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Developing Learning Devices Based on the Open-Ended Approach to Improve Student's Creative Thinking Abilities

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ABSTRACT
Learning tools based on an open-ended approach with virtual manipulative applications were developed to improve students creative thinking skill. The purpose of this study is to determine the quality of learning tools and the increase in students creative thinking abilities. This study is a development research using the Dick and Carey development model, which is carried out in ten stages. Learning tools produced from this study are Student Books (SB) and Student Worksheets (LKPD). Based on the data analysis, learning tools had met the criteria of being valid, practical, and effective in terms of their respective criteria and increasing students creative thinking skills using learning tools through an Open-ended approach assisted by virtual manipulative applications on quadrilateral material is 4 students (12.5%) experiencing an increase in creative thinking skills with the High category, 17 students (53.13%) experienced an increase in creative thinking skills with the category Medium and 11 students (34.38%) experienced an increase in creative thinking skills with the Low category.

Keywords: *Developing Learning Devices, Dick and Carey Model, Open-ended, Virtual manipulative, Creative thinking abilities*

1. INTRODUCTION

Learning tools are designed and arranged to support the implementation of the learning process so that it can be implemented properly and can achieve the expected goals [1]. In this case the learning tools that must be developed in managing the teaching and learning process can be in the form of student books and student worksheets (LKPD). Therefore, learning tools are very important in supporting the achievement of the learning process so that teachers are required to be able to design/design their own learning tools according to the abilities to be achieved.

The importance of learning tools was expressed by [2] that the success of a teacher in learning is expected. To meet these objectives requires a thorough preparation. Before the teacher teaches (the preparation stage) a teacher is expected to prepare the material to be taught, prepare props / practicum to be used, prepare questions and directions to provoke students to actively learn, learn about students 'conditions, understand students' weaknesses and strengths, and learn knowledge early students, all of this will be broken down in the implementation of the learning tools [3].

According to [4] effective teachers are very systematic in preparation and implementation in each lesson. This shows that learning activities will be effective if they are well planned and organized. The student book as a learning tool is a reference used by the teacher in teaching a subject matter and it also needs to be a concern. Student books as teaching materials should be designed specifically to improve students 'low mathematical abilities, namely students' creative thinking abilities. Student books are guidebooks for students in learning activities that contain subject matter, conceptual inquiry activities, science activities, information and examples of the application of science in everyday life [5].

LKPD is a learning tool as a complement or means of supporting the implementation of the RPP (Learning

Implementation Plan). Using LKPD will open opportunities for students to be active and creative in the learning process [6].

Student Worksheets (LKPD) are an alternative teaching material that can help students in the learning process as well as a learning medium in which there are several practice questions. This can accustom students to practice their learning skills independently. With the existence of LKPD, teachers are also helped in the learning process which sometimes takes a long time to explain the material to be conveyed in the teaching and learning process.

From the explanation above, it can be seen that there must be a relationship between each learning device that will be used by the teacher in teaching, both between RPP and Student Book as well as with LKS or LKPD. However, this relationship is not seen in the learning tools used in SMP Negeri 1 Kisaran. Based on the results of interviews with class VII teachers of SMP Negeri 1 Kisaran, the learning tools used so far have been complete in the form of a syllabus, annual program, semester program, lesson plans, textbooks and worksheets, but they are not made by the teacher themselves and have not focused on creative thinking skills so that students are not used to it. to try various ways of solving problems other than those taught by the teacher, even the activities listed in the lesson plans and student books are not related to each other, while the worksheets are only used as exercises after material discussion or as homework.

This is what causes the learning tools that have been made by teachers have never been measured for their validity, practicality and effectiveness, while this aspect is very important in determining the quality of learning devices that are arranged as stated by [7] states that learning tools are said to be good if fulfills the quality aspects which include: validity, practically, and effectiveness.

The development of learning tools in this study refers to the Dick and Carrey development model. This development model has 10 stages, namely: (1) Identification of objectives; (2) Perform instructional analysis; (3) Identifying the initial behavior/characteristics of students; (4) Formulating performance goals; (5) Development of benchmark reference tests; (6) Development of teaching strategies; (7) developing or choosing teaching; (8) Designing and implementing formative evaluation; (9) Writing devices; and (10) Revision of teaching.

In writing this proposal, the writer will discuss students' creative thinking skills. In the characteristics of 21st century learning, students are expected to have creativity as the ability to provide new ideas by finding many possible answers to a problem, which emphasizes the aspects of quantity, dependability and diversity in solving problems. The data can affect their learning achievement.

Creative thinking is very important to be developed so that students can become useful people for themselves and others, [8] said that Students use creative thinking as a tool to aid their mathematical abilities by building abstract mathematical ideas into more concrete minds by using logical thinking, because creative thinking is assign or configuration of marks, characters, or objects that mark and configuration to describe, or represent something other than himself.

From the opinions above, it is only natural that the ability to think creatively should receive special attention, seeing its role in directing students to practice solving problems from various points of view in order to be able to face complex situations, especially in mathematics learning.

However, the reality in the field shows that students rarely come up with creative ideas when attending classes in class, most of them are passive and only do what the teacher assigns without effort or without enthusiasm to be creative in building discussions, which causes the results of learning mathematics to not meet expectations.

To carry out mathematics learning that can develop mathematical power and increase students' understanding and active participation, it is necessary to have a learning approach that can support the achievement of learning objectives. One alternative to learning mathematics that can meet these expectations is learning with an Open-ended approach.

According to [9] the Open-ended approach is a learning approach that presents a problem that has more than one correct solution or final answer. This approach provides the opportunity for students to gain knowledge and experience to find, recognize, and solve problems with several techniques. This learning is in accordance with the constructivist view, where students can construct their own knowledge based on investigations of problems and elaborate with previous knowledge. In addition, the Open-ended approach can train students' reasoning and creativity. The application of the Open-ended approach to mathematics learning provides an opportunity to investigate various ways or strategies that he believes are suitable for his ability to elaborate on problems and his thinking skills.

Various studies, especially mathematics education, show that the Open-ended approach can be a solution to overcome problems in an effort to improve students' mathematical creative thinking skills. Among them are based on research conducted by [10] which states that Open-ended learning can significantly increase students 'creative thinking abilities and based on [11] states that learning with an Open-ended approach can improve students' creative thinking abilities.

Of course it will be easier if students in the process of solving the problems presented are assisted by learning media so that it makes it easier to represent their ideas in various ways, both written, pictorial and verbal and various experiments.

This is in line with one of the six principles of learning mathematics according to [12] which states that "technology is important in learning mathematics, because technology is very influential in improving the mathematics learning process" [13]. From this statement it is confirmed that the learning process carried out should use technology. Because with technology it is expected that learning will be interactive, interesting and not boring.

NCTM states that the expectation that must be achieved after grade 6-8 students learn geometry is that students are able to: (1) Draw geometric objects with certain properties, such as the size of the sides of the corner; (2) Using two-dimensional representations of three-dimensional objects to visualize and solve problems such as those involving surface area and volume; (3) use visual tools such as networks to represent and solve problems; (4) Using geometric models to represent and explain numerical and algebraic relationships; and (5) Recognizing and applying geometrical ideas and relationships in fields outside the mathematics classroom, such as art, science and everyday life.

This hope can be realized by using virtual manipulative applications in learning geometry in seventh grade. Virtual manipulative tools are interactive, web-based visual representations with dynamic objects that represent opportunities to build mathematical knowledge and understanding. According to [14] that using virtual manipulatives in teaching mathematics will help students learn: (1) To connect real-world situations into mathematical symbols; (2) To cooperate cooperatively in solving problems; (3) To discuss mathematical ideas and concepts; (4) To verbalize mathematical thinking; (5) To make a presentation in front of a large group; (6) That there are many ways to solve the problem; (7) That mathematical problems can be symbolized in various ways; and (8) That they can solve math problems without just following the teacher's instructions.

By looking at the results of these studies, teachers should not only use computers as a tool for typing and storing data, but also use computers as learning media. Because by using computers it is possible to improve students' creative thinking skills, especially in the field of mathematics, which so far most students consider the most difficult and frightening lessons due to the large number of calculated formulas that must be memorized.

Based on the description above, the author is interested in developing a learning tool based on an Open-ended approach with virtual manipulative application to improve the creative thinking skills of students of SMP Negeri 1 Kisaran.

2. RESEARCH METHOD

This research is categorized into the types of Development Research. The final product is evaluated based on the specified product quality aspects, namely learning tools through an open-ended approach that is valid, practical and effective along with all learning tools and research instruments needed for the process of developing these tools. The development of learning tools is in the form of Student Books (BS), Student Worksheets (LKPD). This research was conducted at SMP Negeri 1 Kisaran Class VII in the even semester of the 2019/2020 academic year on quadrilateral material. The subjects in this study were students of SMP Negeri 1 Kisaran, class VII-2 and class VII-3. Whereas the object in this study was a mathematics learning tool for class VII SMP based on an Open-ended approach assisted by a virtual manipulative application developed. The learning device developed in this study is the rectangular material.

The development of learning tools in this study refers to the Dick and Carrey development model. This development model has 10 stages, namely: (1) Identification of objectives; (2) Perform instructional analysis; (3) Identifying the initial behavior / characteristics of students; (4) Formulating performance goals; (5) Development of benchmark reference tests; (6) Development of teaching strategies; (7) developing or choosing teaching; (8) Designing and implementing formative evaluation; (9) revision of equipment; and (10) summative evaluation.

The instruments in this study consisted of tests of creative thinking skills, observation sheets for the implementation of learning devices and observation sheets of the teacher's ability to manage learning.

3. RESEARCH RESULT AND DISCUSSION

3.1. Learning Tool Validity

Analysis of the validity of the learning device was assessed by 5 experts consisting of 3 lecturers and 2 mathematics teachers. The results of the analysis of the validity of the learning tools are as follows:

Table 1. Summary of learning tool validation results

Device	The average value of the total validity	Validation Level
Student Book (SB)	4.56	Valid
LKPD	4.51	Valid

The validity criteria are as follows: 4 ⩽ Va< 5 : Valid

After being declared valid, the learning tools and instruments were tried out (field evaluation) in class VII-2 of SMP Negeri 1 Kisaran. However, in the first trial, one indicator of the practicality of the learning device did not meet the practical criteria, namely the classical completeness of the ability to think creatively. Classical completeness data on creative thinking skills in the first trial are shown in table 2 below.

Table 2. Classical completeness levels of creative thinking ability in trial I

Categori	Pretest		Postest	
	Total Student	Percentage	Total Student	Percentage
Completed	17	53,125%	25	78,125%
Not complete	15	46,875%	7	21,875%
total	32	100%	32	100%

The percentage of classical completeness criteria for students' creative thinking abilities is presented in Figure 1.

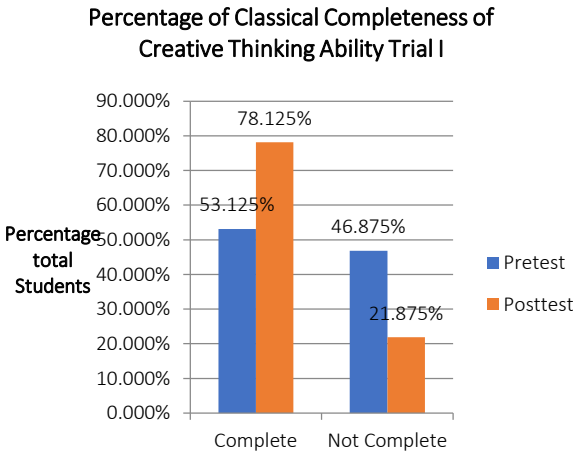

Figure 1 Percentage of Classical Completeness of Creative Thinking Ability in Trial I

Based on the data in Table 2 and Figure 1, it can be seen that classical completeness from the results of students' creative thinking skills in the posttest has not yet fulfilled classical completeness because it only obtained a percentage of 78.13% completeness.

3.2. Evaluation

Based on the results of the analysis of the learning tools in the first trial, data showed that the learning tools could not be said to be effective. For this reason, before the second trial was carried out, a revision would be made to the LKPD used in the I trial. Revisions would be made based on the results of the analysis in Trial I. The most effective revision used was the addition of guidelines for opening virtual manipulative applications that previously did not exist in LKPD. Then the research continued to trial II.

3.3. Learning Device Practicality Data

3.3.1. Learning device implementation data

The average value of the observation of the implementation of the learning tools for each meeting in the second trial is shown in Table 3 below.

Table 3. Average value of observation of learning device implementation in trial II

Aspects Observed and Assessed	$\overline{P_2}$ Meeting to				$\overline{P_3}$
	I	II	III	IV	
Student Book (SB) Implementation	3.63	3.75	3.88	3.94	3.80
Implementation of LKPD	3.69	3.75	3.88	4,00	3.83

Based on Table 3, it is found that the overall average of 2 (two) observers on Student Book Implementation (BS) is 3.80 and LKPD is 3.83 which is in the high category ($3 \leq \bar{P} \leq 4$).

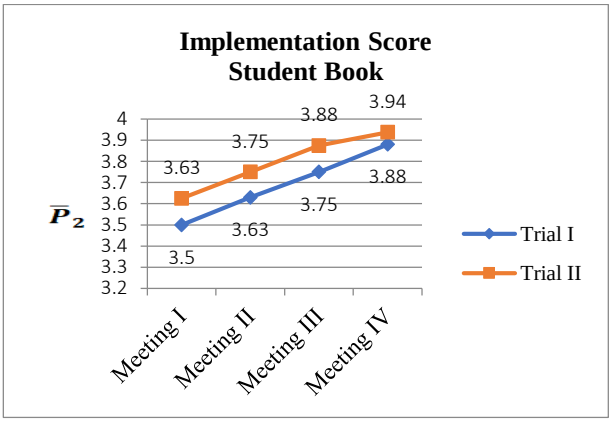

Figure 2 Scores of Student Book Implementation in Each Trial I and II

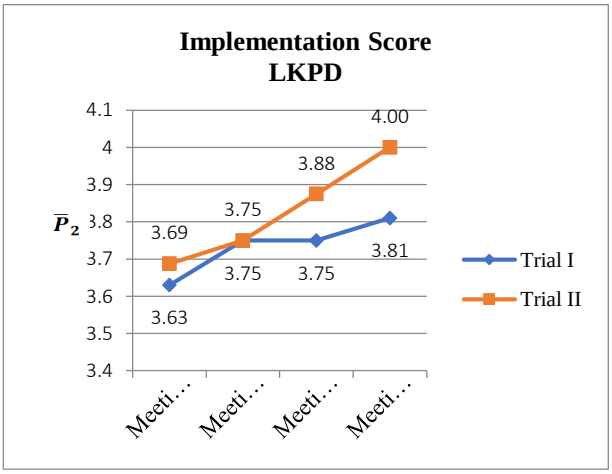

Figure 3 LKPD implementation score in Each Trial I and II

The average value of the observation of learning device implementation for each meeting in trials I and II is shown in the figure 2 and figure 3.

3.3.2. Data on the ability of teachers to manage learning

Observation of the teacher's ability to manage learning was carried out every meeting observed by 2 observers. The following is the observation data on the teacher's ability to manage learning:

Table 4. Data on teacher ability to manage learning in trial II

Observed aspects	Average Value of Each Aspect
Preliminary	4.542
Core activities	4.19
Closing	4
Ability to Manage Time	3.626
Class situation	4.25
Overall Average Score	4.17

From Table 4 above, it can be seen that the average ability of all teachers to manage learning using the tools developed in the trial was 4.17 and was in the "Good" category where 3.50 ⩽ KG <4.50 = Good.

3.4. Learning Device Effectiveness Data

3.4.1. Classical student learning completeness

Table 5. Classical completeness levels of creative thinking ability in trial II

Categori	Pretest		Postest	
	Total Student	Percentage	Total Student	Percentage
Completed	22	68.75	28	87.5%
Not complete	10	31.25%	4	12.5%
total	32	100%	32	100%

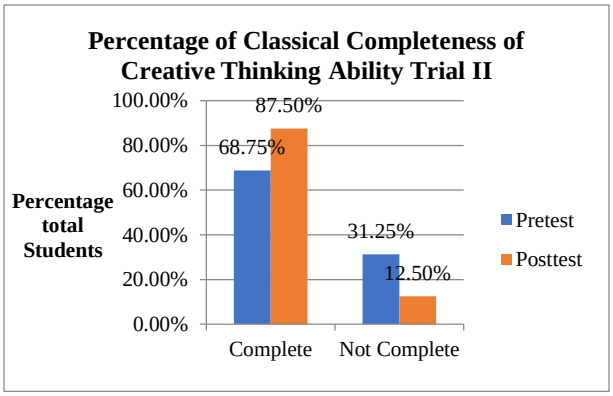

Figure 4 Percentage of Classical Completeness of Creative Thinking Ability in Trial II

The results of classical completeness of students' creative thinking abilities in the second trial can be seen in Table 5.The percentage of classical completeness criteria for students' creative thinking abilities is presented in Figure 4.

Based on the data in Table 5 and Fig. 4, it can be seen that the classical completeness of students' creative thinking skills in the posttest II trial was 87.5%. Thus, the posttest results of the ability to think creatively have fulfilled classical completeness.

3.4.2. Completeness of learning objectives

The following will describe the number of students who achieved the completeness of the learning objectives for each meeting in Trial II.

From Table 6 it can be seen that in the posttest results the students have reached the "Achieved" criteria on each item.

Table 6. Achievement of learning objectives in trial II

Question number	Students Who Achieve Completion of Learning Objectives		Information	
	Pretest	Postest	Pretest	Postest
1	62.5%	81.25%	Not Reached	Reached
2	43.75%	87.5%	Not Reached	Reached
3	59.38%	81.25%	Not Reached	Reached

3.4.3. Learning Time

From the results of time attainment at each meeting for trial II in using learning tools based on the Open-ended approach assisted by virtual manipulative applications, it was obtained that time was efficient, namely learning using learning tools based on the Open-ended approach assisted by virtual manipulative applications was the same as ordinary learning done.

3.5. Increase in Creative Thinking Ability in Trial II

The increase in creative thinking skills in the second trial will be seen through the N-Gain of the pre-test and post-test results. The results of the N-Gain calculation of

Table 7. Summary of n-gain results of creative thinking ability trial II

N-Gain	Interpretation	Total students	%
g > 0.7	High	4	12.5%
0.3 < g ≤ 0.7	Moderate	17	53.13%
g ≤ 0.3	Low	11	34.38%

trial II are presented in Table 7.

3.6. Designing and Developing a Summative Evaluation

After the valid, practical and effective criteria were met in the second trial, the next step was to hand over the equipment to the MGMP forum at SMP Negeri 1 Kisaran represented by Ms. Nurjanna, S.Pd. Submitting learning tools to the MGMP forum in the hope that the math teachers who are members of the forum can apply these learning tools in subsequent lessons. The main step after handing over the device is to submit the development results to the entire population in this study.

4. CONCLUSION

1. The quality of the learning tools developed met the criteria of validity, practicality and effectiveness where (1) the validity of the learning tools developed were included in the valid category with an average value of the total validity of the Student Book at 4.56; LKPD of 4.51; (2) The learning tools developed using the Open-ended approach assisted by virtual manipulative applications have met the practical criteria in terms of: (a) the implementation of the learning tools has reached a high category, namely 3.83 for student book implementation and 3.80 for LKPD implementation ; (b) the teacher's ability to manage learning was in a good category, namely 4.17; (3) The learning device developed using the Open-ended approach with the help of virtual manipulative applications has met the effective criteria in terms of: (a) classical student learning completeness has reached 87.5% in trial II; (b) completeness of the learning objectives that are in the achieved category for each Posttest item.
2. Increasing students' creative thinking skills using learning tools through an Open-ended approach assisted by virtual manipulative applications on quadrilateral material are 4 students (12.5%) experiencing an increase in creative thinking skills in the "High" category, 17 students (53.13%) experienced an increase in creative thinking skills in the "moderate" category and 11 students (34.38%) experienced an increase in creative thinking skills in the "low" category.

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