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Development of Mathematics Learning Devices by Applying Problem Based Learning to Increase Students Mathematical Solving Skills of Class VII Junior High School

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A B S T R A C T

This research was motivated by the low ability of Mathematical Problem Solving (KPMM) of students. In order to improve KPMM, teachers can do designing the learning process. This study aims to develop mathematical learning tools that are valid, practical and effective. The development model used the Borg and Gall model. The research instrument consisted of syllabus validation sheets, lesson plane (RPP), student worksheet (LKPD), observability of implementation, student questionnaire responses and KPMM test instruments. The result shows the mathematics learning kit using the PBL model was already valid which is for the syllabus was 85.41%, RPP was 85.11%, LKPD was 88.67% and the test instrument was 81.71%. The learning kit fulfills the practicality requirements in large group trials with an average questionnaire of students responses of 91.99% and an average of 94.58%. Effective mathematics learning tools is to improve KPMM of students with student learning outcomes that is based on the achievement of KKM with the percentage of completeness reached is 88.24%. Development of learning tools can significantly improve students mathematical problem solving abilities at a significant level of P = 0,000 with $\alpha = 0.05$. Thus, it can be concluded that the development of mathematics learning tools by applying problem based learning can improve students mathematical problem solving abilities

1. Introduction

Mathematical thinking is a mathematical process that includes five aspects, one of them is to solve mathematical problems (Heleni et al., 2018). Mathematical problem-solving ability is one of the basic abilities that must be mastered by

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students, this is because the problem-solving ability is considered the heart of mathematics, (Putra et al., 2018). The importance of developing the ability to solve mathematical problems has been recognized by many parties. This can be seen from Permendikbud number 22 of 2016 stating that one of the goals or competencies that must be achieved in learning mathematics is that students have the ability to solve problems. The results of the preliminary study related to the mathematical problem solving ability of students in Kampar are still low (Yunita et al., 2018). The results of research conducted by Suharti (2013) show that students' mathematical problem solving abilities are still low.

Problem solving ability is the ability of students to use several high-level thinking processes in order to obtain solutions to the problems encountered (Nitko et al., 2011). One learning model that can improve students' mathematical problem solving abilities is the problem based learning model (Vikriyah, 2015). The problem based learning model is a learning model that uses problems as a focus for developing problem solving skills, materials, and self-regulation (Eggen et al., 2012). This shows that the ability to solve mathematical problems is an ability that must be possessed by students and is one of the factors that determine student learning outcomes in mathematics (Guswinda et al., 2019). Furthermore, Rianti et al., (2020) also states that learning tools developed can improve mathematical problem solving abilities.

This problem based learning model is very suitable to be applied to material related to daily life. One material that is closely related to daily life is social arithmetic material. Social arithmetic is a part of mathematics that discusses financial calculations in commerce and everyday life. Social arithmetic material emphasizes the ability of students to understand contextual mathematical concepts that describe everyday life. The questions given require students to be able to solve problems in the form of story questions (Siswanto et al., 2013). Although the basics of this social arithmetic material have been studied at the elementary level, in reality there are still senior high school level students who have difficulty when learning social arithmetic materials. Thus, teachers need to develop learning tools so that learning objectives can be achieved properly.

Facts that occur in schools show that until now there are still many teachers who have not developed learning tools that are in accordance with the 2013 curriculum. This is in line with the results of research conducted by Heleni et al., (2017), the results of his research indicate that the syllabus developed by teachers is not in accordance with the components in Permendikbud number 22 of 2016, RPP is made not based on a syllabus that has been packaged well and the worksheet used is a worksheet that contains a summary of material and a collection of questions that are not in accordance with the principles of learning curriculum 2013. Researchers conducted interviews with several people teacher in Kampar. Based on the results of interviews that have been conducted, information is obtained that there are still many teachers having difficulty developing tools in accordance with the 2013 curriculum. In addition, teachers also have difficulty designing LKPD that can help students find their own concepts of the material being studied and can develop mathematical problem solving abilities.

Therefore, researchers have developed learning tools through problem based learning in social arithmetic material as a means to train and improve students' mathematical problem solving abilities. Learning devices are said to have good quality if they are valid, practical and effective (Nieven in Novrini, et al, 2015). Then, Nieven in Rochmad (2012) revealed that the developed learning device is expected to meet the validity criteria, that is, the device is based on adequate theory and all components of the learning device used are consistently related. Furthermore, Sari et al., (2016) states that the device developed meets practicality criteria, namely mathematics education experts and education practitioners in theory that the device can be implemented in the field and the level of implementation is in good category. Based on these descriptions, this study was conducted with the aim of developing mathematics learning tools through problem based learning on valid, practical and effective social arithmetic materials to improve students' mathematical problem solving abilities.

2. Methodology

This research was a development research. The trial was conducted on grade VII students of SMPN 1 Kampar. Data collection techniques in this study was to provide a questionnaire to collect validity and practicality data, while the data of student learning outcomes namely KPMM data are collected through tests. Data analysis techniques used in this study were validity analysis, practicality analysis and effectiveness analysis.

Analysis of the Validity of Mathematics Learning Devices.

The formulas used to analyze the results of the validation are as follows:

$$Vp_x = \frac{TSe}{TSh} \times 100\%$$

Where:
V_ (px): Expert validator, based on each syllabus, RPP and LKPD with x = 1,2,3
TSe: Total empirical score (validation results from validator)
TSh: Maximum expected total score

On average of all validators, the percentage level can be adjusted according to the validity category as in Table 1.

Table 1 Categories of RPP and LKPD Syllabus Validities

Interval	Category
85,01 % - 100,00%	Very valid, or can be used without revision
70,01 % - 85,00 %	Valid, or can be used but needs a small revision
50,01 % - 70,00%	Invalid, it is recommended not to be used because it needs major revisions
01,00% - 50,00%	Invalid, or may not be used.

Learning tools can be used if the average validation score is in the valid category or very valid.

Analysis of Practicality of Mathematics Learning Devices

The data analyzed in this study were the results of the students' questionnaire responses and the results of the observation sheets.

1. Analysis of Student Response Questionnaire

To find out the final results of students' responses, the average is calculated using the modified formula from Akbar (2013). Following is the formula to find the average results of the questionnaire responses of students.

$$R = \frac{\sum P}{jumlah\ peserta\ didik}$$

Note: R = The final result of students' responses
$\sum P$ = Total percentage of practicality

The percentage level of the results of the average analysis of all learners is adjusted according to the practicality category in Table 2. Learning tools are said to be practical to use if the average obtained is in the category of minimal practical or very practical.

Table 2 Practical Categories

Interval	Category
85,01 % - 100,00%	Very practical
70,01 % - 85,00%	Practical
50,01 % - 70,00%	Less Practical
01,00 % - 50,00%	Not practical

2. Data Analysis of Learning Implementation

The formula that was used to calculate the percentage of activity implementation at each meeting is a modified formula from Akbar (2013):

$$P = \frac{TSe}{TSh} \times 100\%$$

Note: P = Percentage of practicality
TSh = Total expected maximum score
TSe = Total empirical score

The percentage level of analysis results from observers, adjusted for the category of performance in Table 3. The implementation of the learning process is said to be practical if the percentage of implementation is at least good or very good.

Table 3 Categories Implementation of Learning

Interval	Category
85,01 % - 100,00%	Very good
70,01 % - 85,00%	Good
50,01 % - 70,00%	Pretty good
01,00 % - 50,00%	Not good

Analysis of the average difference test

The average difference test was done to see the difference in KPMM of students. The difference test was done by t-test. Before the t-test was carried out, a prerequisite test was done which is the normality test and the variance homogeneity test.

Normality Test. The normality test was sought using SPSS 20 using the Kolmogorov-Smirnov test.

Variance Homogeneity Test. Homogeneity test aimed to determine the similarity of data variants. Homogeneity test was sought using SPSS 20 using one way ANOVA test.

Difference Test Two Average KPMM Test Results. Average comparison test is used to see the difference in the average KPMM results of students in the experimental class and the control class.

3. Results and Discussion

This research was a development research, which is developing learning devices that meet valid, practical and effective criteria to improve mathematical problem solving abilities. The results of this study describe the process of developing learning tools in the form of syllabus, lesson plans and mathematics teaching workshops for grade VII junior high schools using problem based learning models.

Research Results

In developing of learning tools, format selection is carried out. The choice of format is adjusted to the steps of the problem based learning model. Then the format of each device to be developed. After completion, the learning device is validated by a validator and continued with a trial. The following is a cover image of the revised LKPD (Figure 1).

Figure 1. Revised LKPD cover

Learning Device Validation Results

Validator assessment of learning tools developed, namely syllabus, lesson plans and LKPD, obtained an average score of validation results as in Table 6.

Table 6. Results of Syllabus, RPP, and LKPD Validation Results

Average Validation Score	Silabus	RPP	LKPD
	85,41%	85,11%	96,65%
Criteria	Very Valid	Very Valid	Very Valid

Based on the validity criteria of the learning tools, the syllabus, lesson plans and worksheets developed are in the very valid category, so that the syllabus, lesson plans and workshops can already be used.

Results of Validation of Tests for Mathematical Problem Solving Abilities

The validator's evaluation of the test questions about mathematical problem-solving abilities includes aspects of material, construction and language. The results of the validation of the mathematical problem solving ability test questions can be seen in Table 7.

Table 7. Results of KPMM Test Instrument Validation Results

Average Validation Score	KPMM Test
	81,71%
Criteria	Valid

Based on the validity criteria of the developed mathematical problem solving ability test instrument, it was found that the average results of the instrument validation were 81.71% with a valid category, so that the mathematical problem solving ability test questions could be used.

Readability Test Results

Readability test was conducted for 8 students. Based on the results of the questionnaire responses to LKPD used by students, it was found that the average total of LKPD-1, LKPD-2, LKPD-3 and LKPD-4 was 96.65%. Based on the practicality criteria, it can be concluded that the developed LKPD is in the very practical category.

Practical Trial Results

Practicality trials are carried out after the device is revised. Practicality trials were conducted on 30 students. The practicality of the device was assessed from the students' questionnaire responses and the observation sheet of accomplishment. The results of the questionnaire responses of students after using the learning device is 91.99% meaning that the device used is very practical and the results of

the observation sheet carried out during the 4 meetings obtained an average total of 94.58% means the device developed is very good to use.

Effectiveness Test Results

The effectiveness test in this study was conducted on 31 students. The effectiveness of learning devices can be seen from the completeness of student learning outcomes. The complete students in this study numbered 27 people. This completeness criterion is based on the KKM set by the school, which is 75. So the percentage of students who reach the KKM is 87.1%. Based on the percentage of students completeness, it can be concluded that the learning tools developed are effective for improving student learning outcomes.

Difference Test Results of Two Averages (t-Test)

Based on the t-test that has been done, obtained a significant level of $P = 0.00 < \propto = 0.05$ so that it can be concluded that H0 is rejected or there are differences in the results of students' mathematical problem-solving abilities between the experimental class and the control class. Thus there are differences in the ability to solve mathematical problems between students who use learning tools that are developed with students who do not use learning tools that are developed. Therefore it can be concluded that learning tools can also improve students' mathematical problem solving abilities.

Discussion

This development research was conducted with the aim of producing a product in the form of a learning device. Learning tools developed are syllabus, lesson plans and LKPD by applying problem based learning and KPMM test instruments.

Learning tools that have been developed are assessed for validity, practicality and effectiveness. The validity test of the learning device was conducted by three validators. After the learning kit is validated by the validator, the validation results are analyzed and a revision is made. Furthermore, the revised equipment was tested on a small group to obtain LKPD readability data and was tried on a large group to obtain practicality and effectiveness data of the device.

The evaluation aspects contained in the syllabus consist of two aspects, namely the content and construction aspects. This is in line with Rochmad (2012) which states that the validity in a development study includes content validity and construct validity. Both aspects are included in the syllabus validation sheet. The results of the validation of the content aspect is 87.50% with a very valid category and the construction aspect is 83.33% with a valid category. So the average syllabus evaluation is 85.41%, which means the developed syllabus is in the "very valid" category. This shows that the syllabus that has been developed is in accordance with the syllabus component of Permendikbud No. 22 of 2016. However, there are suggestions from the validator, namely adding learning resources, so that students get more information.

Next, the results of the RPP validation developed were analyzed. The assessment aspects of the CSP consist of two aspects, namely the content and construct aspects. The results of the validation of the content aspect are 85.37% and the construct aspect is 83.33%, meaning that the developed lesson plans are in the "valid" category. The RPP is in accordance with the RPP component of Permendikbud No. 22 of 2016. Nevertheless, the validator gives several suggestions, namely to clarify the symbols contained in the facts in RPP-1 and incorporate the problems contained in LKPD into the RPP.

The results of the validation of the content aspect is 88.19%, the didactic aspect is 87.50%, the construction aspect is 89.17% and the technical aspect is 89.81%. So the assessment of the three validators of the LKPD developed as a whole is in the "very valid" category. Then it can be concluded that the developed LKPD meets the requirements of a good LKPD. This is in line with Nurhayati et al., (2015) which states that LKPDs are prepared that have good quality if they meet didactic, construction, and technical requirements. However, there are some suggestions from the validator that the supporting images contained in LKPD-1 are replaced with pictures that researchers took themselves and the sentence sentences contained in LKPD-1 are clarified again.

The researcher also analyzed the results of the validation of the mathematical problem solving ability test questions. It was found that the average validation of mathematical problem solving ability test questions was 81.71% with a valid category. This means that the problem solving ability test questions can be used with minor revisions. Subsequently revised editorial test questions mathematical problem solving ability in accordance with the advice of the validator.

After completing the revision of the device, the researcher then tested the LKPD to 8 students. This is done to see the readability of students towards LKPD that has been developed. The same thing was expressed by Ahmad et al., (2017) that the readability test process is the process of seeing students' readability towards learning tools. The results of the questionnaire responses of students to LKPD in the initial field trial of 96.65% means that the readability of LKPD developed "very practical" is used by students

Then a large group trial is conducted. This large group trial was conducted with the aim of seeing the practicality and effectiveness of the devices that had been developed. The same thing was expressed by Oktaviani et al., (2017) who stated that the practicality of the developed learning tools can be known from the analysis of the results of the teacher and student assessment questionnaire, as well as the results of observing the implementation of learning in the pilot class. However, in this study the researchers only used the observation sheet of the feasibility and student questionnaire responses. Observation sheets are used to determine the feasibility of learning in accordance with the design of learning devices (Roliza et al., 2018). The observation sheet is given to the observer at each meeting to find out the practicality of the syllabus and lesson plans. The aspects contained in the teacher activity observation sheet consist of three aspects,

namely, preliminary activities, core activities and closing activities. At the core activity, the learning model applied is the problem based learning model.

The results of the data analysis on the observation sheet of implementation, it was found that the average aspect of the preliminary activities was 96.25%, the average aspect of core activities was 93.75% while the average on the closing activity aspect was 93.75%. Based on the practical results of the observation sheet the implementation of teacher activities in implementing problem based learning models in all three aspects have been implemented well, with an average yield of 94.58%. Learning tools are said to be good if the achievement of learning performance / the ability of teachers to manage learning is at least good enough (Novrini et al., 2015).

Then, a questionnaire was given to all students present to find out the practicalities of the LKPD. Roliza et al., (2018) in her research stated that the aspects observed in students' questionnaire responses consisted of aspects of skills, aspects of material, aspects of attractiveness, aspects of language, and aspects of time. However, in this study, aspects that will be observed consist of four aspects, namely aspects of format, aspects of content, aspects of language and writing and aspects of the benefits of observation sheets.

Based on the questionnaire responses of students it was found that the average response of students to the practicality of LKPD was 91.99%, meaning that the device developed was "very practical" to use. Learners revealed that the developed LKPD can help students in understanding social arithmetic problems related to daily life. Next, a large group trial is conducted to see the effectiveness of the learning tools. This effectiveness test was conducted on two classes, namely class VIIb as the experimental class and class VIIc as the control class. experimental class using learning tools that researchers developed. In this study, data on learning outcomes were obtained from the results of tests of mathematical problem solving abilities.

The effectiveness of the learning tools developed can be seen from the completeness of the test results of students' mathematical problem solving abilities in a classical way. Then the researchers tested the average difference in mathematical problem solving abilities between the experimental class and the control class. This test is conducted to see an increase in students' mathematical problem solving abilities. Based on completeness tests of students' mathematical problem solving abilities obtained the percentage of students who reach KKM after the use of mathematical learning tools developed is 75%. Then it can be concluded that the learning tools developed are effective for improving students' mathematical problem solving abilities.

Researchers then tested the average difference to see differences in the mathematical problem solving ability of the experimental class and the control class. Based on the t-test it was found that the significance level of $p < \propto = 0.05$. So it can be concluded that H_0 is rejected or there are differences in the ability to solve mathematical problems between students who use mathematical learning

tools that are developed with students who do not use learning tools that are developed.

Based on the observation sheet of the implementation of teacher activities in the learning process towards the use of syllabus and lesson plans, as well as the questionnaire of students' responses to the use of LKPD it can be concluded that the syllabus, lesson plans and LKPD have met the practicality criteria. Based on the test results of students 'mathematical problem solving abilities it can be concluded that the learning tools developed are effective for improving students' mathematical problem solving abilities. Based on the average difference test (t-test), it is known that there are differences in the ability of solving students who use devices that are developed with those that do not use devices that are developed.

4. Conclusion

This development research resulted in a learning device. Learning tools in the form of syllabus, lesson plans, and LKPD. The device was rated by three validators. As for the results of the assessment that has been done, it was found that the device was valid. Then conducted two trials, namely the initial field test (readability test) and the main product field test (practicality test). Then a large scale field test (effectiveness test) is performed. Based on the results of validation and trials conducted, it was found that the development of learning tools in the form of syllabus, lesson plans and LKPD through the application of problem based learning in social arithmetic material already fulfills valid aspects, is practical for use for the student of junior high school or the same level with it (SMP or MTs students) and is effective for improving mathematical problem solving abilities.

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