Journal of Educational Sciences
Journal homepage: https://jes.ejournal.unri.ac.id/index.php/JES

P-ISSN 2581-1657
E-ISSN 2581-2203

Development of Learning Tools with the Application of Learning Inventions to Improve Mathematical Problem Solving Ability Social Arithmetic Material

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ARTICLE INFO

Article history:

Received: 06 July 2019
Revised: 14 Oct 2019
Accepted: 04 Jan 2020
Published online: 24 Jan 2020

Keywords:

Development Research
Discovery Learning
Mathematical Problem Solving Ability
Social Arithmetic

A B S T R A C T

The results of the preliminary study indicate that the learning tools used by the teacher do not meet the 2013 curriculum rules. This study aims to produce learning tools with the application of discovery learning to improve Mathematical Problem Solving Ability (KPMM) on social arithmetic materials for grade VII junior high school. This study used the Borg and Gall development model with stages: (1) research and data collection; (2) planning; (3) development of learning tools; (4) limited trials; (5) product revisions; (6) field trials; (7) product revisions; (8) final product test; (9) revision of the final product; and (10) dissemination and implementation. The validation results showed that it was very valid with consecutive average percentages for KPMM problems that were 94.64%, syllabus was 90.10%, RPP was 93.14%, and LKPD was 92.60%. In the final product test phase, learning tools were used through pre-experimental research to see the increase in KPMM. The final product test results indicated that there was an increase in KPMM of students using learning tools. This means that the learning tool with the application of discovery learning in social arithmetic material in class VII SMP has been valid, practical, and effective.

1. Introduction

Learning in the 2013 curriculum is activity-based learning that gives students the opportunity to develop their potential, interests and talents to achieve their goals (Kemendikbud, 2017). School-based curriculum standards reveal that students must have a set of mathematical competencies that are manifested after the learning process occurs (Hutapea, 2019). Students' thinking skills must be

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Doi: https://doi.org/10.31258/jes.4.1.p.44-52

developed to understand mathematics correctly (Heleni, et al, 2018). One of the goals of mathematics learning listed in the 2013 Curriculum is mathematical problem solving. Mathematical problem solving is defined as an area of cognitive psychology that deals with the process of solving problems (Pal, et al, 2017).

Mathematical Problem Solving Ability (KPMM) is an important mathematical ability and needs to be mastered by students. The fact that is experienced now shows that KPMM of students is still low. One of the factors causing the low KPMM is due to the lack of emphasis in the learning process both the availability of learning resources and the facilities provided by the teacher (Apriyani, et al, 2018). Most schools do not teach students to think critically or solve problems. Worksheets contain facts that require students to remember only, so the evaluation ability test is limited to memorization (Yennita, et al, 2018). Researchers conducted KPMM analysis of the number of 38 students with the results that: (a) 52.63% of students were unable to identify what was known and asked correctly; (b) 65.79% of students have not been able to use concepts and formulas based on the problem given correctly; (c) 60.53% of students have not been able to calculate and solve problems correctly; and (d) 60.53% of students have not been able to provide conclusions based on the problems given correctly.

The application of discovery learning model is one alternative to improve KPMM of students in mathematics. Balım (2009) explains that discovery learning is one of a variety of learning models that actively involve students. Discovery learning model facilitates students to find concepts and materials taught through various activities (Wasilah, et al, 2018).

Mathematics is often regarded as a subject that is difficult to understand both in theory and its application (Roza, et al, 2017). One of the mathematical material that can be taught with the application of discovery learning is social arithmetic. Setyono, et al (2013) stated that errors in solving mathematical problems in the form of stories in social arithmetic material are still quite high. Mastery of the ability to solve mathematical problems in the form of stories is very important for students, but in reality there are still many students who experience difficulties.

The teacher as a professional educator is expected to arrange the learning tools and develop them according to the situation and conditions. The results of the needs analysis show that learning tools with the application of discovery learning in social arithmetic materials are still limited. Based on the results of researchers 'interviews with five junior high school mathematics teachers in Pekanbaru, it was shown that 20% of teachers developed tools and used them in the learning process, while 80% of teachers used learning tools that came from publishers or the results of the Subject Teachers' Consultation (MGMP). Learning tools in the form of syllabus and lesson plans that have been used have not met the demands of Permendikbud Number 22 of 2016. Worksheets used by students also have not been able to facilitate students to construct their knowledge.

Based on the above problem, it is necessary to develop a learning device with the application of discovery learning to improve KPMM on social arithmetic

materials. Researchers develop learning tools in the form of syllabi and lesson plans that serve as guidelines for teachers in implementing the learning process. Researchers also developed LKPD which were used by students to investigate and construct knowledge about social arithmetic which includes profit, loss, profit percentage, percentage loss, discount, single interest, gross, net, and tare. The purpose of development in this research is to produce learning tools with the application of discovery learning to improve KPMM on valid, practical and effective social arithmetic materials.

2. Methodology

This research included research development (research and development). This study used the Borg and Gall (1983) development model with the following stages.

Research and Data Collection Stage

At this stage, researchers conducted a analysis that related to the developed learning tools. The analysis of learning tools was done by interview techniques and document study. The researchers conducted some interviews with five junior high school mathematics teachers in Pekanbaru. Then, the researchers studied the document to know the learning tools used by the teacher. Material analysis was done by analyzing the competencies which contained in Basic Competence (KD). Based on the results of the analysis in the material that contained in the BC, the researchers developed a learning tool with the scope of the material, namely: (1) advantages and disadvantages; (2) profit percentage and loss percentage; (3) discount; (4) single interest; and (5) gross, net and tare. Analysis of student characteristics was done by observing and analyzing students KPMM. The KPMM analysis of students was done by examining the test results based on indicators. Build upon on the results of the needs analysis, the researchers designed a learning device with the application of discovery learning to improve KPMM on social arithmetic materials for grade VII in junior high school.

Development Phase of Learning Devices

The researchers developed learning tools based on a design that had been prepared before. The developed learning tools consisted of syllabus, lesson plans, and LKPD. The learning device was further validated by three validators. Learning tools would be valid if the percentage of validation is more than 70% (Akbar, 2013). The validation results were analyzed to be revised according to the suggestions of the validators.

Limited Trial Phase

At this stage, LKPD was tested on eight students of second grade in SMP Negeri 8 Pekanbaru who had not yet studied social arithmetic material. The students at the limited trial phase were chosen based on advice and consultation with mathematics subject teachers. Then, the students learned using the developed LKPD and

answered questionnaire of responses which aimed at assessing aspects of the material, appearance, and use of LKPD. LKPD would be practical if the percentage of practicality is than 70%. The researcher then revised the LKPD based on the results of a limited trial that had been carried out.

Field Trial Phase

The revised learning tools at the limited trial phase were then tested on 40 students of class VII-5 in SMP Negeri 8 Pekanbaru. The field trials were conducted in five meetings to see the practicality of the syllabus, lesson plans, and LKPD developed. At this stage, the researchers pretended to be as teacher who used learning tools in the classroom, while the real teacher acted as an observer.

The teacher was given an observation sheet and questionnaire responses to assess the learning tools used. While the students were give a questionnaire response after the learning process ended. The students assessed the credibility of LKPD that had been used in the learning process. Then the data would be analyzed by using an average percentage. According to Akbar (2013), learning tools would said to be practical if the percentage of practicality is than 70%. The researchers then revised the learning tools based on the results of field trials that had been carried out.

Final Product Testing Stage

At this stage, the learning tools were used through pre-experimental research with the Intact-Group Comparison design. The experimental design involved two classes, namely experimental class and control class. The control class was conducted in VII-4 class SMP Negeri 8 Pekanbaru. Meanwhile, the experimental class was conducted in VII-2 class SMP Negeri 8 Pekanbaru.

The experimental class was treated by learning process which used the learning tools that were developed, while the control class, which was a comparison class of learning process, did not use learning tools that were developed. The researchers gave KPMM tests to students after the trial was conducted for five meetings. The student test results in the experimental class and the control class were analyzed to see an increase in KPMM. The effectiveness of the learning kit had been done by comparing the KPMM test results with minimal learning completeness. The learning tools would be effective if the KPMM of students in the experimental class had been reached a minimum of 80% learning completeness (Fitria et al, 2014). The learning devices that had been tested were then revised again as needed.

Dissemination and Implementation Stage

At this stage, the researchers reported the results of researching on learning tools in social arithmetic material class at first grade of SMP in the results of seminar. The research article was then published in a journal.

3. Results and Discussion

Research result

The result in this study was developing learning media to improve KPMM on social arithmetic materials in first grade of junior high school. The result of the learning tools are in the form of syllabus, lesson plans, and LKPD that arranged for five meetings on social arithmetic materials.

The result of the needs analysis at the research and data collection stage showed that the learning tools used had not met the 2013 Curriculum rules. The researchers examined the 2013 curriculum and other related theories to develop learning tools, to determine learning models that could engage learners to be active and to find out what abilities students must have. One of the alternatives, the researchers developed a mathematics learning tool to improve KPMM on social arithmetic materials for first grade in junior high school.

Researchers designed learning tools based on the needs analysis. One component developed in the syllabus was learning activities. Learning activities were developed in general by using a scientific approach to social arithmetic materials. The learning activities were arranged according to the learning material in the syllabus.

One component developed in the lesson plan was learning activities. The learning activities contained stages of discovery learning with KPMM indicators. The learning activities contained stages of discovery learning, it can be seen in Table 1.

Table 1. Learning Activities with the Application of Discovery Learning

Description of Activities	Stages of Discovery Learning
Students were given discourse and problems related to the material to be studied at LKPD.	Stimulation
Students were asked to identify problems that existed in LKPD	Identification of problems
Students gathered a variety of relevant information to solve problems or test hypotheses in LKPD by reading references such as math material book in class VII which was published by the Ministry of Education and Culture	Data collection
Students processed data based on information that had been collected to solve problems in LKPD	Data processing
Students were asked to check the work that had been done with the hypothesis that has been made	Verification
Students, with the guidance of the teacher, concluded the results of problem solving that contained in the LKPD	Generalization

Learning activities that contained KPMM indicators can be seen in Table 2.

Table 2. Learning Activities with KPMM Indicators

Description of Activities	KPMM indicator
Students were asked to identify and to make temporary answers to problems that were given.	Understand the Problem
Students were guided to write a plan for solving a math problem.	Planning for Completion
Students were asked to solve the problems which contained in the LKPD	Solve the problem
Students were asked to check the work that had been done according to or not with the hypothesis that had been made	Re-checking

One component developed in LKPD was stimulation which was complemented by problems related to learning material. The stimulation of LKPD can be seen in Figure 1.

Figure 1. Stimulation of LKPD

Then, the learning tools were validated by three validators. The results of the learning devices validation can be seen in Table 3.

Table 3. Results of Validation of Learning Devices

Learning Media	Validation Results	Criteria
KPMM matter	94,64%	Very Valid
Syllabus	90,10%	Very Valid
RPP	93,14%	Very Valid
LKPD	92,60%	Very Valid

The results of the questionnaire responses of students at the limited trial stage showed that LKPD had fulfilled the practical criteria. The results of the limited trial can be seen in Table 4.

Table 4. Limited Trial Results

Learning Media	Meeting to -					Average	Criteria
	1	2	3	4	5		
LKPD	93,30	93,30	91,96	88,62	92,86	92,01	Very practical

The results of the students' questionnaire responses, teacher's questionnaire responses, and observation sheets at the field trial stage indicated that the learning devices had fulfilled practical criteria. The results of field trials can be seen in Table 5.

Table 5. Results of Field Trials

Instrument	Average Percentage	Criteria
Questionnaire responses of students	90,53	Very practical
Teacher Response Questionnaire	85,60	Very practical
Observation Sheet	83,91	Practical

Learning tools were then used through pre-experimental research with the Static-Group Comparison design. The final product test results showed that the KPMM test results of students in the experimental class were better than the results of the KPMM test of students in the control class. It described that there was an increase in KPMM students using learning tools with the application of discovery learning in social arithmetic material on first grade of junior high school. KPMM test results for students in the final product test phase can be seen in Figure 2.

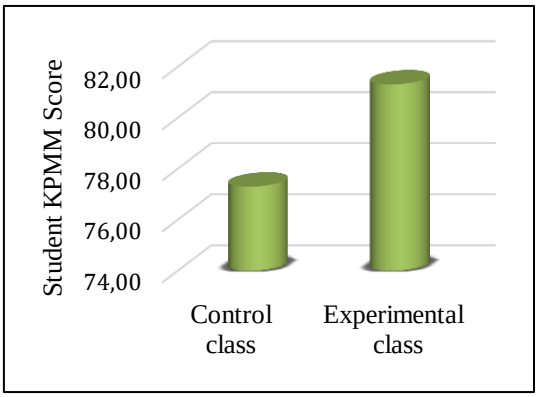

Figure 2. KPMM Test Results at the Final Product Test Stage

Discussion

The results showed that the learning tools with the application of discovery learning to improve Mathematical Problem Solving Ability (KPMM) on social arithmetic material was valid, practical, and effective. The application of discovery learning model was one of some alternatives to improve KPMM of students in mathematics. Sahrudin (2014) suggested the implementation of discovery learning strategies could improve KPMM. This was in line with

Rosdianwinata (2015) who argued that the application of discovery methods could increase KPMM.

The final product test results indicated there were some differences in KPMM students in the experimental class and the control class. KPMM test results in the experimental class showed that 33 out of 40 students achieved minimal learning completeness, with a percentage of KPMM achievement of 82.5%. KPMM test results in the control class showed that 24 of 38 students achieved minimal mastery learning, with a percentage of KPMM achievement of 63.16%.

Fitria, et al (2014) suggested that learning tools were said to be effective if the KPMM of students in the experimental class reached a minimum of 80% learning completeness. The results showed that the KPMM achievement of students in the experimental class reached a minimum mastery of 82.5%. It means that the learning tools used by students in the experimental class were effective in increasing KPMM.

Learning tools, in the form of syllabus and lesson plans, were produced to facilitate the teacher in creating an active learning process. The resulting LKPD facilitates students to construct knowledge independently. Students understood the learning material presented in LKPD. Clear LKPD usage guidelines made students were able to do LKPD well. The problems contained in LKPD were oriented to contextual problems, so students were aware of the usefulness of mathematics in everyday life. Learning tools that had been produced were effective in increasing KPMM of students.

4. Conclusion

Development research conducted had resulted a product in the form of learning tools with the application of discovery learning to improve Mathematical Problem Solving Ability (KPMM) on social arithmetic materials. The results of the learning device validity met the very valid criteria. Learning tools were already practical based on the results of limited trials and field trials. The final product test results showed that there was an increase in KPMM of students using this learning tools.

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How to cite this article:

Ningsih, F., Murni, A. & Roza, Y. (2020). Development of Learning Tools with the Application of Learning Inventions to Improve Mathematical Problem Solving Ability Social Arithmetic Material. *Journal of Educational Sciences, 4(1),* 44-52.