and their answer keys, and examining test questions before they are printed or duplicated (Budiyono, 2003).

From the results of the development testing conducted on 15 students taken purposively, several notes were obtained (Table 3). Besides the revision of the test questions as in Table 3, the process of solving the problem using Polya's steps written on the instructions for working on the items need not be written down. Because the problem-solving process is a heuristic process, not a process of problem-solving procedures that must be ordered. This is contrary to the results of previous research which states that in solving problems, a student must solve in order (Pardimin & Widodo, 2016), in solving problems, a student must understand the problem, plan the problem, and carry out the plan (Polya, 2004). If problem-solving is designed as a heuristic process, the problem-solving procedure can be ignored by students implicitly carrying out the problem-solving stages of Polya. This is like the findings in previous studies which stated that (1) some students did not make the stage of understanding the problem by not writing what was known and asked of the problems, but students could solve the problem correctly; (2) or students in writing do not do the stages of checking answers again, but students can provide a conclusion in solving problems (Widodo, 2014; Widodo et al., 2019; Widodo & Turmudi, 2017).

Conclusion

The ability to solve problems is one of the cognitive skills that must be possessed by every student in learning mathematics. To measure the ability to solve mathematical problems, we need a good test instrument, which is valid and practical. To get a good instrument, we need a trial instrument that must pay attention to content validity. Based on the results and discussion explained in the previous section, it was found that the mathematical problem-solving test instrument on triangles and triangle material had fulfilled validity and practicality. For that instrument can be used to measure the ability to solve mathematical problems, especially in the material triangle and quadrilateral in junior high school students.

Recommendation

The results of this study indicate that the problem-solving test on geometry material can be concluded as valid. For this reason, this problem-solving test can be used to extract data on junior high school students' ability to solve mathematical problems, especially flat geometry.

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