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Development of Learning Devices Based on ContextualTeaching and Learning to Improve Students' Creativity of Mathematics at SMPN 1Padangsidimpuan

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Abstract: *This study aims to: 1) Develop the learning devices based on CTL that meet the validand effective criteria; 2) Improving students' creativity of mathematics by using learning devices based on CTLdeveloped. This research is a development research. This research was conducted using Four-D development model which consist of: define, design, develop, and disseminate. Subjects in this study are students of class VII-1 SMPN 1 Padangsidimpuan. While the object in this study is a learning device of mathematics in junior high school (SMP)Class VII based on CTL developed. From the results of trial I and trial II, learning devices obtained the result that: 1)the learning devices developed meet the valid criteria, in terms of content validity and construct validity; 2)thelearning devicesdeveloped meet the effective criteria, viewed from: a) the level of mastery of students to the creativity of Mathematics; b) student activity; and c) students' positive responses; 3) an increase in mathematical creativity of students by using thelearning devices based on CTL developed.*

Keywords: *Development, Learning Devices, Contextual Teaching and Learning, Creativity Mathematics*

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I. Introduction

Formal education has a very close relationship with mathematics, because at every level of formal education in the field of mathematics is always studied by students. Mathematics has a very important role in life because basically math is required by all scientific disciplines to improve the prediction and control of the science. Mathematics also plays an important role in the development of modern technology, various disciplines and advances the human mind. Given the importance of mathematics in life, it should be taught at every level of mathematics education. Cornelius (Abdurrahman, 2012) suggests five reasons for studying math because math is: (1) a means to think clearly and logically, (2) the means to solve the problems of everyday life, generalizations experience, (4) the means to develop creativity, and (5) a means to increase the awareness of culturaldevelopment.

The importance of mathematics is also evident from the statement of Cockroft (Abdurrahman, 2009) that "mathematics needs to be taught to students because it is always used in all aspects of life". One of the goals of learning mathematics in the 21st century is that students are able to have high-level thinking skills. In study of mathematics, the ability to think and to solve the problem is one of the most important abilities that must be owned by the students (Mustafa et al., 2017). One of the most important thinking skills of a student is the creativity of Mathematics that is the result of creativethinking.

According to Chukwuyenum (2013) critical thinking has been one of the tools used in our daily life's to solve some problems because it involves logical reasoning, interpreting, analyzing and evaluating information to enable one take reliable and valid decisions. The same thing also expressed by Saragih and Napitupulu (2015) that "the students are expected to use mathematics and mathematical mindset in daily life, and to study many kinds of sciences which stress to be logical arrangement and student's character building and also ability to apply mathematics". Wherever in fact, when the learning difficulties students to problem solve related in daily life that require to use of mathematics and compile them into a mathematical model. This is because all this time the questions given don't non-routine matters, so as not to make the students perform activities of reflection, experimentation, inquiry, conjecture, and generalization. The difficulties encountered can be seen from how students think critically to solve the problems which is given. The same thing also expressed by Saragih and Habeahan (2014) stated when students are exposed to issues that are not routine, for example, related a story about solving problems related to everyday life, the value obtained by the student will be usually be lower when compared to the multiple-choicequestions.

One of the focus of learning objectives of mathematics is that students have creative thinking skills to create creativity of thinking in mathematics (NCTM, 2000). As Alexander (Rahmawati, 2016) states "the

success of individual life is largely determined by its ability to creatively solve problems, both large and small". With the increasingly tight global competition today, then from the outset students need to be equipped with the ability to think creatively. Munandar (2012) also stated that creativity is very meaningful in life, so it needs to be developed early on through proper education. Guilford (Munandar, 2012) states that in learning activities, a student is said to have creativity when able to solve problems with flexibility, fluency, originality, and elaboration.

With the importance of mathematical creativity, students should have good mathematical creativity. However, based on the results of initial observations in the field found that the creativity of student mathematics is still low. Based on the diagnostic test given to 24 students, only 1 student (4.17%) can provide the answer correctly but without making any settlement steps. Furthermore, 19 students (79.17%) gave wrong answers, and 4 students (16.67%) did not provide an answer. Based on the observations, the main constraint in the process of settlement that occurs is the Fluency aspects of students in solving the problem is still low. So the chance to determine the answer that flexibility and originality is very small.

Field findings also show that low mathematical creativity because the learning model used by teachers has not been well targeted. The commonly used model is direct learning that is not focused on training in mathematical creativity. Another cause is the learning device used in the learning process is not effective against the achievement of desired learning objectives. Aufa et al (2016) stated that there is no single learning resource that can meet all kinds of learning process objectives. Therefore, to overcome the problems found to be developed a learning device with the application of learning approaches that are able to train and cultivate students' mathematicalcreativity.

.One approach to learning is considered appropriate is Contextual Teaching and Learning. In its application, CTL is a learning approach that teaches learners to real-world problems. As Sanjaya (2014) states, CTL is a learning that emphasizes the full process of student involvement in order to discover the material learned and relate it to real life situations. On the other hand, Johnson (2006) states that CTL is a system that stimulates the brain in formulating patterns that embody meaning. The mindset developed through the application of CTL is seen as a solution to cultivate math creativity. Based on the description, learning devices with the application of CTL approach is expected to be an alternative to create a good learning in improving students' mathematicalcreativity.

II. Literature

2.1. Creativity ofMathematics

Creativity is not just an artist or a scientist, but a part of life. Creativity can be viewed as a product of creative thinking, while creative activity is a learning activity directed to encourage or create student creativity. As stated by Pehkonen (1997) that creativity is not a characteristic only found in artists and scientists, but it is also a part of everyday life. On the other hand, Puccio and Murdock (Mahmudi, 2009) stated that creative thinking is associated as a process in creativity. The creative process refers to the individual's efforts to produce creative solutions or products.

Pehkonen (1997) mentions that creativity is the performance of an individual resulting into something new or unexpected. The same is also stated by Hurlock (Siswono, 2004) which explains that creativity is a person's ability to produce any composition, product or idea that is basically new and previously unknown to the author. Correspondingly, Baron (Sity, 2015) states that "Creativity is the ability to bring something new into existence." From these statements it appears that creativity is the ability to create something new, in the form of ideas and real works that are relatively different from what has been there before.

Mathematical creativity is owned by a student when solving a given problem by fulfilling all the indicators of creative thinking. Some experts put forward the indicators of creative thinking ability, among which Some experts put forward indicators of creative thinking ability, including Silver (1997), Torrance et al (Wang, 2011) and Guilford (Sity, 2015) summarized in Table 1below:

Table 1. Indicator of Mathematics Creativity According to Some Expert

Expert	Silver	Torrance et al	Guilford
Indicators of Creativity	Fluency Flexybility Novelty	Fluency Flexybility Originality Elaboration	Fluency Flexibility Originality Elaboration Redefinition

Mawaddah et al (2015) states several criteria for answers from indicators presented by some experts in Table 2 below:

Table 2. The Criteria of Answer Process Based nnMathematics Creativity Indicators

Indicator	Criteria of Answer Proccess
Fluency	✓ Suggests many ideas in problemsolving ✓ Provide many answers in problemsolving
Flexybility	✓ Produce various variations of problemsolving ✓ See a problem from a different perspective and present a concept in differentways
Originality	✓ Provide new or unusual ideas in solvingproblems ✓ Create unusual combinations of parts or elements in either language, ideasor ways
Elaboration	✓ Develop or enrich ideas ✓ Add or perceive an idea to improve the quality of theidea

Based on the above description by considering the ease of application, then in this study students are said to have mathematical creativity when able to solve problems with fluency, flexybility, and novelty

2.2. Contextual Teaching and Learning(CTL)

Contextual comes from the word context which means relationship, atmosphere or circumstance. So Contextual can be interpreted "related to the atmosphere" So Contextual Teaching and Learning (CTL) can be interpreted as a learning that is related to the atmosphere or certain circumstances. According to Hosnan (2014) "CTL is a learning concept whereby teachers present the real world into the classroom and encourage students to make connections between their knowledge and application in their daily lives." The learning pattern applied in CTL is a pattern that directs students to learn independently and actively involves students in using their thinking.

The application of CTL in learning enables students to acquire their knowledge and skills from a limited context, bit by bit, and from the process of constructing itself, as a provision to solve problems in its life as a member of society. In line with that, Sanjaya (2014) states that CTL is a learning that emphasizes the full process of student involvement in order to find the material learned and relate it to real life situations that encourage students to apply it in theirlives.

CTL approach has a foundation on the learning philosophy of constructivism. Constructivism emphasizes that learning is not just memorizing, but students construct knowledge in their thinking (Dahar, 2011). Knowledge can not be separated into separate facts or propositions, but reflects applicable skills. That is, the contextual approach is pragmatic. The application of CTL learning leads students to learn through 'experiencing' rather than 'memorizing'. As Zahorik (1995) points out that knowledge is contructed by humans. Knowledge is not a set of facts, concepts, or laws waiting to be discovered. It is not something that exists independent of a knower. Humans create or construct knowledge as they attempt to bring meaning to their experience.

Hosnan (2014) found seven main components in CTL learning activities: (1) Constructivism, (2) Inquiry, (3) Questioning, (4) Learning Community, (5) Modeling, (6) Reflection, and (7) Authentic Assessment. All components will be applied in the learning activities through the design of learning devices developed.

2.3. Quality of LearningDevices

Akker (1999) states in the study of the development of learning models need quality criteria that is validity, practically, and effectiveness. This is also in line with Rochmad (2012) 's opinion that "to determine the quality of the outcomes of the development of models and learning devices it is generally necessary to have three criteria: validity, practicality and effectiveness". However, in this study the quality of instructional devices is only focused on valid and effective criteria, because it does not find the right instrument in measuring the practicality of instructionaldevices.

Akker (1999) states "validity refers to the extent that the design of the intervention is based on state-of-the art knowledge (content validity) and that the various components of the intervention are consistently linked to each other (contruct validity)" . The components of the indicators of the validation aspects of the validation criteria in general are: format, language, illustrations, material content and learning objectives (Akker, 1999).

Herman (2012) states that the effective criteria of a learning if it meets 3 of the 4 criteria of effectiveness, namely the achievement of learning achievement, student activity, positive student response and the ability of teachers to manage learning. Mulyana, et al (2013) states the effectiveness analysis using the analysis of learning completeness, student activity analysis, learning achievement analysis of test class. While Mustafa et al (2017) states effectiveness can be reviewed based on the completeness of learning outcomes, student activities, and positive responses of students. Based on some expert opinions, the effective criteria in this study focused on: (1) mastery of students' learning outcomes classically, (2) student activities, and (3) positive student responses.

III. Methods

This type of research is Research Development. The development model used is the 4-D development model Thiagarajan et al (1974) which consists of 4 development stages: define, design, develop, and disseminate.

3.1. Subjects and objects ofresearch

Subjects in this study were students of SMP Negeri 1 Padangsidimpuan Class VII-1 as many as 22 students. While the object in this study is learning devices developed with learning-based Contextual Teaching and Learning (CTL) on the matter of integers.

3.2. Development ofLearning Devices

Learning devices that were developed in this study were Learning Implementation Plan (RPP), Student Book (BS), Student Activity Sheet (LAS) and Research Instrument in the form of Test of Math Creativity Capability (TKKM). Learning device development is done by applying 4-D development model (Thiagarajan et al, 1974) with four development stages: define, design, develop, and disseminate. The design of device development in this study can be seen in Figure 1 below:

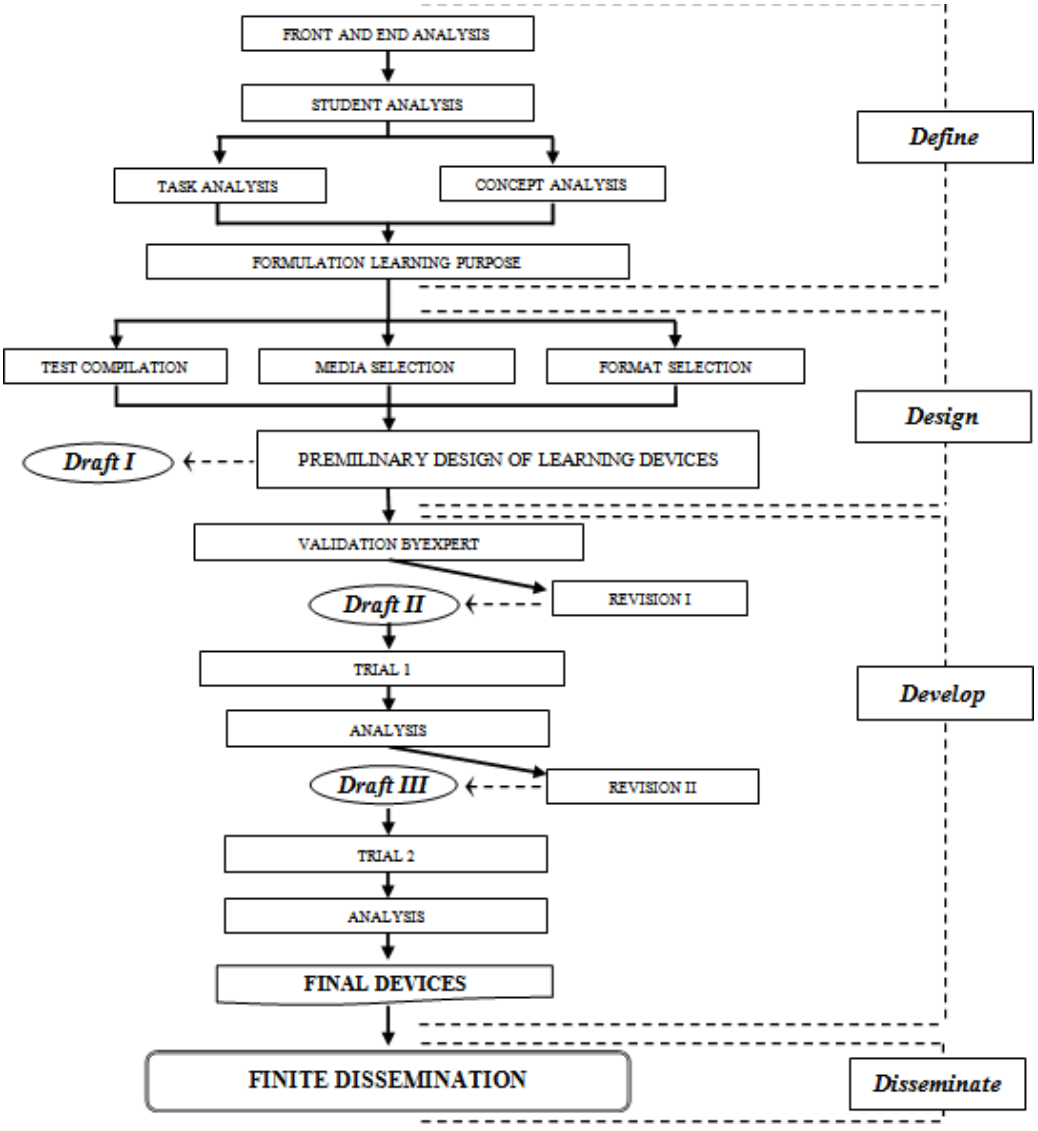

Figure 1. Chart Development of Learning Devices with 4-D Model

3.3. Instruments and Data AnalysisTechnique

The instruments used in this study include instruments for assessing the quality of instructional devicescovering aspects of prevalence, practicality and effectiveness. Instruments used in the form of observationsheets, questionnaires, and tests. For more details can be seen in Table 3 below:

Table 3. Research Instruments

Aspect	Instruments	The Observed Data	Respondent
The Validity of Learning Devices	Validation Sheet	Validity of RPP, LAS, BS, BPG, and TKKM	Expert/Practitioners
The Effectiveness of Learning Devices	Test	Creativity Mathematics Skill Test	Research Subject
	Observation Sheet	Students Activity	Observer
	Questionnaire	Student Response	Research Subject

The Learning devices are said to be valid if they meet the criteria of content validity and construct validity. The learning devices satisfies the expected content validity if the average validator's assessment of all learning devices is at minimum valid criteria with an average value of ≥4 (Mustafa, et al 2017). If not fulfilled, it is necessary to re-do the validation activities. And so on until obtained learning devices that meet the validity of the contents. Furthermore, the validity of the construct to test creative thinking. Before being used for field trials, the points of creative thinking tests were tested outside the research subject to measure validity and reliability. To measure the validity of item can use product moment correlation formula and to calculate the reliability coefficient of test items used Alpha-Cronbach formula (Arikunto2012).

The effectiveness of instructional tools is reviewed based on: 1) Student learning completeness is classically met if ≥ 85% obtains a test score ≥ 2.18 of scale 4; 2) student activity fulfilled if fulfill ideal time tolerance percentage specified, and 3) student response fulfilled if classically ≥ 80% subject give positive response (Mustafa et al, 2017).

The criteria of student activity based on the achievement of the ideal time tolerance set as follows:

Table4. PercentageofIdealTimeand StudentActivityToleranceLimit

Student Activity Category	Ideal Time	PWI Tolerance Interval	Ideal Criteria
1. Pay attention / listen to teacher /friend explanations	25 % from WT	20 % ≤ PWI ≤ 30 %	Three of 1, 2, 3, 4, 5 are fulfilled and 3, 4 must be met
2. Reading student's books (BS) andstudent activity sheets (LAS)	15 % from WT	10 % ≤ PWI ≤ 20 %	
3. Take note of the teacher'sexplanations, notes from books, solve problems in the LAS, summarizes the work of the group	30 % from WT	25 % ≤ PWI ≤ 35 %	
4. Discuss, ask ideas, between studentsand friends or between students and teachers, and draw conclusions of a procedure or concept	30 % from WT	25 % ≤ PWI ≤ 35 %	
5. Perform behavior that is not relevantto learning	0 %from WT	0 % ≤ PWI ≤ 5 %	

Sumber: Aufa et al. (*2016*).

Explanation:

PWI :theidealtimepercentage
WT :thetimeavailableateachmeeting.

After learning devices meet the valid and effective criteria, then reviewed the improvement of the mathematical mathematical creativity of students based on: 1) the increase of classical average value based on the results of TKKM and 2) increase the average value of each indicator of mathematical creativity based on the results of TKKM from trial I to test try II

IV. Result

The following is the result of the study obtained based on the experimental learning device in SMP Negeri 1 Padangsidempuan with two trials. The results of the tests described include: 1) validation of learning devices, 2) the effectiveness of learning devices, and 3) improvement of students' mathematical creativity.

4.1. Device Learning DeviceValidity

Based on the validator's appraisal, it was found that the learning devices developed obtained the assessment as listed in Table 4 below:

Table 5. The Result of Content Validity ofLearning Devices

No	Learning Devices	Average Value of Total Validity	Validation Level
1	Learning Implementation Plan (RPP)	4,49	Valid
2	Student Activity Sheet (LAS)	4,50	
3	Student Book (BS)	4,52	
4	Creativity of Mathematics Test (TKKM)	-	All Items Valid

Based on Table 4 it is found that all learning devices meet the valid criteria as it obtains the overall average rating ≥ 4. Then the results of the instrument test show that all the items of the mathematics creativity test meet the valid criteria. CTL based learning devices developed meet the criteria of content validity and construct validity.

4.2. The Effectivenessof Learning Devices

4.2.1. Description of Learning Device Effectiveness in Trial I

Based on the results of the first test, the students' mathematical creativity ability test result showed that the number of subjects who completed or got the value of ≥ 2.18 reached 18 students (75%) from 24 students who tested the Mathematical creativity ability. Based on the results of the completeness criteria of student learning outcomes in classical luminous achieved.

Furthermore, the effectiveness criteria based on student activity observation can be seen in Table 5 below:

Table 5.Average Percentage of Ideal Time Student Activity Trial I

Meeting	Average Time of Student Activity for Each Category (in percent)				
	1	2	3	4	5
I (2 x 40')	21,88	18,23	29,17	23,96	6,77
II (2 x 40')	24,48	15,63	26,04	25,52	8,33
III (2 x 40')	27,61	14,59	30,21	23,44	4,17
IV (2 x 40')	23,96	18,75	27,61	26,04	3,65
Average	**24,48**	**16,80**	**28,26**	**24,74**	**5,73**
Interval Tolerance	20 % ≤ PWI ≤ 30 %	10 % ≤ PWI ≤ 20 %	25 % ≤ PWI ≤ 35 %	25 % ≤ PWI ≤ 35 %	0 % ≤ PWI ≤ 5 %
Criteria	Achieved	Achieved	Achieved	Achieved	Not Achieved

Based on Table 5, all aspects of observed activity meet the ideal time tolerance criteria specified, except the 5th indicator. So effectiveness based on the effectiveness of students in learning activities are met. This is because 3 of the 5 indicators are met with indicator 3 and 4 fulfilled. Then based on the test results also obtained the percentage of the average total positive response of students to the device and learning activities in the first test of 89.08%. Therefore, students' responses are also fulfilled because students who respond positively to the components and learning implementation achieve ≥80%.

Based on the above results obtained that the learning device is only activity and the positive response of the students set, but not yet meet the completeness criteria of student learning outcomes in the classical defined. Thus the learning device developed has not met the effective criteria. Therefore, revisions should be made to the learning devices and re-tested to produce effective learningdevices.

4.2.2. Description of Learning Device Effectiveness in TrialII

Based on the result of second try, the result of students' mathematical creativity ability test in class showed that the total number of subjects who completed or got the value of ≥ 2.18 reached 19 students (86.36%) from 22 students who tested the ability of mathematical creativity. Based on the results of the completeness criteria of student learning outcomes in classicalhave been achieved.

Furthermore, the effectiveness criteria based on student activity observation can be seen in Table 6 below:

Table 6. Average Percentage of Ideal Time Student Activity Trial I

Meeting	Average Time of Student Activity for Each Category (in percent)				
	1	2	3	4	5
I (2 x 40')	23,44	13,54	32,29	27,09	3,65
II (2 x 40')	23,75	16,88	29,38	27,50	2,50
III (2 x 40')	24,48	18,23	26,69	27,08	1,04
IV (2 x 40')	25,63	17,50	29,38	26,88	0,36
Average	**24,33**	**16,54**	**30,19**	**27,14**	**1,96**
Interval Tolerance	20 % ≤ PWI ≤ 30 %	10 % ≤ PWI ≤ 20 %	25 % ≤ PWI ≤ 35 %	25 % ≤ PWI ≤ 35 %	0 % ≤ PWI ≤ 5 %
Criteria	Achieved	Achieved	Achieved	Achieved	Achieved

Based on Table 6, all aspects of observed activity meet the ideal time tolerance criteria set. So that effectiveness based on students' effectiveness in learning activities are fulfilled. Then based on the test results also obtained the percentage of the average total positive response of students to the device and learning activities in the second trial of 92.27%. Therefore, students' responses are also fulfilled because students who respond positively to the components and learning implementation achieve ≥ 80%.

Based on the above results obtained that the learning device meets all the criteria of the established aspects, namely the completeness of learning outcomes in a classical, student activities and positive responses of students. Thus the learning device developed has met the effective criteria.

4.3. Description of Improving Student's Creativity ofMathematics

Based on posttest result of student's mathematical creativity, it is obtained the average value of classical in trial I is 2,86 and trial II is 3,26. Thus there is an increase in the average value of mathematical creativity of students between trials of 0,40 or 13.97%. Then the improvement of students' mathematical creativity in each indicator can be seen in Table 7below:

Table 7.Improving Student's Creativity of Mathematicsof Each Indicator

Indicator of Creativity Mathematics	Mean			
	Trial I	Trial II	Increase	%
Fluency	8,77	9,45	0,68	7,75
Flexibility	4,81	5,95	1,14	23,70
Novelty	4,31	4,95	0,64	14,85

These results indicate that students' mathematical creativity using CTL-based learning devices developed improved from trial I to trial II. So it is concluded that learning devices based on CTL developed can improve students' mathematical creativity.

V. Discussion

The results showed that the developed learning-based CTL meet the valid and effective criteria. The results show that the developed learning devices have good device quality. The validity of instructional devices should be reviewed based on the content validity and construct validity (Akker, 1999). In this research both aspects of validity have been fulfilled. The validity of the content through validator assessment, and the validity of the construct through the test instrument test outside the subject of research. The validity of the content of a test questioned how far a test measures the level of mastery of the content of a certain material that should be mastered with the purpose of teaching, while the construct validity as how exactly the test is capable of measuring the concept that should be measured (Asmin and Mansyur, 2014).

According to Nieveen (2007) learning devices are said to have good quality must meet effective criteria. Effective in question is the extent to which developed learning devices are able to achieve the predefined goal criteria. In this study the learning devices that have been developed meet the effective criteria based on: 1) mastery of classical learning outcomes, 2) student activities, and 3) student responses. The effectiveness of instructional devices is fulfilled through two series of trials, between the two experiments carried out the revision process of learning devices. The revision is done because in the first experiment the learning device has not fulfilled all the specified effective criteria. Meanwhile, after the revision process of learning devices, all the effective criteria set are met. This is in accordance with relevant relevant research findings (Yuliani and Saragih, 2015; Aufa et al, 2016; Mustafa et al,2017).

The learning devices based on CTL developed also able to improve students' mathematical creativity. Penigkatan mathematical creativity of students due to the improvement of the quality of the device and the learning process. As Haggarty and Keynes (Muchayat, 2011) stated that "in order to improve the teaching and learning of mathematics in the classroom it is necessary to improve the understanding of teachers, students, materials used for learning and interaction between them".

On the other hand, the role of CTL approach in learning also influences the improvement of students' mathematical creativity. With the application of CTL during the learning process also involves students in their own inquiry, enabling them to interpret and explain real-world phenomena and develop an understanding of the phenomenon independently. As Piaget's constructivism theory (Sugiyono, 2012) states "the importance of learners' activities to actively build their own knowledge, such as the activities of learners in processing materials, working on problems, making conclusions, and formulating a formula with its own words which is an indispensable activity so that learners can build knowledge ". Thus the learning devices based on CTL developed have been appropriate to develop and improve students' mathematicalcreativity.

VI. Conclusion

Based on the results of analysis and discussion in this study, presented several conclusions as follows:

1) The learning devices based on CTL developed to improve students' mathematical creativity obtained valid criteria. Validity is reviewed based on content validity and constructvalidity.

2) The learning devices based on CTL developed to improve students' mathematical creativity obtained effective criteria. The effectiveness of learning devices is reviewed based on: a) mastery of student learning outcomes in a classical manner, b) student activity, and c) student positiveresponses.
3) Students' creativity of mathematicsby using the learning devices based on CTL developed were increased. ImprovementisreviewedbasedonTKKMresultfromtrialItotrialIIand
b) classical average of each indicator based on TKKM result from trial I to trial II.

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