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Development of Learning Problem Based Learning to Increase Mathematical Connection Ability Students of SMK Darul Arqom Kerasaan.

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Abstract

This research aim to analysis: (1) the increasing of students' mathematical connection ability by using learning problem based learning that has been developed, (2) the quality of learning problem based learning developed. The development of learning based on problem based learning by using the 4-D development model. The stageof this research includes define, design, develop, and disseminate. The subjects of this research were students of class X^{-1} and X^{-2} SMK Darul Arqom. From the results of trial I and trial II were obtained: (1) there was an increase in students' mathematical connection ability on posttest trials I and trials II of 5 point, (2) according to the expert, the validity of learning material is valid, the practicality of the learning material has fulfilled the practical criteria that have reviewed from: a) the validator stated the learning materials can be used with a little revisions; b) the result of observation of learning material has been done as said good, and the effectiveness of learning material has fulfilled the effective criteria interms of: a) the mastery of students learning in classical; b) limits of tolerance that have been established on students' active activity; c) students' responses ispositive to the components of learning materials and learning activities.

Keywords: Learning Materials, Problem Based Learning, Mathematical Connection Abilities

INTRODUCTION

Education is the right means and tool in forming the desired society and nation, namely a society that is cultured and can solve the life problems it faces. Because until now the world of education is seen as an effective means of trying to preserve and pass on life values. One form of education that the community can undertake is education in schools starting from SD/MI, SMP/MTs and SMA/MA with all its aspects. Appropriate curriculum, approaches, methods, strategies and models, adequate facilities and professional human resources are interrelated aspects to achieve planned goals. Meanwhile, in a broad scope, competent parties have thought about efforts to prepare quality human resources.

In Law no. 20 of 2003 concerning the National Education System states that "education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble morals, and the necessary skills himself, society, nation and state". (Evans et al., 2001)

This shows that education plays an important role in improving the quality of reliable and competitive human resources in this era of globalization. In realizing these national education goals, the government through schools provides students with various subjects that must be mastered One of

The subject that has an important role in aspects of life in realizing educational goals is Mathematics. Because mathematics is one of the main subjects taught from formal education, elementary to high level. Mathematics is also a universal science that underlies the development of modern technology, has an important role in various disciplines and develops human thinking power.

Mathematical thinking abilities have received a lot of attention from researchers and

educators. Much attention has been focused on limitations in students' understanding of concepts and also on their thinking, reasoning, and problem-solving skills in mathematics (*(OECD). 2010. PISA 2012 Mathematics Framework. PISA,... - Google Cendekia*, n.d.). The idea of mathematical activities that focus on these abilities views mathematics as an active, dynamic, generative and explorative process. This mathematical process is called high-level mathematical thinking and reasoning. Some aspects of higher level mathematical thinking are mathematical problem solving, mathematical communication, mathematical reasoning and Romberg's mathematical connections (Evans et al., 2001).

The relationship between higher level thinking and mathematics lessons was explained by Romberg (Evans et al., 2001) by stating that several aspects of higher level thinking are mathematical problem solving, mathematical communication, mathematical reasoning and mathematical connections. Branca (Hendriana et al., 2016) states that solving mathematical problems is very important so that it becomes the general goal of teaching mathematics, even as the heart of mathematics, prioritizing processes rather than results (Sugiyono,2015), andas the focus of school mathematics and aims to help in developing think mathematically. Mathematical connection abilities are abilities that help students to develop their perspective, view mathematics as an integrated part rather than as a collection of topics, and recognize its relevance and application both in the class room and out side the classroom (Evans et al., 2001)

However, the reality in the field shows that students have not been able to solve problems well, which causes students' mathematics learning outcomes to remain low. This can be seen from "the research results of the Trends International Mathematics and Science Study (TIMSS) in 2007 and 2011 in the field of mathematics for grade 2 high school students, that more than 95% of Indonesian students were only able to reach the intermediate level, while for example in Taiwan almost 50% of the participants students are able to reach high and advanced levels" (Kemendikbud, 2013:75). From these results it can be concluded that what is taught in Indonesia is different from what is tested or standardized at international level.

The low ability of students' mathematical connections is caused by many factors, including the use of learning tools, the way a teacher teaches in the learning process, the orientation of education in Indonesia generally treats students as objects, the teacher as the highest scientific authority and the material is subject-oriented. (Handayani, n.d.) (2019 said that teacher-centered learning results in students being passive in learning in class. Such education causes our educational practices to isolate our selves from real life outside of school, less relevance between what is taught and needs in work, too concentrated on intellectual development which does not go hand in hand with development, individual as a unified whole and personality.

The learning device itself is a medium that is used as a guide or instruction in a learning process. The learning device itself has the aim of fulfilling the teacher's success in learning. Learning devices can also make it easier for a teacher in the learning facilitation process, because with learning devices teachers can also convey material without having to remember a lot but only need to look at the device they have.

This is what prompted there search entitled "Development of Problem-Based Learning Tools to Improve the Mathematical Connection Ability of Darul Arqom Vocational School Students".

RESEARCH METHODS

This research includes development research. In this research, what was developed was learning tools and the necessary instruments. The development process relates to activities at

each development stage. The final product is evaluated based on the specified product quality aspects. Thus, the product of this research is a problem-based learning tool that is valid, practical and effective. The development of learning tools is in the form of a Learning Implementation Plan (RPP), Student Activity Sheet (LAS) and research instruments in the form of a Mathematical Connection Ability Test (TKKM).

This research was carried out at Darul Arqom Vocational School in the odd semester of the 2024/2025 academic year on trigonometry material. The reason the researcher chose this school was because at Darul Arqom Vocational School, research had never been carried out on developing learning tools based on problem-based learning on trigonometry material.

The subjects in this research were class X students at Darul Arqom Tengah Vocational School for the 2024/2025 academic year. Meanwhile, the object of this research is a Class X high school mathematics learning device based on problem-based learning that was developed. The learning tool developed in this research is trigonometry material.

RESULT AND DISCUSSION

This research is development research to produce problem-based learning model-oriented learning tools for trigonometry material in class X at Darul Arqom Vocational School. The aim of this research is to: (1) produce quality Problem Based Learning tools, namely valid, practical and effective tools, (2) analyze the increase in students' mathematical connection abilities that are taught using Problem Based Learning tools.

Apart from the above, this research also analyzes the extent to which Problem Based Learning tools are meaningful as are sult of development. Therefore, the research also aims to compare the mathematical connection abilities of students who are taught using Problem Based Learning tools with students who are taught using regular learning.

The definition stage consists of several stages of analysis, namely: beginning-to-end analysis, student analysis, concept analysis, task analysis and formulation of learning objectives. These stages are explained as follows: Based on the results of observations and analysis of the learning tools at Darul Arqom Vocational School, it shows that weaknesses are still found in the learning tools which indirectly contribute to low ability. students' mathematical connections. The learning tools used by teachers and students produce teacher- centered learning so that students are not active in learning.

Based on observations on learning tools, teachers have not used learning tools based on the 2013 curriculum. In the RPP, teachers have prepared RPPs with innovative learning models or approaches (written in the RPP) but they have not been implemented properly and correctly. RPPs are not conditioned according to students' needs or characteristics.

Trial I was carried out in class X-1 of Darul Arqom Vocational School with a total of 32 students. In this research, student learning outcomes are reviewed from students' ability to complete TKKM after learning using draft 3 Problem Based Learning Tools after Trial I). In other words, the data used to analyze student learning mastery is the result of mathematical connection abilities. A description of the results of students' mathematical connection abilities in trial I is shown in Table 1 as follows:

Table 1. Description of Results of Mathematical Connection Ability Test I

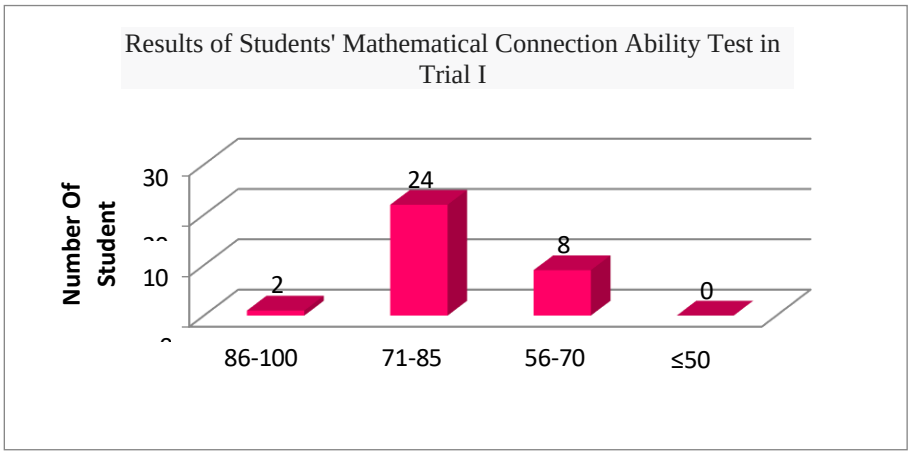
Information	**Value**
Highest Value	85
Lowest Value	65
Average	**75.28**

Based on Table 1, it shows that the average mathematical connection ability of students is 75.28. If categorized based on the level of student mastery, then the level of mastery of students' mathematical connection abilities in the results of trial I can be seen in Table 2.

Table2. Students' Mathematical Connection Ability Test Mastery Scores in Trial I

No	Value Interval	Number of Student	Percentage	Category
1	86–100	2	3,12%	A
2	**71–85**	24	68,75%	**B**
3	56–70	8	28,13%	C
4	≤55	0	0%	D

Based on Table 2, it can be seen that the number of students who got a grade of A was 2 students (3.12%), the number of students who got a grade of B was 24 students (68.75%), the number of students who got a grade of C was 8 students (28.13 %), the number of students who got a D grade was 0 students (0%). For more details, see the diagram presented in Figure 1 below.



Pigure 1: Students' Mathematical Connection Ability Test Mastery Scores in Trial I

Based on Figure 1, it is found that the most dominant score for students' mathematical connection abilities in trial I was B, 24 students, followed by C, 8 students, then A, 2 student, and finally D. Next, the overall results were The students' classical mathematical connection abilities in trial I can be seen in Table 3 below

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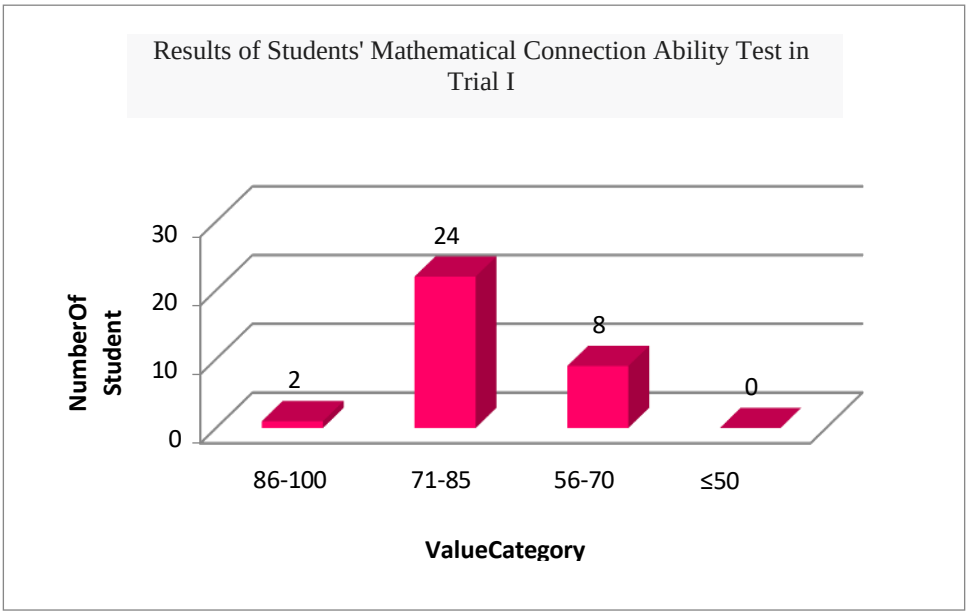

Pigure 2: Students' Mathematical Connection Ability Test Mastery Scores in Trial I

Based on Figure 2, it is found that the most dominant score for students' mathematical connection abilities in trial I was B, 24 students, followed by C, 8 students, then A, 2 student, and finally D. Next, the overall results were The students' classical mathematical connection abilities in trial I can be seen in Table 3 below.

Table 3 Level of Classical Completeness of Mathematical Connection Ability in Tria lI

Category	Mathematical Connection Ability	
	Number of Student	Percentage
Complete	23	71,87%
Incomplete	9	28,13%
Amount	32	100%

An illustration of the percentage of classical completeness criteria for students' mathematical connection abilities in trial I is presented in Figure 2

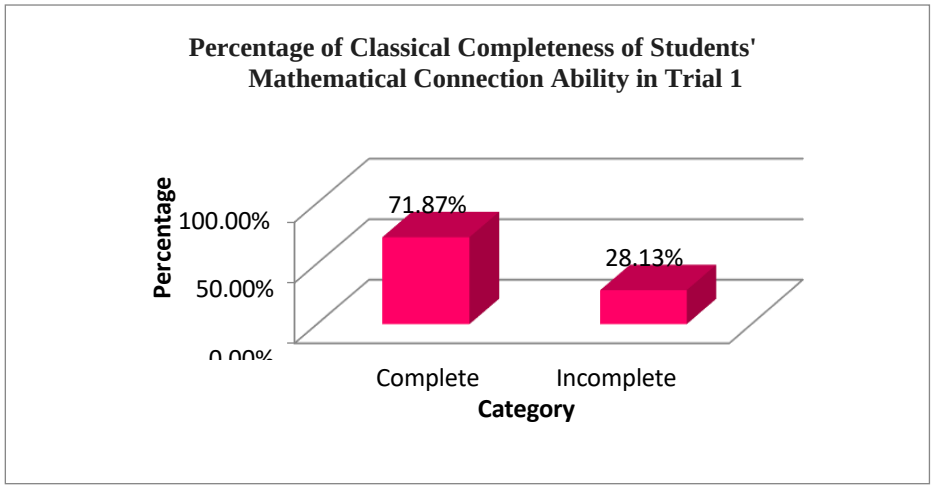

Figure 2 Percentage of Classical Completeness of Students' Mathematical Connection Ability in Trial 1

Based on the data in Table 3 and Figure 2, it can be seen that, classical student learning completeness from the results of the mathematical connection ability test, namely the students who completed it were 23 students out of 32 students or (71.87%) and the number of students who did not complete it was 9 students or (28.13%) of 32 students who took the mathematical connection ability test. In accordance with the criteria for classical student learning completeness, namely a minimum of 85% of students who took part in the study were able to achieve a score ≥ 71 with a B predicate, so the results of the mathematical connection ability test were not classically complete because only 71.87% of students were able to achieve a minimum score of B. So It can be concluded that this development research was not successful in Trial I so the problem based learning device had to be revised and then tested.

One aspect of effectiveness is the achievement of learning objectives. The achievement of the learning objectives in this research is that 65% of students have at least moderate mathematical connection abilities, or a minimum mathematical connection ability score of 65. Data processing shows that there are 1 students with very high connection abilities (3.13%); high connection ability 7 people (21.87%); medium connection capability20 people (62.50%); low connection capability 4 people (12.50 %); and very low connection capability of 0 people (0.00%). These results are shown in Figure 3 below:

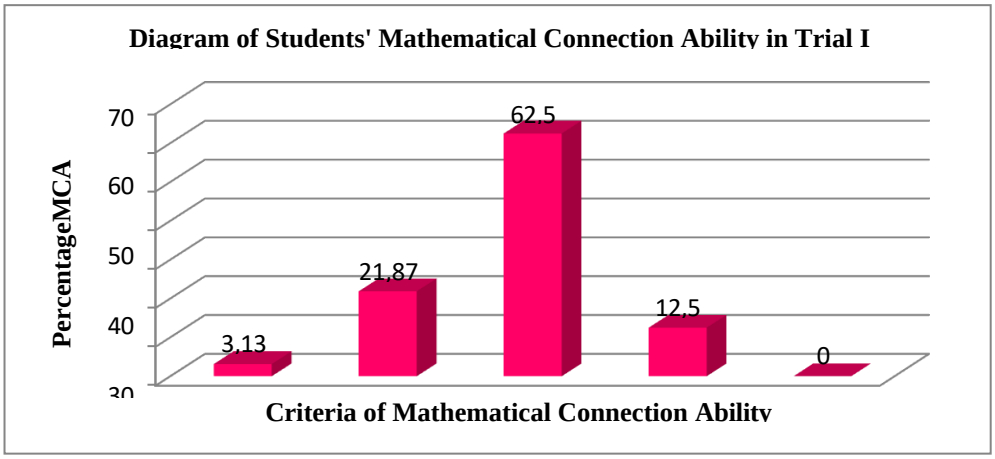

Figure 3 Diagram of Students' Mathematical Connection Ability in Trial I

In Figure 3 above, it can be seen that mathematical connection abilities are dominated by moderate abilities. The number of students who have at least moderate mathematical connection skills is: 20 + 7 + 1 = 28 people or 87.50%. Thus, it can be seen from the achievement of learning objectives that have been achieved.

Table 4 Description of Results of Mathematical Connection Ability TestI I

Information	Value
Highest Value	**90**
Lowest Value	**55**
Average	**80.30**

Based on Table 4, it shows that the average student's mathematical connection ability is 80.30. If categorized based on the level of student mastery, then the level of mastery of students' mathematical connection abilities in the results of trial II can be seen in Table 5.

Table 5 Student Mathematical Connection Ability Test Mastery Scores in Trial II

No	Value Interval	Number of Student	Percentage	Category
1	86–100	6	20%	A
2	**71–85**	21	70%	**B**

3	56–70	3	10%	C
4	≤55	0	0%	D

Based on the table above, it can be seen that, there are 5 students (20%) who get an A grade, 21 students (70%) get a B grade, 4 students (70%) get a C grade, and 4 students (10%) get a C grade. There were 0 students (0%) who got a D grade. For more details, see the diagram presented in Figure 4 below.

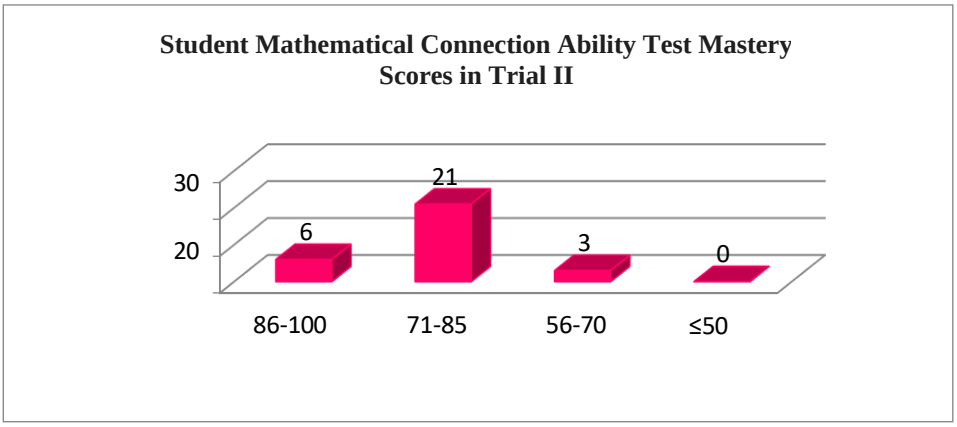

Figure 4 Mathematical Connection Ability Test Results in Trial II

Based on Figure 4, it can be seen that the most dominant score for students' mathematical connection abilities in trial II was B, 21 students, followed by A, 6 students, then C, 3 students, and finally D. Next, the overall results were The students' classical mathematical connection abilities in trial II can be seen in Table 6 below.

Table 6 Classical Completeness Levels of Mathematical Connection Ability in TrialsI I

Category	**Mathematical Connection Ability**	
	Numberof Student	**Percentage**
Complete	27	90%
Incomplete	3	10%
Amount	30	100%

An illustration of the percentage of classical completeness criteria for students' mathematical connection abilities in trial II is presented in Figure 5.

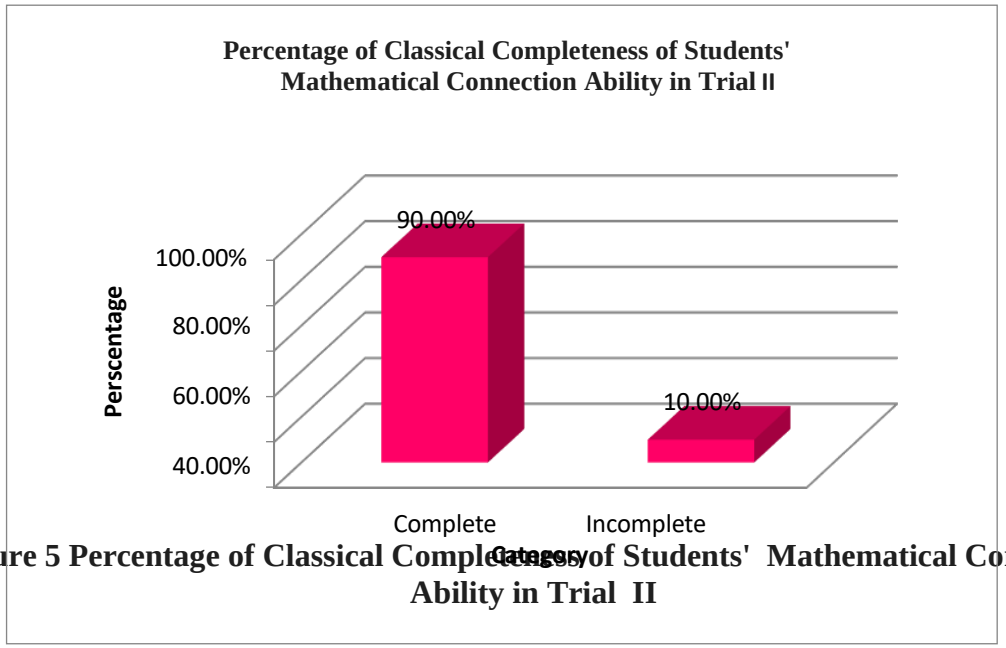

Figure 5 Percentage of Classical Completeness of Students' Mathematical Connection Ability in Trial II

Based on the data in Table 6 and Figure 5, it can be seen that, classical student learning completeness from the results of the mathematical connection ability test, namely27 students out of 30 students who completed it or (90%) and the number of students who did not complete it was 3 students or (10%) of 30 students who took the mathematical connection ability test. Classical completion is achieved because more than 85% of students have completed it. So it can be concluded that this development research has met the effectiveness of Trial II in terms of learning completeness.

Based on the previous description, the objectives of this research were achieved in Trial II of the problem based learning device. In Trial II, a problem based learning device was obtained that met the criteria of being valid, practical and effective. In other words, development research using the Thiagarajan, Semmel and Semmel (1974) model has produced a quality PB-PBM device. In Trial II, data analysis showed that learning using the problem based learning device improved students' mathematical connection abilities.

Based on the results of the analysis of the increase in mathematical connection abilities in trial I and trial II, it shows that the average mathematical connection ability of students in the posttest results of trial I was 2.73, increasing to 2.93 in trial II. Thus, therewas an increase in the average value of students' mathematical connection abilities by 0.2. Furthermore, the increase in each application of relationships between mathematics topics was 0.16, in the indicator of application of relationships between mathematics topics and topics of other scientific disciplines it was 0.20 and in the indicator of application of relationships between mathematics and everyday life was 0.20. This shows that students' mathematical connection abilities using the developed problem-based learning model- oriented learning tools have increased from trial I to trial II.

This is because the presentation of contextual problems as a starting point for the learning process can make students more active in producing and constructing their knowledge through making mathematical models. These mathematical models are a form of representation of the problem that is needed to make it easier to solve contextual problems. With this model, both informal and formal, students can discover for themselves the mathematical concepts or procedures they are studying.

Increasing students' mathematical connection abilities cannot be separated from the

problem-based learning model which is the basis of problem based learning tools. As Bruner (Dahar: 2006) said, problem-based learning facilitates students' thinking with problem- solving skills which can then be connected to various situations so as to increase intellectual potential. Meanwhile, students' experiences when solving problems with their study groups using a socio-cultural approach, in accordance with Vygotsky's thinking (Ansari: 2009).

To solve a problem, a person can use the strategy or steps formulated by Polya (1987), namely: first understand the problem; see clearly what is required. Second, understand how things are connected, how the unknown is connected to data, to get ideas about solutions, to create a resolution plan. Third, connect the problem both to mathematical topics and to the real world. Fourth, pay attention to the solutions that have been obtained, review and discuss them. Learning activities using Problem Based Learning tools in this research include the Polya solving strategy. When learning using PB-PBM tools, in accordance with Dewey's ideas (Ansari: 2009), students learn by doing (learning by doing) through a scientific approach. To improve students' mathematical connection abilities, students are taught by systematically connecting mathematical problems both into mathematical topics and into everyday life.

This is reinforced by the results of research conducted by Malasari, Nindiasari and Jaenudin (2017) stating that the application of problem-based learning can improve mathematical connection abilities. Apart from being able to improve mathematical connection abilities, the application of problem-based learning is also suitable for developing students' self-esteem, and the results of research by Syahputra and Surya (2017) showed that using teaching materials can improve students' high-level thinking abilities.

Thus it can be understood that the contextual problems given can be used as a starting point in developing students' mathematical connection abilities, especially in writing. Next, the discussion acts as a bridge to help each other between students who are poor and students who are better at understanding the model given. So it can be concluded that the problem-based learning model-oriented learning tools developed have a positive impact on increasing mathematical connection abilities.

Trial I of the Problem Based Learning tool (draft 3) showed that the PB-PBM tool did not meet its practicality empirically, because the learning implementation was still at sufficient criteria, while the specified learning implementation criteria were good or very good. The criteria for effectiveness have also not been achieved from the aspect of classical completeness. Only 78.12% of students have completed it, while the criteria for achieving the effective criteria for classical completion are at least 85% of students must have completed it.

In Trial II, students from the lower groups took an active role in the discussion. These students actively ask questions to the upper group when solving problems in LAS or take a role in writing problem solving reports. The results of the analysis of the quiz scores at the first meeting showed that the results obtained by the lower group students were not far below those of the upper group and were complete when viewed from the KKM. These results are in accordance with the ideas of Ansari (2009): "Higher mental functions are the mediated, internalized result of social interaction". The quote states that higher mental functions are the result of socialization mediated by social interactions.

The results of the research above show that students' classical learning completeness using the learning tools developed meets the effectiveness criteria. This is because problem-based learning model-oriented learning tools are influenced by the philosophy of constructivism which holds that the nature of knowledge influences the concept of the learning process, because learning is not just memorizing but constructing knowledge through experience. Knowledge is not the result of "giving" from other people such as teachers, but the result of a construction process carried out by each individual.

The effectiveness of the PB-PBM device, seen from the students' positive responses, was

achieved in Test I and Trial II. In Trial II, all students (100% of students) stated that they were happy with the components of the Problem Based Learning tool and stated that it was easier and more motivated to learn mathematics. Learning using the PB-PBM device is fun for students even though students are faced with non-routine problems to discover mathematical concepts. This is in accordance with what Schoenfeld (2013) wrote: "Problem solving provided a way into the joys of doing mathematics and the pleasures of discovery". The quote states that mathematical problems provide a way to the joy of doing mathematics.

CONCLUSION

Based on the results of the analysis and discussion in this research, several conclusions are put forward as follows: The increase in students' mathematical connection abilities using problem-based learning model-oriented learning tools in comparative material is that the average achievement of students' mathematical connection abilities in trial I was2. 73, increasing to 2.93 in trial II. Besides that, the average of each indicator of mathematical connection ability increased from trial I to trial II. The learning tools developed, including lesson plans and LAS, are effective for use in learning, because they meet the indicators for the effectiveness of learning tools. The effectiveness indicators are: Classical student learning completeness in trial I was 71.87% and trial II was 90%. This means that trial I was not effective while trial II was effective.

The achievement of learning objectives in trial I was 8.507% and trial II was 90%. This means that the achievement of learning objectives for trial I and trial II has been achieved. The learning time criterion is that the minimum learning time equal to normal learning in trial I and trial II has been achieved. This means that the learning time criteria are effective. Student responses to the components of the developed problem-based learning model-oriented learning tools and learning activities were positive.

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