

Development of Learning Devices Based on Realistic Mathematics Education to Improve Students Critical Thinking Ability at SMP Harapan 2 Medan

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Abstract:

This study aims to: 1) Develop the learning devices based on RME that meet the valid, practically, and effective criteria; 2) improvement of critical thinking ability of junior high school students by using developed learning devices based on RME. 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 were students of class IX-A and class IX-B SMP Harapan 2 Medan. While the object in this study is a learning device of mathematics in junior high school (SMP) Class IX based on RME developed. From the results of trial I and trial II obtained:

1) the learning devices based on RME developed meet the valid criteria, both in the content validity and construct validity;

2) the learning devices based on RME developed meet the effective criteria, effectiveness in terms of: a) students' learning mastery in a classical way; b) achievement of learning objectives; c) learning time; and d) students' positive responses;

3) An increased in students' critical thinking ability by using learning devices based on RME.

Keywords: Development, Learning Devices, Realistic Mathematics Education, Critical Thinking

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I. Introduction

Education is one of the main pillars in anticipating the future, because education is always oriented to the preparation of learners to play a role in the future (Tirtarahardja, 2008). The role of education in facing the future is closely related to mathematics learning. Mathematics is one branch of science that is very important especially in its application in everyday life. Hasratuddin (2015) states "mathematics is a means or means to find answers to problems facing humans, ... and the most important thing is to think in man himself to see and use his relationships." From that opinion we can say that mathematics is a means of thinking to find solutions from various problems of life. The importance of mathematics is also evident from the continuous learning of mathematics from elementary to college level. Cockroft (Abdurrahman, 2009) states that mathematics needs to be taught to students because it is always used in all aspects of life. The purpose of learning mathematics in the 21st century is that students are able to have high-level thinking ability. 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 possessed by a student is the ability to think critically.

The ability to think critically is important because critical thinking ability can support students in decision making, assessment and problem solving (Hassoubah, 2004). With this ability students can study problems systematically, formulate innovative questions and design original solutions. In line with this according to Johnson (2011) said that "with critical thinking, students can achieve a deep understanding". This understanding will help students solve problems in everyday life and help students make informed decisions. A student is said to have critical thinking ability if in solving problems capable of: (1) analyzing, (2) synthesizing, (3) finding solutions, and (4) summing up.

With the importance of critical thinking ability, students should have good critical thinking ability. But, based on the results of observations in the field kemampuan critical thinking students are still low. From the diagnostic test given to 24 students, only 6 students (25%) were able to answer the question correctly, but have not been able to answer by fulfilling all indicators of mathematical critical thinking ability. Based on the observations, the main constraint in the process of completion that occurs is at the stage of analyzing and

synthesizing. Students have not been able to analyze the problem well, it is difficult to separate the information into smaller and more detailed sections, and it is difficult to incorporate the information into new forms or arrangements so that problem solving is not appropriate.

The findings in the field indicate that the low ability of students critical thinking because the ability is not a major focus in learning activities. This is also because teachers have not been able to prepare appropriate learning devices to improve students' critical thinking ability. As Mustafa et al (2017) stated that the low ability of students thinking is caused by the teacher has not been able to arrange the appropriate learning devices to trained students high-level thinking ability. The statement is also supported by Haggarty and Keynes (Muchayat, 2011) 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". In order for learning objectives to achieve the expected goals, it is necessary to develop learning devices by choosing the right learning approach. One approach that is considered appropriate is Realistic Mathematics Education. This approach is a learning approach that directs students to real problems, uses models, uses student contributions, is interactive, and uses interrelationships. Gravemeijer (Hasratuddin, 2002) states that there are three principles of PMR that can be used as a reference in developing learning devices, namely: (1) Guided reinvention / progressive mathematizing, (2) Didactical phenomenology, and (3) Self-developed model. Based on the description, learning devices with the application of realistic mathematics education is expected to be an alternative to create a good learning in improving students' critical thinking ability.

II. Literature

2.1. Critical Thinking Ability

Thinking is manipulating or managing and transforming information in memory (Santrock, 2007). Thinking is done to form concepts, reasoning and thinking critically, making decisions, thinking creatively and solving problems. According Sagala (2010) that "thinking is a dynamic process by taking three steps: the formation of understanding, the formation of opinions and decision-making". Through these three steps a person takes the stage of thinking before finally taking a decision in various ways.

Critical thinking is a cognitive activity associated with the use of reasoning. Learning to think critically means using mental processes, such as watching, categorizing, selecting and judging / deciding. Chaffee (Johnson, 2011) states that "thinking is an active, orderly, and meaningful process that we use to understand the world". The point is in thinking there is a process of formulating, solving problems and seeking answers in the achievement of meaning that this process starts from the desire to find answers and achieve understanding. On the other hand, Johnson (2011) states critical thinking is a well-directed and clear process used in mental activities such as solving problems, making decisions, persuading, analyzing assumptions, and conducting scientific research.

Dewey (Fisher, 2009) defines critical thinking as "active, persistent, and conscientious consideration of a belief or form of knowledge that is taken for granted in terms of the reasons that support it. On the other hand Norris and Ennis (Fisher, 2009) "critical thinking is a reasonable and reflective thinking by emphasizing decision-making on what to believe or do". Based on some expert opinions above, then in this study the ability of critical thinking is the ability of a person thinks reasonable and reflective to take a conclusion that is believed to be true and believed truth, with the indicator that is: (1) analyze, (2) synthesize, find solutions, and (4) conclude.

2.2. Realistic Mathematics Education (RME)

Realistic Mathematics Education (RME) is rooted in 'mathematics as a human activity,' and the underlying principles are guided reinvention, didactical phenomenology, and emergent models. These principles are based on Freudenthal's philosophy which emphasizes reinvention through progressive mathematization (Freudenthal, 1991). In RME, context problems are the basis for progressive mathematization, and through mathematizing, the students develop informal context-specific solution strategies from experientially realistic situations (Gravemeijer & Doorman, 1999). Thus, it is necessary for the researchers who adapt the instructional design perspective of RME to utilize contextual problems that allow for a wide variety of solution procedures, preferably those which considered together already indicate a possible learning route through a process of progressive mathematization.

The realistic mathematics education approach is based on a different point of view of mathematics education. The main difference with the mechanistic and structural approaches is that RME does not start from abstract principles or rules with the aim to learn to apply these in concrete situations (Wubbels et al., 1997). On the contrary, much importance is attributed to informal strategies and constructions that pupils develop themselves. They form the most natural way for pupils to attack problems and RME makes use of this in the

instructional design of lessons. The art of teaching according to RME is to give pupils the opportunity to produce more concrete things themselves and to take their own productions as starting points for the mathematization and the gradual formalization of the informal strategies. The general idea behind this is that by making free productions, pupils are forced to reflect on the path they themselves have taken in their learning process and, at the same time, to anticipate its continuation (de Lange, 1995). Thus, in lesson work pupils are encouraged to realize and identify mathematical aspects in their daily life and to give meaning to problems from a real world context.

De Lange (1995) mentions "there are five basic characteristics in doing RME based learning, yesotu: (1) The use of real-life contexts, (2) The use of use models, (3) Student's free production; (4) Interaction, (5) Intertwining ". In this research, Realistic Mathematics Education approach is a learning process that starts from real things for students and environment and emphasizes the skills of 'process of doing mathematics'. The steps of Realistic Mathematics Education approach in this research are: (1) Understanding the contextual problem, (2) Resolving contextual problem, (3) Comparing or discussing answers, and (4) finding solutions.

2.3. Quality of Learning Devices

Rochmad (2012) states that "to find the quality of the outcomes of model development and learning devices generally required three criteria: validity, practicality, and effectiveness". Along with this Nieveen (2007) says that "a development of learning component is said to be good if the model is:(1) valid; (2) practical; and (3) effective ". 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 instructional devices.

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 (construct validity)" . The components of the indicator of the validation aspects of the validation criteria in general are: format, language, illustrations, content and learning objectives (Akker, 1999).

Hasratuddin (2015) mentions the criteria of effectiveness include the achievement of classical learning completeness, achievement of learning objectives, time spent in learning, and student responses to learning. On the other hand, Herman (2012) states that the effective criteria of a learning if it meets 3 of the 4 criteria of effectiveness, namely achievement of learning outcomes, student activities, positive responses and the ability of teachers to manage learning. Based on the expert's opinion, the effective criteria in this study focuses on: (1) students' learning completeness in a classical manner, (2) achievement of learning objectives, (3) learning time; and (4) students' positive responses.

III. Methods

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

2.4. Subjects and Objects of Research

Subjects in this study were the students of class IX SMP Harapan 2 Medan academic year 2017/2018. While the object in this study is a learning device mathematics SMP Class IX beorientasi based learning Realistic Mathematics Education developed. The learning devices developed in this research is especially to teach the material of Building Curved Sided Space.

2.5. Development of Learning Devices

Learning devices that were developed in this study were Learning Implementation Plan (RPP), Teacher Handbook (BPG), Student Book (BS), Student Activity Sheet (LAS) and Research Instrument in the form of Critical Thinking Test (TKBK). 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:

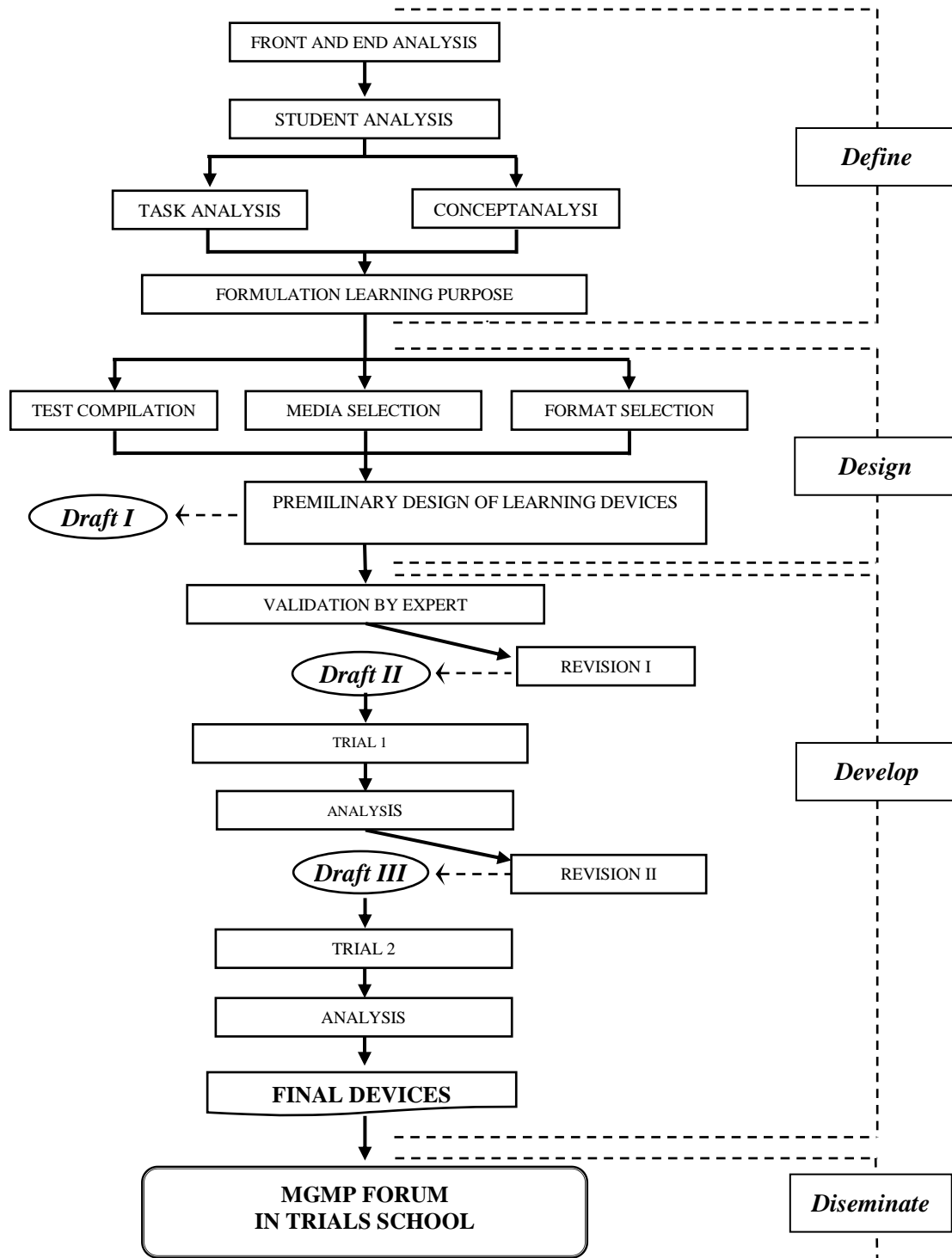


Figure 1. Chart Development of Learning Devices with 4-D Model

3.3. Instruments and Data Analysis Technique

The instruments used in this study include instruments for assessing the quality of instructional devices covering aspects of prevalence, practicality and effectiveness. Instruments used in the form of observationsheets, questionnaires, and tests. For more details can be seen in Table 1 below:

Table 1. Research Instruments

Aspect	Instruments	The Observed Data	Respondent
The Validity of Learning Devices	Validation Sheet	Validity of RPP, LAS, BS, BPG, Critical Thinking Skill Test	Expert/Practitioners
The Effectiveness of Learning Devices	Test	Completeness of Learning Outcome & Achievement Learning Objectives	Research Subject
	Questionnaire	Students Response	Research Subject

Learning devices are said to be valid if they meet the criteria of content validity and construct validity. Learning devices meet the expected content validity if the average validator rating 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 constructs to test critical thinking. Before being used for field trials, the critical test items 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 (Arikunto 2012). The effectiveness of learning devices is reviewed based on: 1) students' learning achievement inclassicalmet if $\geq 85\%$ gets test score ≥ 65 ; 2) achievement of learning objectives is met if the score of each item reaches 75% of the maximum score; 3) the learning time is fulfilled if does not exceed the usual learning time (Hasratuddin, 2015), and 4) student responses are met if the classical $\geq 80\%$ of subjects provide a positive response (Mustafa et al, 2017). After learning device obtain valid and effective criterion, then reviewed the improvement of students' mathematical critical thinking ability based on: 1) improvement of classical average value based on TKBK result and 2) increase of average value of each indicator based on TKBK result from trial I to trial II.

IV. Result

The following is the result of the study obtained based on experimental learning device in SMP Harapan 2 Medan with two trials. The results of the tests described included: 1) validation of learning devices, 2) the effectiveness of learning devices, and 3) improvement of students' mathematical critical thinking ability.

4.1. The Validity of Learning Devices

Based on the validator assessment consisting of 3 experts and 2 practitioners, it was obtained that the learning devices developed obtained the criteria as listed in Table 2 below:

Learning Implementation Plan (RPP), Teacher Handbook (BPG), Student Book (BS), Student Activity Sheet (LAS)

Table 2. The Result of Content Validation of Learning Devices

No	Learning Devices	Average Value of Total Validity	Validation Level
1	Learning Implementation Plan (RPP)	4,52	Valid
2	Student Activity Sheet (LAS)	4,56	
3	Teacher Handbook (BPG)	4,43	
4	Student Book (BS)	4,37	
5	Critical Thinking Ability Test (TKBK)	-	All Items Valid

Based on Table 2, it was found that all learning devices obtained valid criteria because they got the overall average score ≥ 4 . Then the result of the instrument test showed that all the items of critical thinking ability test obtained valid criteria and obtained the reliability value that is $r_{11} = 0,908$ (very high category). Therefore, the learning devices based on RME that were developed obtain the criteria of content validity and constructed validity be appointed.

4.2. The Effectiveness of Learning Devices

4.2.1. Description of Learning Device Effectivenessin Trial I

Based on the results of the test I obtained the completeness of student learning achiemenetin classical as listed in Table 3 below:

Table 3. Posttest Results of Students' Critical Thinking Abilities In Trial I

No	Score Interval	Sum of Students	Percentage	Category
1	$0 \leq \text{SKBK} < 54$	1	4,17 %	Very low
2	$54 \leq \text{SKBK} < 65$	4	16,67 %	Low
3	$65 \leq \text{SKBK} < 79$	14	58,33 %	Medium
4	$79 \leq \text{SKBK} < 89$	5	20,83 %	High
5	$89 \leq \text{SKBK} \leq 100$	0	0,00 %	Very High

Explanation:

SKBK : score of students' critical thinking ability

From Table 3, it can be seen that the total number of completed subjects obtained ≥ 65 reaches 19 students (79.16%) of 24 students, so that they have not obtained the completion criteria of the classical learning result set.

Furthermore, the achievement of learning objectives in trial I can be seen in Table 4 The following:

Table 4. Achievement of Learning Objectives in Trial I

Number of Item	% Achievement of Learning Objectives	Eksplanation
1	66,41%	Not achieved
2	73,44%	Not achieved
3	71,35%	Not achieved

From Table 4, it can be seen that there is no item that can reach the percentage of 75% attainment. Thus the achievement of learning objectives in the first trial is based on the posttest result of students' mathematical critical thinking ability has not been achieved. The result of learning time achievement in trial I is 10 x 40 minutes (5 x meetings). Compared to the usual learning done so far, there is no difference between achieving RME-based learning time and achieving regular learning time. This is in accordance with the predetermined learning time criteria, so the achievement of time trial I have been met. Based on the results of the experiment, the average percentage of total positive responses of students to learning devices and activities in the first test was 83.89%. Therefore, students' responses are also fulfilled because students who respond positively to the components and learning implementation achieve $\geq 80\%$.

Based on the above results obtained that the learning devices only get the aspects of learning time and positive response of students who set, but have not obtained criteria mastery learning outcomes in the classical and achievement of learning objectives set. Thus, the learning devices developed have not received effective criteria. Therefore a revision of the learning device must be revised and re-tested to produce an effective learning devices.

4.2.2. Description of Learning Device Effectiveness in Trial II

Based on the results of the second experiment, the students' learning achievement in classical as shown in Table 5 is as follows:

Table 5. Posttest Results of Students' Critical Thinking Abilities In Trial II

No	Score Interval	Sum of Students	Percentage	Category
1	$0 \leq \text{SKBK} < 54$	0	0 %	Very low
2	$54 \leq \text{SKBK} < 65$	3	12,50 %	Low
3	$65 \leq \text{SKBK} < 79$	8	33,33 %	Medium
4	$79 \leq \text{SKBK} < 89$	12	50,00 %	High
5	$89 \leq \text{SKBK} \leq 100$	1	4,17 %	Very High

Explanation:

Skbk : score of students' critical thinking ability

From Table 5, it can be seen that the total number of subjects who completed the score ≥ 65 reached 21 students (87,50%) from 24 students, thus obtaining the completeness criteria of the classical learning result be appointed.

Furthermore, the achievement of learning objectives in trial II can be seen in Table 6 below:

Table 6. Achievement of Learning Objectives in Trial II

Number of Item	% Achievement of Learning Objectives	Eksplanation
1	75,52%	Achieved
2	78,13%	Achieved
3	76,04%	Achieved

From Table 6, it can be seen that the whole item reached the percentage of 75% attainment. Thus the achievement of learning objectives in the second trial is based on posttest students' mathematical critical thinking ability has been achieved. The result of learning time achievement in trial II is 10 x 40 minutes (5 x meetings). Compared to the usual learning done so far, there is no difference between achieving RME-based learning time and achieving regular learning time. This is in accordance with the predetermined learning time criteria, so the achievement of time trial II has been met. The test results also obtained the average percentage of total positive responses of students to the device and learning activities in the second trial of 89.17%. Therefore, students' responses are also fulfilled because students who respond positively to the components and learning implementation achieve $\geq 80\%$.

Based on the above results obtained that the learning devices obtain all the criteria of effectiveness set, namely mastery learning outcomes in classical, achievement of learning objectives, learning time and positive response of students. Thus the learning device developed has obtained effective criteria.

4.3. Description of Improving Student's Critical Thinking Ability

Based on the posttest result of students' critical thinking ability, the average score on trial I was 70,40 and II test was 76,56. Thus there is an increase in the average score of students' critical mathematical thinking skills between trials of 6.16 or 8.80%. Then improvement of critical thinking ability on each indicator can be seen in Table 7 below:

Table 7. Improving Student's Critical Thinking Ability of Each Indicator

Indicator of Critical Thinking Skill	Rata-rata			
	Trial I	Trial II	Increase	%
Analyze	3,08	3,24	0,16	5,20
Synthesis	2,74	3,03	0,29	10,58
Find a Solution	2,48	2,86	0,38	15,32
Concluded	2,96	3,13	0,17	5,74

The results show that students' mathematical critical thinking ability using the learning devices based on Realistic Mathematics Education developed improved from trial I to trial II. It is concluded that the learning devices based on Realistic Mathematics Education developed to improve students' mathematical critical thinking ability.

V. Discussion

The result of the research shows that the learning based on Realistic Mathematics Education developed the valid and effective criteria. The results show that the developed learning devices have good device quality. Nieveen (2007) states that the validity of learning devices should be reviewed based on the content validity and construct validity. According to Asmin and Mansyur (2014) the content validity of a test questioned how far a test measures the level of mastery over 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 able to measure the concept that should be measured. In this research both aspects of validity have been fulfilled. Content validity through validator assessment (3 experts and 2 practitioners), and construct validity through test instrument test outside research subject. Learning devices are said to have good quality must obtain effective criteria (Nieveen, 2007). Effective in question is the extent to which developed learning devices are able to achieve the predefined goal criteria. In this study learning devices have been developed to obtain effective criteria based on the achievement: 1) mastery of classical learning outcomes, 2) achievement of learning objectives, 3) learning time, and 4) student response. The effectiveness of instructional devices is fulfilled through two series of trials, between the two experiments carried out the revision process of learning devices. Revision is done because in experiment I the learning device has not obtained all the effective criteria set. Meanwhile, after the revision process of learning devices, all the effective criteria set forth (Mustafa, 2017, Aufa, 2016; Yuliani and Saragih, 2015).

The learning devices Based on RME developed are also able to improve students' critical thinking ability. The improvement of students' critical thinking ability is 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 the RME approach in learning also influences the improvement of students' critical thinking ability. With the implementation of RME 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. This is in line with Piaget's constructivism theory (Sugiyono, 2012) that "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 the activity which is necessary for learners to build their knowledge ". Thus the learning devices based on RME developed is appropriate to cultivate and improve students' critical thinking ability.

VI. Conclusion

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

- 1) The learning devices based on RME developed to improve students' critical thinking ability of mathematics obtained valid criteria. Validity is reviewed based on content validity and construct validity.
- 2) The learning devices based on RME developed to improve students' critical thinking ability obtained effective criteria for use in learning mathematics. The effectiveness of learning devices is reviewed based on: a) mastery of student learning achievement in a classical manner, b) achievement of learning objectives, c) learning time, and d) students' positive responses.
- 3) Critical thinking ability of students' by using the learning devices based on RME developed were increased. Improvements were reviewed based on: a) classical average based on TKBK result from trial I to trial II and b) classical average of each indicator based on TKBK result from trial I to trial II.

References

- [1]. Tirtarahardja, U. (2008). Pengantar Pendidikan. Jakarta: Rineka Cipta
- [2]. Hasratuddin. (2015). Mengapa Harus Belajar Matematika. Medan: Perdana Publishing.
- [3]. Abdurrahman, M. (2009). Pendidikan Bagi Anak Berkesulitan Belajar. Jakarta: Rineka Cipta.
- [4]. Mustafa, et al. (2017). Development of Learning Devices Through Problem Based Learning Model to Improve Students Metacognition Skill at SMPN 17 Medan. *Journal Education and Practice*. 8(24), 34-41.
- [5]. Hassoubah, Z. I. (2004). Developing Creative and Critical thinking ability (Cara Berpikir Kreatif dan Kritis). Bandung: Yayasan Nuansa Cendekia.
- [6]. Johnson, E. B. (2011). Contextual Teaching & Learning: Menjadikan Kegiatan Belajar-Mengajar Mengasyikkan dan Bermakna. Bandung: Kaifa.
- [7]. Muchayat. (2011). Pengembangan Perangkat Pembelajaran Matematika dengan Strategi Ideal Problem Solving Bermuatan Pendidikan Karakter. *Jurnal PP (Online)*, 1(2), (<http://journal.unnes.ac.id/nju/index.php/jppasca/article/download/1545/1721>, diakses 2 November 2017).
- [8]. Hasratuddin. (2002). Pembelajaran Matematika Unit Geometri Dengan Penekanan Realistik di SLTP 6 Medan. Tesis. Surabaya: Program Pascasarjana Universitas Negeri Surabaya.
- [9]. Santrock, J. W. (2007). Psikologi Pendidikan. Jakarta: Kencana.
- [10]. Sagala, S. (2010). Konsep dan Makna Pembelajaran. Bandung: Alfabeta.
- [11]. Fisher, A. (2009). Berpikir Kritis: Sebuah Pengantar. Jakarta: Erlangga.
- [12]. Freudenthal, H. (1991). Revisiting mathematics education. Dordrecht: Kluwer Academic Publishers.
- [13]. Gravemeijer, K., & Doorman, M. (1999). Context problems in realistic mathematics education: A calculus course as an example. *Educational Studies in Mathematics*, 39, 111-129.
- [14]. Wubbels, T., et al (1997). Preparing teachers for realistic mathematics education. *Educational Studies in Mathematics*, 32, 1-28.
- [15]. De Lange, J. (1995). Assessment: No change without problems. In T.A. Romberg (Ed.), *Reform in school mathematics and authentic assessment*. Albany, NY: State University of New York.
- [16]. Rochmad. 2012. Desain Model Pengembangan Perangkat Pembelajaran. *Jurnal Kreano*, Vol. 3 No. 1.
- [17]. Nieveen, N. (2007). An Introduction to Education Design Research. China. (Online), (www.slo.nl/organisatie/international/publications, diakses 17 Oktober 2017).
- [18]. Akker, J. V. D. (1999). Principles and Methods of Development Research. Dalam Plomp, T; Nieveen, N; Gustafson, K; Branch, R.M; dan Van Den Akker, J (eds). *Design Approaches and Tools in Education and Training*. London: Kluwer Academic Publisher.
- [19]. Herman. (2012). Pengembangan Perangkat Pembelajaran Model Pengajaran Langsung Untuk Mengajarkan Materi Keseimbangan Benda Tegar. *Jurnal Sains dan Pendidikan Fisika*. 8 (1): 1-11
- [20]. Thiagarajan, S., et al. (1974). Instructional Development for Training Teachers of Exceptional Children. A Source Book. Bloomington: Central for Innovation on Teaching The Handicapped.
- [21]. Arikunto, S. (2012). Prosedur Penelitian: Suatu Pendekatan Praktek. Jakarta: Rineka Cipta.
- [22]. Asmin & Abil, M. (2014). Pengukuran Penilaian Hasil Belajar dengan Analisis Klasik dan Modern. Medan: LARISPA.
- [23]. Aufa, M., et al. (2016). Development of Learning Devices through Problem Based Learning Model Based on the Context of Aceh Cultural to Improve Mathematical Communication Skills and Social Skills of SMPN 1 Muara Batu Students. *Journal Education and Practice*. 7(4), 232-248.
- [24]. Yuliani, K., & Saragih, S. (2015). The Development of Learning Devices Based Guided Discovery Model to Improve Understanding Concept and Critical Thinking Mathematically Ability of Students at Islamic Junior High School of Medan. *Journal Education and Practice*, 6(24), 118-128.
- [25]. Sugiyono. (2012). Metode Penelitian Pendidikan. Bandung: Alfabeta.

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