Development of Geogebra Assisted Problem Based Learning Tools to Improve Critical Thinking Skills for SMP Negeri 1 Stabat

Supianto1, Ani Minarni2, Hasratuddin3

{ Supianto7990@gmail.com }

Mathematics Education Postgraduate Study Program, Medan State University, Indonesia123

Abstract. The aim of the reasearch are to: 1) produce valid creteria, practical creteria and effective creteria on PBL tools for students of SMP N 1 Stabat; 2) Analyze the increase in the mathematical critical thinking skills (TKBM) of Junior High School Student N1 Stabat after being taught using the Geogebra-assisted Poblem Based Learning (PBL) tool; This research is included in development research using the Thiagarajan 4D learning device development model. This research was conducted at Junior High School 1 Stabat. The results of the study show that: 1) the geogebra-assisted problem-based learning tool in improving TKBM that has been developed meets valid, practical and effective criteria; 2) The improvement of TKBM.

Keywords: the development of problem-based learning tools, geogebra, critical thinking skills

1. Introductions

Education in the digital era is growing rapidly. Mathematics learning must be able to keep up with these changes. Mathematics learning refers to learning to think at a higher level, namely critical thinking. This thinking ability must be systematic, critical, logical, creative and innovative. Learning mathematics is very important so teachers must be able to teach mathematics well.

In this era of all-technology, students are required not only to be smart academically. But students must also be able to use technology to support achievements in the field of education. Many things have changed, one of which is the way teachers teach. Now teachers not only have to teach but also have to be able to collaborate with technology in teaching. This is in line with the ease of internet access for modern education.

Mathematics is a compulsory subject taught at the junior high school level. Mathematics lessons are difficult for student. This can be seen from the very low math skills, based on the results of the 2018 PISA survey, the survey results show that students in Indonesia are ranked 75 out of 80 participating countries. Factors that make it difficult for students to learn can come from

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within and outside. According to Aunurrahman (2011) Students' learning is influenced by two factors, they are internal and external. Internal factors are genetics and IQ. While external factors include the environment, teachers, learning methods and nutrition.

The external factor that greatly influences student success is the teacher. The teacher is a determinant of the success of an education in schools. The teacher's ability to teach greatly influences the achievement of learning objectives. According to Aripin (2017), teachers must be able to utilize technology during learning so that learning objectives can be achieved properly.

When the teacher wants to teach in class, the teacher should have prepared the learning tools needed according to the curriculum, such as lesson plans and worksheets. Planned learning and having validated measurement tools will make learning activities run well and smoothly. Thus, we can get optimal results in the learning process. Therefore, the quality of education in Indonesia will increase in line with the achievement of these learning objectives.

The developed learning tools must have valid criteria, practical criteria and effective criteria. According to Nieveen (2007) quality learning has 3 criteria, namely valid, practical and effective. Tati (2019) validation is carried out by a team of experts and practitioners. Students can learn and learn in the joy class. So the teacher must make a room that is very comfortable for learning.

When external factors such as teachers, the environment and these devices are implemented properly, it will directly make learning outcomes better.

Good learning is a defense that goes according to plan according to the RPP. So that the implementation of learning and learning outcomes can be evaluated properly according to aspects to be achieved in learning. The achievement of learning objectives cannot be separated from the teacher's role in learning.

According to Arikunto (2017)learning mathematics is very important, therefore teachers must be able to prepare learning tools that can facilitate students in learning mathematics. Teachers can use learning models that suit the needs of students. Nugroho (2017) stated that mathematics is important, so teachers can create tools that apply students to think logically so that later it can be useful for the future. Learning mathematics must be in the context of relevant problems so that students can think logically and creatively in finding solutions. Ironically, learning mathematics at school does not involve students in thinking much. Students consider mathematics a difficult subject so learning mathematics tends to be boring. Teachers also do not create an interactive learning atmosphere for students. So that students tend to be passive in learning in class.

Therefore, we must make a change in learning mathematics. One way is to develop learning tools that suit the needs of students to improve student learning outcomes. Learning Media which can be developed includes: BG, BS, RPP and LKS.

Syahputra and Surya (2017) state that standard reference in learning in class, teachers can use textbooks that are appropriate to learning.According to Trianto (2017:227) argues that The development of a textbook must valid and effective criteria. On reality is, we found some draw on the teaching book at SMP Negeri 1 Stabat. Text books can’t construct students' knowledge learning. Mathematics is learning that emphasizes students to be active in solving mathematical problems according to their abilities. Mathematics should be taught by training students'

thinking skills. So that students are accustomed to thinking and acting logically in solving problems.

Critical thinking skills that students will have role in the life of students in the future. Chukwuyenum (2017: 1) argues that One of the skills that can be used in problem solving is critical thinking. Critical thinking consist of logical reasoning, interpreting, analyzing and evaluating information.

The results obtained that critical thinking skills are still low.Seen from30 students of class VII SMP Negeri 1 Stabatwho are given quadrilateral material. There are 5 students can answer correctly as much (16.7%) and students answered the questions uncorrectly 25 students (83.3%).

We can choose the PBL learning model to maximize students' critical thinking skills. Sinaga and Ani (2019) said that PBL Model is a learning model that can provide active learning conditions to students. Student can use their mind to creative thinking.

In this all-digital era, information technology is widely used during learning mathematics. Kusumah (2003) put forward various benefits of computer programs in learning mathematics. According to him, computer programs are ideal for use in learning high-precision mathematical concepts, and solving graphs accurately. Furthermore, Kusumah (2003) also argued that learning innovations with the help of computers are very good to be integrated into learning mathematical concepts, especially those involving geometric transformations, calculus, statistics, and function graphs.

A very good computer software in assisting students in learning geometry is geogebra. Markus Hohenwarter (2008) developed the Geogebra software in 2001 to make it easier to learn geometry and algebra.

From the explanation above, researchers are interested in developing problem-based learning tools assisted by Geogebra software to improve mathematical critical thinking skills.

2 Research methods

Types of research

The research is a development research with a development model Thiagarajan 4D to produce the valid tool, the practical tool and effective tools.

Research Subjects and Objects

The Subject are students in class VII-A and VII-B of SMP Negeri 1 Stabat, there are 30 student in the class. The objects of this research are 1) problem-based learning, 2) quadrilateral material and 3) critical thinking skills.

2.1 Data analysis

Analysis of learning device validity data

The validation results were obtained from a team of experts in their fields. There are five experts and practitioners who have the ability to validate the devices that have been made.

Analysis of the practicality of learning devices

For practical criteria, the problem-based learning model developed must have the criteria of "slight revision" or "no revision". The results were obtained from the expert team by providing an assessment of the learning device on the device validation sheet.

Data analysis of the effectiveness of learning devices.

A learning device that can be said to be effective when the device has the following three criteria: 1) the device has classical student learning completeness, (2) the device has achieved learning objectives based on problem-based learning models, and (3) when the learning process takes place, students have a good response to learning that applies the PBL learning model.

Data Collection Instruments and Techniques

Validation Instrument of Learning Device

Based on the expert's assessment, the learning device validation instruments are in the form of RPP validation sheets, we have to create the teacher's books, also the student's books, and the student activity sheets. This validation sheet contains the components that are assessed including: format, language, illustration, and content.

Test Instrument of Mathematical Critical Thinking Ability

The instrument for testing mathematical critical thinking skills developed in this study is in the form of a structured essay test written based on the indicators and learning objectives to be achieved.

2.3 Instructional Media Development Procedures

Define Stage

At this early stage, we write down, define and define student learning needs by analyzing learning objectives and learning material limitations. At this stage an initial and final analysis is also carried out, we also carry out student analysis, besides that we also have to analyze concepts, then we also determine task analysis, and finally we also have to determine the specifications of learning objectives.

Design Phase

In the next stage, namely concept analysis, we will obtain the appropriate test. The test is a test of students' mathematical critical thinking skills. The KBKM test is made based on predetermined indicators. In addition, the selection of appropriate media to support problem-based learning is in the form of geogebra applications. The geogebra application is used to visualize quadrilateral learning material to make it more attractive and easily understood by students. With the geogebra application, quadrilateral material can be presented clearly. This application has also been adapted to the instruments and tests contained in the test.

So, in this phase we get the initial draft (draft 1). In this initial draft there is a selection of formats, teacher books and student books. In draft 1, all content has been adapted to the principles, characteristics and steps of the problem-based learning model.

Development Stage

The next stage is development.

The steps in the development stage, namely:

Validation/Expert Appraisal

The instruments that we have prepared will be validated by a team of experts in their field. they evaluate the instrument that has been adjusted based on indicators. The results of the evaluation are in the form of suggestions for improvement as well as an assessment of all materials that have been developed at the design stage. After being repaired according to the direction of the expert team, a valid instrument will be produced and ready to be tested in the field.

Trials of Research Instruments

Before being tested in the field, the research instrument was in the form of students' mathematical critical thinking tests which had been validated by a team of experts, the tests which had been validated were tried out in classes outside the sample. The results of the trial were then tested for validity instrument and reliability instrument . It will produce a research instrument with a valid category and the instrument may be used after being tested.

Field Trials

Learning tools that have been developed based on PBL. Then the device is tested . The result is that the device has practical criteria and effective criteria. So that an increase in students' mathematical critical thinking skills will be achieved in accordance with the indicators to be achieved.

Dissemination Stage

When the resulting device has gone through evaluation and has been tested properly and is valid. Then the next stage is Deployment. The dissemination of learning tools that have been tested is limited to all mathematics teachers at SMP N1 Stabatl. Teachers can use this device to teach in class. The resulting device is one of the learning alternatives on quadrilateral material.

3. Results

The Validation of Learning Device

The research instrument that has been developed is a TKBM test. The test is then carried out in class outside the sample. After being tested, the results are evaluated. Then tested the validity instrument and reliability instrument of the test. The results of the calculating instrument by correlating the item score with the total score, the test results of the student's TKBM test instrument using the person product moment correlation formula in Table 1.

Table 1. The validity of the items about TKBM

Number	r_{xy}	t_{count}	t_{table}	Interpretation
1	0,91	9.79	2.08	Valid
2	0.92	10.58	2.08	Valid
3	0,87	7.67	2.08	Valid

We can see the results in Table 1, the TKBM test given to students after being analyzed with a significance level of 5%, degree of difficulty (dk = 28), obtained ttable = 2.08. Based on the test criteria, t-count > t-table, we can use the TKBM test that we have tested in the field because it meets the "valid" criteria.

After the test validation was carried out, the next stage was an assessment from a team of experts and practitioners on the practicality of problem-based learning devices. The results of the assessment by the team have been described in Table 2.

Table2. The Result of Learning device validatior

Validators	Instrument				
	RPP	LKPD	BS	BG	TKBKM
Validators-1	TR	RK	TR	RK	TR
Validators-2	TR	TR	RK	TR	RK
Validators-3	TR	RR	TR	TR	TR
Validators-4	RK	TR	TR	RK	TR
Validators-5	RK	TR	TR	TR	RK

Based on table 2, according to practicality criteria and experts state that learning tools can be used with “minor revisions” and “no revisions”.

3.1 The effectiveness of learning tools

The PBL tools that are developed must have a positive effect on learning outcomes and an increase in mathematical abilities, and also have a significant effect on learning mathematics in schools. The development of these learning tools must also meet the effectiveness criteria that have been determined, there are 3 effective criteria, namely: (1) students who take part in learning that applies a problem-based learning model must have classical student mastery of at least 85%, (2) learning objectives based on predetermined indicators reach a minimum of 75%, (3) the positive response of research subjects to learning that applies the learning model has a minimum score of 80%, and (4) the learning time is not more than the usual learning time or at least the same as regular learning.

Sall of these things have not been fulfilled in trial I, so it was tested II.

In trial II, the geogebra-assisted problem-based learning that was tested met the criteria for achieving classical completeness. This can be seen from the data obtained, namely as much as 61.9% of the pretest results of TKBM with a post-test of 84.8% and the test of TKBM achieved a score of 80. In addition, the learning objectives in trial II were achieved with the criterion of 75%. Here we get the maximum score for each item on indicator 1, indicator 2 and indicator 3, the results are 92.71%, 82.81% and 78.47% respectively. as we already know that the post-test results of the tested TKBM have been achieved for all indicators. In line with that, the results of achieving learning time in the tria II of VI meetings were relatively the same and had no significant difference. After the results of the second trial data analysis carried out. We can conclude that the problem-based learning tool developed in this study meets the criteria for being effective.

Improving Students' Critical Thinking Ability

The increase in pretest and post-test results after being analyzed based on the N-gain formula which was carried out in the study. The results of increasing TKBM in the first trial were obtained in the following table:

Table 3. Summary of the results of the N-Gain test of TKBM I

Reach	Category	Total students	Percentage
$N \geq 0.7$	Tall	2	10 %
$0.3 \leq N \geq 0.7$	Medium	16	80 %

N < 0.3	Low	2	10 %

From the results shown in table 3 after implementing problem-based learning in the trial I, there was an increase in TKBM. From these results it is known that the N-gain results obtained in the tria I had a score of 0.51 in the "medium" category.

In the analysis results of the increase in N-gain in trial II, namely Table 4. following this:

Table 4. Summary of the results of the N-Gain test of TKBM II

Reach	Category	Total students	Percentage
N ≥ 0.7	Tall	8	40 %
0.3 ≤ N ≥ 0.7	Medium	11	55 %
N < 0.3	Low	1	5 %

From the results shown in table 4 after implementing problem-based learning in the trial I, there was an increase in TKBM. From these results it is known that the N-gain results obtained in the trial I had a score of 0.62 in the "medium" category.

Here we can conclude that the n-gain results in experiment I and experiment II have increased.

4. Discussion

In this digital era, learning mathematics must continue to innovate in accordance with the demands of the times. Innovative learning in accordance with the times to improve the quality of learning. Students not only have to be smart, but students also have to have competent abilities on every problem that exists. The role of the teacher in improving to solve problems that are relevant to life is an urgent necessity today. Students are trained to use their minds and minds to think critically and logically in problem solving.

The teacher as a facilitator in the development of students' thinking must also have the learning methods and models needed by students. Through problem-based learning that is developed, it is expected that students will find it easier to solve the problems they face carefully, systematically and logically. Researchers hope that the problem-based learning model applied to Junior High School Student Stabat N1 will be able to have a positive impact on the development of students' critical thinking in solving mathematical problems. Learning mathematics in problem-oriented schools requires students to think critically and this is in line with the opinion of experts such as Piaget who emphasize students' cognitive development.

Vygotsky explained that students who do tasks that have not been studied can develop a mindset in the zone of proximal development. The more often students do these tasks, the mindset of students will develop well. For this reason, it is necessary to develop learning tools that can improve and develop students' mindsets. The development of the device uses a 4D model. The instruments developed are RPP, worksheets, BG, BS and tests that have been adapted to quadrilateral material.

From the results of the analysis, the assessment has been carried out by a team of experts. Then the results obtained in the form of device validation on each component have met the "valid" criteria. For practicality, we can find out through the expert team's response. They provide assessments and suggestions for these learning devices. The result is a learning tool that can be used with “minor revision” or “no revisions”. In terms of effectiveness, learning tools must meet

3 indicators of effectiveness, namely 1) classically, learning completeness must be achieved in trial II, 2) learning objectives are achieved with a minimum score of 75% and 3) during learning, student responses are categorized as good, namely having a score at least 80%.

Nieeven (2007) argues that student achievement and effectiveness must refer to the curriculum set by the government. The government has set standards for the education system so that the results will be measurable and universal. This is in line with the increase in TKBM which were analyzed in trials I and II. Increasing the ability of these students to be taken into consideration in further research.

From the research results of Hasratuddin, et al (2014) the following conclusions were obtained: (1) TKBM will increase higher in students who are given PBL than those who are given direct learning; (2) learning with TKBM towards increasing students' mathematical critical thinking skills has no interaction; (3) the IL of students who are given PBL will increase and be better than those who are given direct learning; (4) learning with TKBM towards increasing student learning independence has no interaction. Nur (2016) in a study entitled "Utilization of Geogebra in Mathematics Learning".

So I concluded that the PBL tools developed by this study could later improve TKBM.

5. Conclusion

The researcher has conducted analysis and obtained the results which can be concluded as follows: 1) the development of PBL tools assisted by geogebra has met valid criteria, practical criteria and effective criteria. On valid criteria, the conclusions obtained are the results of the validation scores of RPP (4.64), worksheets (4.64), teacher books (4.64), student books (4.63), tests of critical thinking skills declared valid by a team of experts . On practical criteria, based on the responses of the expert team, it was stated that the device could be used with “minor revision” or “no revisions”. On the criteria for effectiveness, we can see from the achievement of classical mastery of at least 80%, the achievement of learning objectives of at least 80% and the student response to learning by 80%. 2) from the N-gain results, there is an increase in TKBM in trials I and trials II.

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