BirLE-Journal
Budapest International Research and Critics in Linguistics and Education
p.ISSN: 2655-2647
e.ISSN: 2655-1470
Budapest Institute

Development of Geogebra-Assisted Problem Based Learning (PBL) Learning Tools to Improve Visual Thinking Skills in Mathematical Problem Solving Students of SMA Negeri 1 Samudera

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Abstract

This study aims to produce valid, practical, and effective learning tools, as well as to analyze the improvement of visual thinking skills in problem solving for XI grade students of SMA Negeri 1 Samudera using mathematics learning tools oriented problem based learning assisted by GeoGebra. The data were obtained through the validation sheet of teaching materials, observation sheets, student response questionnaires, and instruments for testing the ability of visual thinking in solving mathematical problems. This study uses the Dick & Carey (1996) development model. Based on the results of the validity by the validator team, the average validity of the RPP was 4.51, LKPD was 4.22, and student books were 4.29. Expert / practitioner assessment which states that learning devices can be used with a few revisions and without revision, the results of interviews with teachers and students obtain information that learning devices can be used easily and the results of observations of the implementation of learning tools in class in the first trial of 81.67% and in the second trial of 87.22% and included in the good category. Learning devices in trial II, obtaining classical student learning completeness results have been achieved in trial II, namely 87.5%, the achievement of learning objectives has been achieved for each item in trial II, student responses are very positive to the device being developed and learning time does not exceed ordinary learning, namely three meetings.

Keywords
problem based learning (PBL); Geogebra; visual thinking skills in solving student problems

I. Introduction

Mathematics has always occupied a core position, but has not attracted the interest of most students. This happens because of the low student achievement in mathematics. Based on the results of the PISA test and survey initiated by the Organization for Economic Co-operation and Development (OECD) in 2015 involving 540,000 students in 70 countries, it shows that the performance of Indonesian students is still low. The average achievement score for Indonesian students for mathematics ranks 63 out of 70 countries evaluated. Indonesia's ranking and average score are not much different from the results of previous PISA tests and surveys in 2012. Indonesia is ranked 64th out of 65 countries, a low mastery group. According to Tarigan et al (2020) Teaching materials are materials or subject matter that are arranged systematically, which are used by teachers and students in the learning process. One of the learning models is Problem Based Learning (PBL).

Table 1. 2015 PISA Science, Reading, and Mathematics Performance Snippets

	Science		Reading		Mathematics	
	Mean score in PISA 2015	Average three-year trend	Mean score in PISA 2015	Average three-year trend	Mean score in PISA 2015	Average three-year trend
	Mean	Score dif.	Mean	Score dif.	Mean	Score dif.
OECD average	493	-1	493	-1	490	-1
Indonesia	403	3	397	-2	386	4

(Source: OECD, 2015)

Regarding the results of the tests and surveys, the level of questions described the students' proficiency in solving daily problems was lacking. This skill which is commonly referred to by PISA as mathematical literacy refers to the ability of students to formulate problems mathematically based on the concepts and relationships inherent in the problem. Solving problems is not only a goal but the main goal that must be done in learning. Students must be given the opportunity to solve complex mathematical problems and use a variety of strategies, so that students will get a way of thinking, form an attitude of persistence and curiosity.

In solving math problems, visual thinking skills are also needed. According to Modelminds (in Surya, 2013) states 10 reasons why visual thinking is important in solving problems, namely: (1) Visual thinking makes complex problems easy to understand; (2) The result of visualizing a complex problem, makes it easy to communicate and for others to solve it; (3) Visual thinking helps people communicate across cultural and language barriers; (4) Visual thinking makes communication from the emotional side of complex problems easier; (5) Visualization helps facilitate non-linear problem solving; (6) The visualization of a problem allows people to think together with each other's ideas by creating a shared language; (7) A visual mapping of a problem can help to see gaps where solutions can be found; (8) Visualization helps people to remember, make concrete ideas and then ultimately create more accurate results; (9) Visual thinking can provide an important picture of learning from mistakes; (10) Visualization serves as the greatest motivation to achieve goals.

Learning tools developed should produce a learning product that meets aspects of feasibility, practicality and effectiveness in order to achieve the quality of the learning tools used. The quality of learning tools is good according to Nieveen (1999) if it meets several aspects, namely: (1) validity, (2) practicality, and (3) effectiveness. However, the reality that occurs in the field is based on the observations of researchers at SMA Negeri 1 Samudera, namely: most teachers consider learning tools only as a requirement for administrative completeness, without paying attention to the aspects of feasibility, practicality or effectiveness of learning tools that have been made, the tools made have not been implemented optimally in learning activities, many teachers still have difficulty making their own learning tools, especially when the curriculum applied for class XI is the 2013 curriculum.

The learning tools to be made must also refer to a learning model so that the tools developed become a complementary unit and are focused on the goals to be achieved. In their research, Kazemi & Ghoraishi (2012) revealed:

"Learning begins with a scenario carrying a real-life problem to be solved, which students need to solve by means of the knowledge and required information they have already acquired The problems are said to be ill-structured because students have insufficient information to arrive at a solution, and are therefore required to identify what they need to acquire and apply in order to solve the problem."

The description above implies that learning begins with scenarios on real-life problems that must be solved, students complete based on the knowledge and information they have obtained. The problem is said to be unstructured because students have enough information to arrive at a solution, therefore it is necessary to identify what needs to be obtained and applied to solve the problem.

The statement above implies that teacher-centered learning causes a lack of student involvement in the learning process so that students get material passively and are less skilled in solving problems. To overcome the problems mentioned above, a learning model is needed that allows students to be active in the learning process.

Thus, based on this, many researchers agree that problem-based learning is an effective approach to train students to learn things through their own discoveries and also learning that makes students active. In accordance with the research conducted by Surya and Syahputra (2017) which states "Student can connect the information that they got from the given problem. Students are actively communicating their opinion to their study group". This statement implies that students can relate the information they get from the given problem. Students actively communicate their opinions to their study groups. According to Pohan, in Trianto (2011: 91) learning based on problems is the interaction between stimulus and response, a relationship between two directions of learning and the environment.

The characteristics of PBL in general are described by Ali (2010), namely: (1) Learning is encouraged by providing challenges, open-ended problems without limiting one definite solution to the correct answer; (2) Problems in PBL are context problems; (3) Students work independently, as active investigators and work together in groups to solve problems; (4) The teacher acts as a facilitator, not the main source of information and guides the learning process. The basic principles that support the concept in a problem-based approach are complex, real-world problems that are used to motivate students to identify and research the concepts and principles they need to know to work through the problem. Students work in small learning teams, incorporating collective skills in the activities of obtaining, communicating, and integrating information.

From the research of several researchers, it can be concluded that PBL: 1) provides more free space for children to explore thinking skills, 2) is more effectively used than conventional learning, 3) is effective for developing student's problem solving skills, 4) arouses interest and make students have a better focus on understanding and improving student performance, 5) student collaboration activities and student activities in the classroom look better and allow dynamic interactions between teachers and students, students and students, 6) helping students to have better responsibility, students who do not have the courage to express their opinions experience changes when the PBL method, 7) makes it possible to explore academic potentials that are not seen in students, 8) improve creative thinking skills for students, improve higher order thinking skills in students (Higher Order T. hinking Skill), 9) increase student motivation and self-confidence in learning, critical, analytical, self-directed and teamwork abilities.

Computer technology-based problem-based learning is learning that involves active students optimally, allows students to carry out investigations, increases creativity and problem solving that integrates thinking skills and understanding concepts. There are many computer programs that can be used and one of the computer programs (software) is GeoGebra. GeoGebra was developed by Markus Hohenwarter in 2001. According to Hohenwarter (2008), GeoGebra is a computer program (software) to teach mathematics, especially calculus, geometry and algebra. GeoGebra is open source software under the GNU (General Public License) and can be found at www.GeoGebra.org.

With GeoGebra, it can present abstract mathematical material to be concrete because it provides supportive features and is very suitable for conveying mathematical concepts so that it can build student knowledge and encourage students to understand concepts. A study conducted by Zulnaidi and Zamri (2017) shows “All students regardless of their abilities have shown an increase in their conceptual knowledge of the Function topic. This shows that the GeoGebra software has positive effects and it does help to enhance students' conceptual and procedural knowledge on Mathematics ”. Which implies that all students regardless of their abilities have shown an increase in their conceptual knowledge of the topic of Function. This shows that GeoGebra software has a positive effect and it helps to increase students' conceptual and procedural knowledge of Mathematics.

Based on the description above and the weaknesses of the learning tools at SMA Negeri 1 Samudera which indicate that the quality of the available learning tools is not suitable and the ability of visual thinking in solving students' mathematical problems is still low and the importance of developing mathematics learning tools using the PBL model assisted by ICT technology, then The researcher conducted a research entitled "*Development of Problem Based Learning (PBL) Assisted by GeoGebra to Improve Visual Thinking Ability in Mathematical Problem Solving Students of SMA Negeri 1 Samudera*".

II. Research Methods

This The subjects in this study were students of SMA Negeri 1 Samudera in class XI-MIPA for the 2020/2021 school year. Researchers chose class XI (eleven) as research subjects so that students could improve students' visual thinking skills in solving mathematical problems for the next class. In addition, because the ability of visual thinking in solving mathematical problems of students in class XI-MIPA is still low. The object in this study is a Geogebra-assisted Problem Based Learning (PBL) learning tool to improve students' visual thinking skills in solving mathematical problems. The learning device developed in this research is linear program material. The trial design carried out in this study is the One-Group Pretest-Postest Design which is represented as follows:

Test	Treatment	Test
T_1	x	T_2

Information :
T1: Pre-test
T2: Post-test
X : Treatment with Geogebra-assisted PBL learning tools

This research is categorized into the types of development research (development research). This study used the Dick & Carey (1996) development model and researchers developed Geogebra-assisted Problem Based Learning (PBL) learning tools. The learning tools developed are Student Books (BS), Learning Implementation Plans (RPP), Student Worksheets (LKPD), Learning Ability Tests (TKB), especially visual thinking skills in solving students' mathematical problems.

III. Discussion

Student learning devices that have gone through the one-on-one evaluation stage by experts and practitioners, and have been declared valid with minor revisions. The next activity is to conduct research, namely revision and field trials in large groups, in this research it is called trial I. The first trial was conducted in class XI-MIPA 1 which consisted of 32 students. Trials in learning were conducted three times. The trial was conducted by means of the researcher acting as a teaching teacher. Learning is carried out in groups consisting of 3-4 students. There are no specific criteria in grouping students or heterogeneous not differentiating academic ability, gender, so that each student can get a variety of learning experiences and the abilities of students in each group are relatively the same.

The results of data analysis obtained from the results of trial I, trial II and the dissemination stage showed: (1) the validity of the learning tools developed with geogebra-assisted problem-based learning models; (2) the practicality of the learning tools developed with the geogebra-assisted problem-based learning model; (3) the effectiveness of the learning tools developed with a geographic-assisted problem-based learning model; 4) to increase the ability of visual thinking in solving mathematical problems of students who are taught by using geogebra-assisted problem-based learning.

3.1 The Validity of Learning Tools Developed with Geogebra-Assisted Problem Based Learning (PBL-BG)

The validity test was carried out to see the shortcomings of the learning tools developed with the geogebra-assisted problem-based learning model which was designed with attention to problems in class XI-MIPA SMA Negeri 1 Samudera related to basic competencies, material, sample questions, practice questions and evaluation at the end of each chapter. The team of experts (validators) involved in the development of this tool consisted of five experts. The results of the validation of the five validators stated that they were valid with an average total validity of the RPP of 4.51, LKPD of 4.22, student books of 4.29. Data analysis of the results of expert validation on the lesson plan (RPP) is presented in Table 1 below:

Table 1. The Results of the Learning Implementation Plan (RPP) Validation

No	Rated Aspect	Average	Category
1	Format	4,70	Valid
2	Contents	4,44	Valid
3	Language	4,40	Valid
	Average	4,51	**Valid**

From Table 1, it can be seen that the total average value of the RPP validation is 4.51. The five validators concluded that the lesson plan can be used with minor revisions. The results of expert validation on student books are presented in Table 2 below:

Table 2. Results of Student Book Validation

No	Rated Aspect	Average	Category
1	Format	4,57	Valid
2	Language	4,13	Valid
3	Illustration	4,36	Valid
4	Contents	4,11	Valid
	Average	**4,29**	**Valid**

So referring to these criteria, it can be concluded that the developed student book meets the validity criteria with the "valid" category. The five validators concluded that the student book could be used with minor revisions.

Table 3. Validation Results of Student Worksheet (LKPD)

No	Rated Aspect	Average	Category
1	Format	4,43	Valid
2	Contents	4,17	Valid
3	Language	4,40	Valid
Average		**4,22**	**Valid**

Then the test results of the visual thinking ability test instrument in solving mathematical problems are also in the valid category based on the test results showing tcount> ttable, so the test and questionnaire instruments can be used and valid. Reliability of the pretest shows the ability of visual thinking in solving mathematical problems of 0.8106 with a very high category and posttest of visual thinking abilities in solving mathematical problems of 0.8113 with a very high category.

From the results of the analysis above, it can be concluded that the learning tools developed with geographic-assisted problem-based learning have met the validity criteria based on expert / practitioner's judgment.

3.2 Practicality of Learning Tools Developed with Geogebra-Assisted Problem Based Learning (PBL-BG)

Based on the results of data analysis of the results of trial I and trial II, the practicality of learning tools is obtained based on a summary of the results of observations of the implementation of mathematics learning with geogebra-assisted problem-based learning at each stage can be seen in table 4 and table 5 below The implementation of the learning tools used is reviewed at each meeting. The implementation of all learning tools used in the study was observed by an observer who was a teacher of mathematics at every meeting that was held.

Table 4. Recapitulation of the Results of Observation of Learning Devices Implementation in Trial I

Meeting	Average Implementation of Learning Devices	Percentage
I	4,08	81,67%
II	4,16	83,33%
III	4,00	80,00%
Total Average	**4,08**	**81,67%**

In accordance with the reference in Chapter III concerning the implementation of learning, it is said to be successful, namely the fulfillment of the implementation score in the minimum percentage range of $80 \leq k < 90$ in the "good" category. Thus in the first trial, the implementation of learning using the developed learning tools was achieved.

Table 5. Recapitulation of the Results of Observation of Learning Devices Implementation in Trial II

Meeting	Average Implementation of Learning Devices	Percentage
I	4,41	88,33%
II	4,33	86,67%
III	4,33	86,67%
Total Average	**4,08**	**87,22%**

Based on the criteria for the feasibility of learning tools in the range (80 <k <90) with good categories.

The results of the description of the implementation of the learning tools above indicate that the practicality indicators in this study meet the following criteria: (1) the validator's assessment of the learning tools developed as a whole is good and can be used easily, (2) students and subject teachers say that learning tools developed are easy to use, and (3) the implementation of learning using the developed learning tools is in a good category. Based on the three achievement indicators of the practicality of the learning tools, the learning tools developed can be said to be practical. Based on tables 4 and 5 it can be seen that the average percentage of learning implementation in the first trial was 81.67% and in the second trial it was 87.22%. Thus it can be concluded that the implementation of learning at each stage has met the practical criteria and is in the good category $(80 \le k < 90)$.

3.3 The Effectiveness of Learning Tools Developed with Geogebra-Assisted Problem Based Learning (PBL-BG)

Based on the results of the second trial, the learning tools developed with geogebra-assisted problem-based learning have met the effective category in terms of: (1) classical student completeness; (2) the achievement of the learning objectives on each item has reached the specified criteria, namely at least 75%.

a. Classical Student Learning Completeness

Based on the results of the posttest analysis of trial II, it was found that the ability of visual thinking in solving students' mathematical problems had met the completeness criteria classically. In addition, there is an increase in the posttest results of the ability of visual thinking in solving students' mathematical problems based on classical completeness at the trial stage. If seen from the indicators of the ability of visual thinking in problem solving, then the ability of visual thinking in problem solving of the first trial students at the pretest was 73.44% of students were able to retell questions or problems in a systematic way, 58.07% of students were able to present questions in the form Mathematical equations, 41.67% of students were able to present in visual form, and 30.73% of students were able to apply problem solving strategies. After the learning process was carried out, the posttest results increased as follows, 82.81% of students were able to retell questions or problems in a systematic way, 77.87% of students were able to present questions in the form of mathematical equations, 74.48% of students were able to present in visual form , and 68.75% of students are able to apply problem solving strategies.

Table 6. Classical Completeness of Visual Thinking Ability in Students' Mathematical Problem Solving in Trial I

Category	*Pretest* The Number Of Students	Percentage of Classical Completeness	*Posttest* The Number Of Students	Percentage of Classical Completeness
Completed	7	21,88%	24	75%
Not Complete	25	78,12%	8	25%
Total	32	100%	32	100%

Thus, it can be concluded that in the first trial the application of problem-based learning tools with geogebra-assisted learning that was developed did not meet the criteria for achieving completeness of classical learning outcomes.

If seen from the indicators of the ability of visual thinking in problem solving, then the ability of visual thinking in problem solving of the second trial students at the pretest was 74.48% of students were able to retell questions or problems in a systematic way, 59.12% of students were able to present questions in the form of Mathematical equations, only 40.89% of students were able to represent in a visual form, and 30.73% of students were able to apply problem solving strategies while in the posttest there were 89.06% of students able to retell questions or problems in a systematic way, 85.16% of students able to present questions in the form of mathematical equations, 80.73% of students were able to represent in visual form, and 78.65% of students were able to apply problem solving strategies.

Table 7. Classical Completeness of Visual Thinking Ability in Students' Mathematical Problem Solving in Trial II

Category	*Pretest* The Number Of Students	Percentage of Classical Completeness	*Posttest* The Number Of Students	Percentage of Classical Completeness
Completed	8	25%	28	87,5%
Not Complete	24	75%	4	12,5%
Total	32	100%	32	100%

Thus, the posttest results of visual thinking ability in solving mathematical problems fulfill classical completeness because they are able to obtain a completeness percentage of 87.5%. So, it can be concluded that in the second trial the application of the developed geogebra-assisted problem-based learning tools met the criteria for achieving completeness of student learning outcomes classically.

Table 8. Summary of Classical Completeness Results at Each Stage

Step	Percentage of Classical Completeness
Trial I	75,00%
Trial II	87,50%

Table 8 above shows that the percentage of completeness classically at each trial stage always increases. This is because the learning process that takes place uses learning tools developed with geographic-assisted problem-based learning (PBL-BG). Learning materials in student books and student worksheets are developed with a learning process according to the development and characteristics of students so that students can participate in learning and do problem solving well.

b. Achievement of Learning Objectives

Based on the results of the analysis of the achievement of the learning objectives in the first trial, it was found that the achievement of the posttest learning objectives of the visual thinking ability in solving students' mathematical problems in the first trial only achieved 4 indicators, namely in items 1.a, 1.b, 2.a, and 3 .a, while the achievement of the posttest learning objectives of the students' mathematical problem solving abilities in the second trial had been achieved on each item. The achievement of learning objectives by using problem-oriented learning tools assisted by geogebra (PBL-BG) is because learning is carried out using materials and problems that are close to everyday life and problems are solved by visualizing stages that can be reached by students' imaginations which make it easier for students to looking for various possible solutions by visualizing the concept in the form of symbols or mathematical equations then solving the problem with the model found.

Table 9. Summary of the Average Percentage of Achievement of Student Learning Goals at Each Trial Stage

Step	Percent Average Achievement of Learning Objectives				
	No	**a**	**b**	**C**	**d**
Trial I	1	89,06%	85,94%	82,81%	74,22%
	2	81,25%	74,22%	73,44%	71,09%
	3	78,13%	73,44%	67,19%	60,94%
Trial II	1	90,63%	85,94%	82,81%	81,25%
	2	89,06%	84,38%	80,47%	78,91%
	3	87,5%	85,16%	78,91%	75,78%

Table 9 above shows that the percentage of learning objectives achieved at each trial stage. If the results of the analysis are referred to the criteria set out in chapter III, it can be concluded that the achievement of learning objectives meets the criteria at the II trial stage. This means that the learning tools developed with geogebra-assisted problem-based learning (PBL-BG) have met the criteria of being effective.

3.4 Student Response

Based on the results of the analysis of student response data in trial 2, it was concluded that students had a positive response to the components and learning activities. The positive response of students cannot be separated from the conditioning of learning with geogebra-assisted problem-based learning (PBL-BG), including: the problems posed by students originate from contextual problems, namely problems that are close to the student's real world or can be reached by the students' imagination to show the usefulness of mathematics in student life through problem solving. Soedjadi (Sinaga, 2007) argues that determining real problems in the implementation of mathematics learning needs to always pay attention to the reality and the existing environment, so that it is possible and at the same time motivates students to enjoy learning mathematics. Student responses in trial 2 always met the established criteria. This indicates that the application of learning tools developed with geographic-assisted problem-based learning (PBL-BG) can foster student motivation and interest in learning in implementing learning. This is also in line with the results of research conducted by Lestari (2018) that 94.07% student responses have shown a positive response to the components of the learning material and learning activities developed.

Based on these findings, it was found that giving real-world problems or problems about students' daily lives can foster student interest and motivation so that student responses to positive learning. Therefore, it can be concluded that the learning tools developed with geographic-assisted problem-based learning (PBL-BG) meet the effective category in terms of student responses.

3.5 Learning Time

Based on the achievement of learning time carried out during the second trial, the length of learning time using geographic-assisted problem-based learning (PBL-BG) is the same as the usual length of learning time, namely three meetings. Thus, the learning time used is in accordance with the learning time achievement criteria, namely the achievement of the learning time used is the same as the usual learning time, so it is concluded that the achievement of learning time in Trial II has been achieved.

Theoretically, the learning time used at the time of learning using geographic-assisted problem-based learning (PBL-BG) has met the effectiveness criteria. With geogebra-assisted problem-based learning (PBL-BG), students are first given a real problem and are close to everyday life, so that from these problems students can think, observe, solve problems, explain and analyze to find knowledge.

3.6 Improved Visual Thinking Ability in Solving Students' Mathematical Problems Using Geogebra-assisted Problem Based Learning (PBL-BG) Learning Tools

The data obtained from the posttest results of the visual thimkimg ability in solving students 'mathematical problems in trial I and trial II were analyzed to determine the increase in visual thinking skills in solving students' mathematical problems by comparing the average score of students obtained from the results of the posttest test I and test II.

Table 10. Descriptions of Visual Thinking Ability Results in Posttest Mathematical Problem Solving Experiments

Information	*Posttest* Trial I	*Posttest* Trial II
The Highest Score	85,71	95,24
Lowest Value	59,52	61,91
Average	75,59	82,59

Table 11. Summary of N-Gain Results on the Visual Thinking Ability Test in Mathematical Problem Solving in Trial I

Range	Category Improvement	The Number Of Students	Percentage
$N \geq 0,7$	High	0	0,00%
$0,3 \leq N < 0,7$	Medium	17	53,13%
$N < 0,3$	Low	15	46,87%

These results indicate that all students have increased their visual thinking skills in solving mathematical problems from the results of the given pretest and posttest.

The students' N-Gain results when viewed based on the average pretest and posttest scores of visual thinking abilities in solving mathematical problems also increased. The mean pretest and posttest in the first trial were 64.73 and 75.59, respectively, which resulted in the difference between the pretest and posttest scores of 10.86. Based on the results of the N-Gain calculation, it was found that the increase in students' mathematical problem-solving abilities in the first trial was 0.28 or in the "Low" category. Thus the use of geogebra-assisted problem-based learning tools developed can improve visual thinking skills in solving students' mathematical problems in the first trial.

Table 12. Summary of N-Gain Results in the Visual Thinking Ability Test in Mathematical Problem Solving in Trial II

Range	Category Improvement	The Number Of Students	Percentage
$N \geq 0{,}7$	High	4	12,5%
$0{,}3 \leq N < 0{,}7$	Medium	25	78,13%
$N < 0{,}3$	Low	3	9,38%

These results indicate that all students have increased their visual thinking skills in solving mathematical problems from the results of the given pretest and posttest.

The student's' N-Gain results when viewed based on the average pretest and posttest scores of visual thinking abilities in solving mathematical problems also increased. The mean pretest and posttest in trial II were 63.99 and 82.59, respectively, which resulted in the difference between the pretest and posttest scores of 18.60. Based on the results of the N-Gain calculation, it was found that the increase in visual thinking skills in solving students' mathematical problems in the second trial was valued at 0.491 or in the "moderate" category. Thus the use of learning tools based on geogebra-assisted problem-based learning models that are developed can improve the visual thinking skills of students' mathematical problem solving in the second trial.

In the first trial and the second trial, there was an increase from 0.28 to 0.49. This shows that the ability of visual thinking in solving students' mathematical problems using learning tools developed with the geogebra-assisted problem-based learning (PBL-BG) model has increased from trial I and trial stage II.

Improved visual thinking skills in solving students' mathematical problems as a result of the learning process using geogebra-assisted problem basesd learning (PBL-BG) begins with contextual problems, so that students can use their previous experiences in understanding and solving mathematical problems then visualized in the form of graphs that are easier for students to understand. This is in line with the research conducted by Yuliani and Saragih (2015) where the results of the research show that the results of trials 1 and 2 with the Geogebra-assisted problem-based learning model of students can improve their understanding of concepts in solving mathematical problems, students respond positively to learning. which is done, and the process of representing mathematical problems allows students to find various alternative answers.

Based on the results of research and the support of previous research above, it shows that learning with geogebra-assisted problem-based learning is significantly better in increasing visual thinking skills in solving students' mathematical problems. So it can be concluded that the learning tools developed with geographic-assisted problem-based learning have a positive impact on increasing visual thinking skills in solving mathematical problems.

IV. Conclusion

The Based on the results of data analysis and discussion in this study, the following conclusions are stated:

1. The learning tools developed with geogebra-assisted problem-based learning (PBL-BG) have met the valid criteria based on the validity results by the validator team with an average validity of the RPP of 4.51, LKPD of 4.22, and student books of 4, 29.
2. Learning tools developed with problem based learning (PBL-BG) assisted by geogebra meet practical criteria in terms of :

a. Expert / practitioner judgment which states that learning tools can be used with minimal revision and without revision;
b. The results of interviews with teachers and students obtained information that learning tools can be used easily.
c. The results of observations of the implementation of learning devices in the classroom in the first trial were 81.67% and in the second try were 87.22% and were included in the good category.

3. The learning device in the first trial was not yet effective because it did not meet the criteria for effectiveness, namely the classical learning completeness had not been achieved and not all the items had reached the achievement criteria of the learning objectives. However, in the second trial, the learning tools developed with geogebra-assisted problem-based learning (PBL-BG) met the criteria for being effective, in terms of:
   a. Classical student learning completeness has been achieved in the second trial, which is 87.5%
   b. The achievement of learning objectives has been achieved for each item in the second trial
   c. Student responses are very positive to the tools developed
   d. The learning time does not exceed ordinary learning, namely three meetings
4. The ability of visual thinking in solving students 'mathematical problems using learning tools developed with geogebra-assisted problem-based learning (PBL-BG) has increased, in terms of the increase in visual thinking skills in solving students' mathematical problems, it can be seen from the N-Gain calculation of the visual thinking ability test. in solving students' mathematical problems in the first trial was 0.28 increasing to 0.49 in the second trial.

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