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Mathematical Creative Thinking Ability in terms of the Habits of Mind in PBL with a Management System with a Goal Free Problems strategy

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Abstract

Problem Based Learning with a *Management System with a Goal Free Problems* strategy is given to improve the mathematical creative thinking skills of class X mathematics and sciences students at Senior High School 8 Semarang which are not yet optimal. Purpose main from study this is analyze ability think learners reviewed from *Habits of Mind*, as consequence from application of learning models *Problem Based Learning* help the LMS is Google Classroom. Method research used that is *mixed methods* with *posttest only control design*. Sample taken two class with technique *random sampling* from population class X mathematics and science at Senior High School 8 Semarang. Experiment class use PBL model with *Management System with Goal Free Problems* strategy whereas class control using the PBL model. Subject in research this as much 8 students from class experiment. Qualitative data analysis i.e. result data interview and results test mathematical creative thinking skills subject research. Research results showing that: (1) ability think creative mathematical participant educate reviewed from *Habits of Mind* in PBL with *Management System* reach more from criteria minimum completeness is 68; (2) ability think creative mathematical participant educate reviewed from *Habits of Mind* in PBL with *Management System* reach completeness classic that is more from 75% of participants educate reach limit complete; (3) average ability think creative mathematical reviewed from *Habits of Mind* in PBL with *Management System* more tall from *Problem Based Learning* model learning; (4) proportion completeness results test ability think creative mathematical reviewed from *Habits of Mind* in PBL with *Management System* more tall from *Problem Based Learning* model learning; (5) ability think creative mathematical with four indicator think creative is in the subject category *Persisting*, *Thinking about Thinking*, *Thinking Flexibly*, and *Applying Past Knowledge to New Situation* .

1. Introduction

Education should be managed both in quality and quantity which is expected to give birth to a quality generation and bring good changes for the development of the nation and state. In the challenges of developing the Indonesian nation in the 21st century, superior human resources are needed. According to Hosnan (2016), there are 3 elements that can be done so that human resources become qualified in the

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educational process, namely the curriculum, teachers, and students. The use of the 2013 curriculum in Indonesia aims to prepare Indonesian people to have the ability to live as individuals and citizens who are faithful, productive, creative, innovative, and affective and able to contribute to the life of society, nation, state, and world civilization (Permendikbud No 40 of 2014). In the learning process in education units, students are required to have 4C competencies, namely Critical Thinking Skills, Creative Thinking Skills, Communication Skills, and Collaboration Skills to improve efficiency, and the effectiveness of achieving superior and highly competitive graduate competencies.

Mathematics is one of the subjects taught in the 2013 curriculum. There are still many students who consider mathematics to be a difficult subject and often cause problems that are difficult to solve so that it has an impact on student learning outcomes (Saironi & Sukestiyarno, 2017). So that educators must hone the abilities of students so that they can think at a high level or *HOTS* .

One of the efforts to create higher order thinking skills or HOTS (*Higher Order Thinking Skills*) in mathematics is to hone creative thinking skills. It is expected that students become creative human beings so that students must have the ability to think creatively. By developing creative thinking skills, students will be able to solve mathematical problems in various alternative ways. According to Dewi & Masrukan (2018) creativity is a product of creative thinking activities that can generate and generate new ideas. The creative thinking ability of good students can affect success in learning.

Another factor to achieve success in mathematics is the cognitive factor of students. Habits of Thinking or *Habits of Mind* is a way how a person can always develop mathematical ideas to solve problems or new knowledge concepts cognitively. According to Hartini et al. (2018) teachers need to plan a series of activities that are appropriate and involve students actively so that they can maintain their *Habits of Mind* in order to have the skills to behave intelligently when faced with problems.

Learning in mathematics is in accordance with the 2013 curriculum, but students are still less active and teacher-centered. Learning resources and supporting factors are not fully adequate. The teacher's learning process is still explaining in front of the class. Students only follow what the teacher says so that they are not maximal in improving their thinking skills. In addition, students do not attach importance to mathematics because they feel bored and lack of information that mastering mathematics is a strong and important foundation in the development of educational success. Furthermore, the determination of the minimum criteria in class X, especially mathematics, is 68. However, there are still many students who score according to the minimum criteria even less than the minimum criteria. With a low minimum criteria, students should be able to exceed this value. When given questions about problems of daily life, class X students are able to understand what is known and asked and the purpose of the questions. However, students did not continue to solve the problem because they were still confused. The problems experienced by students are related to the ability to think creatively in mathematics which is still low. Therefore, innovation is needed in the learning process so that students' creative thinking abilities increase.

In the learning process, teachers and students also use electronic media as a reference for learning support tools. However, the opportunity was used by students to play games and social media. This makes students lazy to learn so that it has an impact on their creative thinking skills. For that, during the learning process, learning activities require innovation by utilizing cellphones to be used as learning, namely using ICT products, namely *Google Classroom*. This is also in accordance with the development of the 21st century in the field of education today.

According to Rochmad & Masrukan (2016) the main supporters in the success of learning carried out in the classroom are because teachers or lecturers use appropriate, varied learning models, teach well (*good teaching*) and use good questions (*good questions*). The teacher's role as a bridge in developing curriculum and learning is very important in maximizing the potential of students in all fields. So that to improve creative thinking skills, learning models and approaches are needed that are in accordance with the 2013 curriculum, one of the learning models is *Problem Based Learning*. The use of *Problem Based Learning* makes students more active because they are required to find their own material or answers that are studied according to the problems given so that they can help improve aspects of creative thinking (Rizal et al., 2016).

The learning process using *Problem Based Learning*, where students are directed to construct their own knowledge through problems with steps where students make small groups, then distribute problem sheets to each group followed by reading and understanding the problems that have been given. Furthermore, students are given questions about what is known regarding the problems that have been given and students

look for solutions to these problems through mathematical modeling in accordance with their own thinking. After finishing finding a solution to the problem, representatives from each group presented the results of their work. Based on the activity steps in the *Problem Based Learning learning* , it is designed to obtain concepts and representations of students regarding their initial knowledge which will later be discussed with other students so that they are able to correct themselves if there are errors.

In addition to learning models and *Habits of Mind* to stimulate students to be creative, teachers can use open-ended questions with the *Goal Free Problems* strategy. Open-ended questions can provide opportunities for students to gain knowledge, experience, find, explore, and solve problems with several techniques (Kowiyah, 2016: 69). The *Goal Free Problems strategy* is one of the learning techniques related to presenting problems with non-specific goals. According to Sity et al., (2017) Goal Free Problems direct students to "count as many solutions as possible" instead of calculating a given goal. That way, the teacher gives open-ended questions with *a goal-free problem strategy* to facilitate students to solve problems flexibly and improve problem-solving skills and develop ideas in interpreting mathematical problems.

The trend of change and innovation in the world of education will continue to occur and develop in entering the 21st century today. Technology also has an influence on critical thinking skills, problem solving abilities, and creative thinking skills from the use of ICT (Cambridge, 2015). The use of ICT (*Information and Communications Technology*) in the learning process provides a new atmosphere for students to be more interested in receiving learning. In this study, the ICT used is the *Learning Management System* (LMS), namely *Google Classroom*. *Google Classroom* is a social networking service and virtual learning environment for schools and higher education institutions that allows users to create, manage, and share academic content. According to Hasanuddin et al (2018:17) *Google Classroom* is an online-based learning media so that it can facilitate the learning process without using paper anymore.

2. Method

The method used in this research is a combination research method (*mixed methods*). Method study combination is approach for investigate something object with combine shape study quantitative and form qualitative research. Study quantitative in research this done for knowing effectiveness learning *Problem Based Learning* with a *Management System with a Goal Free Problems* strategy towards ability think creative mathematical students. Whereas study qualitative done for describe ability think creative mathematical students viewed from the *Habits of Mind* on the PBL learning model with the *Management System with the Goal Free Problems* strategy.

Population this research is class X mathematics and science SMA Negeri 8 Semarang. The samples were taken from two classes with *random sampling technique* . The experimental class uses the PBL model with the *Management System with the Goal Free Problems* strategy , while the control class uses the PBL model . The subjects in this study were 8 students from the experimental class. Qualitative data analysis i.e. result data interview and results test think mathematical creative, subject study selected 2 students each in each category of *Persisting*, *Thinking about Thinking*, *Thinking Flexibly*, and *Applying Past Knowledge to New Situations* based on the results of the highest and lowest questionnaire scores. Data collection techniques used in study this is mathematical creative thinking ability test, questionnaire *Habits of Mind*, and interviews.

Quantitative data analysis conducted to analyze the achievement of students' mathematical creative thinking skills in terms of the *Habits of Mind* in PBL with a *Management System with a Goal Free Problems* strategy. Quantitative data analysis includes analysis of initial and final data, can be seen in Table 2.1 and Table 2.2.

Table 2.1 Initial Data Analysis

Normality Test	To find out whether the two classes come from a normally distributed population.
Homogeneity Test	To find out whether the two classes have the same or homogeneous variance.
Average Similarity Test	To find out whether the two classes have the same average initial ability.

Table 2.2 Final Data Analysis

Normality Test	To find out whether the two classes come from a normally distributed population.
Homogeneity Test	To find out whether the two classes have the same or homogeneous variance.
Hypothesis Test 1	To find out whether the average mathematical creative thinking ability of students in PBL with a Management System with the Goal Free Problems strategy reaches more than the minimum criteria.
Hypothesis Test 2	To find out whether the proportion of students' mathematical creative thinking skills in PBL with a Management System with the Goal Free Problems strategy achieve classical completeness of more than 75%.
Hypothesis Test 3	To find out whether the average mathematical creative thinking ability of PBL learning students with the Management System with the Goal Free Problems strategy is better than the average mathematical creative thinking ability of PBL learning students.
Hypothesis Test 4	To find out whether the proportion of students who achieve mastery learning in PBL learning with a Management System with a Goal Free Problems strategy is more than the proportion of students who achieve learning mastery in PBL learning.

Calculation of analysis of initial data and final data using SPSS 26, *t* test, and *z* test.

Qualitative data analysis was carried out with the stages of data reduction, data presentation, conclusions. Data reduction to obtain the required data and discard unnecessary data. The presentation of the data is done to make it easier to understand what is happening in the research process and then plan the next steps. In qualitative research, the findings or data can be declared valid if there is no difference between what is reported by the researcher and what actually happened to the object under study. To determine the validity of the qualitative data in this study, triangulation techniques were used, namely by checking or comparing the suitability of the data obtained from tests and interviews.

3. Results and Discussion

This research was conducted at Senior High School 8 Semarang , which is located on Jalan Raya Tugu, Tambakaji, Ngaliyan, Semarang City, 50185. Distribution class study that is class X mathematics and science 3 as class control and class X mathematics and science 4 as class experiment. The implementation of this research includes pre-test questions, online learning through *Zoom Meetings* and *Google Meets* , filling out the Habits of Mind questionnaire, conducting final tests of mathematical creative thinking skills, conducting interviews, and analyzing mathematical creative thinking skills for each *Habits of Mind category*.

3.1. Quantitative Data Analysis

Initial data analysis on research this taken from the results of the initial ability test for class X mathematics and science 3 and X mathematics and science 4 then normality test, homogeneity test, and similarity test were carried out two average. The initial data for the normality test after being calculated showed that the data for both classes were normally distributed, then for the homogeneity test it was found that the two classes had the same variance or were homogeneous. After being proven to have a normal and homogeneous distribution, the average similarity test was calculated to show that the average initial ability of the two classes was the same.

The final data analysis was taken from the results of the students' mathematical creative thinking ability test scores after being given treatment in the control class and experimental class. Furthermore, this final data analysis was carried out to test the hypotheses that had been described previously to reach a conclusion. The final data for the normality test showed that the final test data for the mathematical creative

thinking ability of the two classes came from a normally distributed population, and for the homogeneity test, it was found that the final test data for the two samples had the same variance (homogeneous). To test hypothesis 1, namely the minimum completeness criteria test, it can be concluded that the average value of mathematical creative thinking skills in the PBL class with the *Management System with the Goal Free Problems* strategy reaches more than the minimum criteria. To test hypothesis 2, namely classical completeness test, it was concluded that the percentage of experimental class students reached the actual completion limit in proportion to the mathematical creative thinking ability test of students in PBL with a *Management System with a Goal Free Problems* strategy more than 75%. Next, test hypothesis 3, namely the difference test of the average mathematical creative thinking ability, it was concluded that the average mathematical creative thinking ability of students in PBL learning with the *Management System with the Goal Free Problems* strategy was better than the average mathematical creative thinking ability of students in learning. PBL. Finally, to test hypothesis 4, namely the difference in the proportion of mastery mathematical creative thinking skills, it was concluded that the proportion of students who achieved learning mastery in PBL learning with the *Management System with the Goal Free Problems* strategy was more than the proportion of students who achieved learning mastery in PBL learning.

3.2. Qualitative Data Analysis

Qualitative data in this study were obtained from the results of filling out questionnaires, ability tests think mathematical creativity of students and the results of interviews with research subjects. The selection of research subjects used the results of questionnaires and tests of mathematical creative thinking skills. Two research subjects were selected from each category *of Habits of Mind* with the highest and lowest score criteria. The choice of this subject is expected to describe students' mathematical creative thinking skills in terms of the *Habits of Mind* in PBL with a *Management System with a Goal Free Problems* strategy.

There are 6 test items for the mathematical creative thinking ability of students with each item containing four indicators of mathematical creative thinking, namely *fluency*, *flexibility*, *elaboration* and *originality*. The work on the test questions is carried out online for 50 minutes which is done independently by students.

In the mathematical creative thinking test, it is concluded that if students meet the fluency indicator, namely being able to give the whole answer smoothly and precisely, the flexibility indicator is being able to provide more than one way of completion, elaboration indicator is being able to detail the details. details of the answers given, and indicators of originality, namely being able to come up with ideas from the results of their own thoughts. Analysis of the results of the mathematical creative thinking test results and the results of interviews was carried out by using data reduction steps, data presentation, and drawing conclusions or verification. The reduction activities in this research are simplify results interview into a good and neat arrangement of language, then transformed into notes and discarded some of the things that considered no need. The results of the mathematical creative thinking test are neatly arranged according to the sequence to make it easier for researchers to analyze the results of the mathematical creative thinking test the. The presentation of the data in this study includes the classification of test data algebraic thinking based on the results of the mathematical creative thinking test and the results of interviews. Drawing conclusions or verification is carried out taking into account the results mathematical creative thinking test and interview results. Next, the researchers carried out the technique triangulation by comparing the results of the mathematical creative thinking test with the results of interviews to check the validity of the data and conclude the level of students' mathematical creative thinking skills. After analyzing the data, the mathematical creative thinking skills of students from the results of the mathematical creative thinking test and interview results, as well as the results of the triangulation of each subject in each category of students ' *Habits of Mind were obtained* data as follows.

Table 3.1 Mathematical Creative Thinking Ability in terms of Habits of Mind Persisting Category

Subject Code	*fluency*	*flexibility*	*elaboration*	*originality*	Level
P1	√	–	√	√	Level 3
P2	√	–	√	–	Level 2

Table 3.2 Mathematical Creative Thinking Ability in terms of Habits of Mind Category Thinking about Thinking

Subject Code	*fluency*	*flexibility*	*elaboration*	*originality*	Level
T1	√	–	√	√	Level 3
T2	√	–	√	–	Level 2

Table 3. 3 Mathematical Creative Thinking Ability in terms of Habits of Mind Thinking Category Flexibly

Subject Code	*fluency*	*flexibility*	*elaboration*	*originality*	Level
TF1	√	–	√	√	Level 3
TF2	√	–	√	√	Level 3

Table 3. 4 Mathematical Creative Thinking Ability in terms of Habits of Mind Category Applying Past Knowledge to New Situations

Subject Code	*fluency*	*flexibility*	*elaboration*	*originality*	Level
AP1	√	–	√	√	Level 3
AP2	√	–	√	√	Level 3

The following is a description of mathematical creative thinking skills in terms of the Habits of Mind of each research subject.

Mathematical Creative Thinking Ability Judging from Habits of Mind Persisting Category

In the *Persisting category* , the indicator is able to persevere during learning and analyze problems systematically.

The results of the analysis of the mathematical creative thinking ability of the subject P1 on questions number 3 and 5 were able to understand the problem by writing down what he knew and asked correctly and completely, explaining the steps he had to do. However, subject P1 is still not able to provide more than one answer to the completion of the two questions. So that subject P1 fulfills three indicators, namely *fluency, elaboration* , and *originality* .

The results of the analysis of the mathematical creative thinking ability of the subject P2 in questions number 3 and 5 are able to understand the problem by writing what he knows and asked correctly and completely, but has not been able to provide more than one way of solving and has not been able to work on the solution with his own idea. So that the subject of P2 fulfills two indicators, namely *fluency* and *elaboration* .

Thinking Ability Judging from Habits of Mind Category Thinking about Thinking

In the *Thinking about Thinking category* , the indicators design a plan and describe the steps needed to solve the problem.

The results of the analysis of the mathematical creative thinking ability of the subject T1 on questions number 3 and 5 were able to understand the problem by writing down what he knew and asked correctly and completely, explaining the steps he had to do. However, the subject of T1 is still unable to provide more than one answer to the completion of the two questions. So that the subject of T1 meets three indicators, namely *fluency, elaboration*, and *originality* .

The results of the analysis of the mathematical creative thinking ability of the subject T2 in questions number 3 and 5 are able to understand the problem by writing down what he knows and asked correctly and completely, but has not been able to provide more than one way of solving and has not been able to work on the solution with his own idea. So that the subject of T2 fulfills two indicators, namely *fluency* and *elaboration* .

Mathematical Creative Thinking Ability Judging from Habits of Mind Thinking Category Flexibly

In the *Thinking Flexibly category* , indicators are able to organize thoughts when obtaining new or additional information in solving problems.

The results of the analysis of the mathematical creative thinking ability of the TF1 subject on questions number 3 and 5 were able to understand the problem by writing down what he knew and asked correctly and completely, explaining the steps he had to do. However, the subject of TF1 was still unable to provide more than one answer to the completion of the two questions. So that the subject of TF1 meets three indicators, namely *fluency, elaboration* , and *originality* .

The results of the analysis of the mathematical creative thinking ability of the TF1 subject on questions number 3 and 5 were able to understand the problem by writing down what he knew and asked correctly and completely, explaining the steps he had to do. However, the subject of TF1 was still unable to provide more than one answer to the completion of the two questions. So that the subject of TF1 meets three indicators, namely *fluency, elaboration* , and *originality* .

Mathematical Creative Thinking Ability Judging from Habits of Mind Category Applying Past Knowledge to New Situations

In the category of *Applying Past Knowledge to New Situations* with indicators capable of connecting, using, and interpreting the knowledge that has been possessed to solve new problems.

The results of the analysis of the mathematical creative thinking ability of AP1 subjects on questions number 3 and 5 were able to understand the problem by writing down what he knew and asked correctly and completely, explaining the steps he had to do. However, the subject of AP1 is still not able to provide more than one answer in solving the two questions. So that the subject of AP1 meets three indicators, namely *fluency, elaboration* , and *originality* .

The results of the analysis of the mathematical creative thinking ability of AP2 subjects on questions number 3 and 5 were able to understand the problem by writing down what he knew and asked correctly and completely, explaining the steps he had to do. However, the subject of AP2 is still not able to provide more than one answer in solving the two questions. So that the subject of AP2 meets three indicators, namely *fluency, elaboration,* and *originality* .

4. Conclusion

Based on results research and discussion obtained conclusion about students' mathematical creative thinking skills in terms of Habits of *Mind* in PBL with a *Management System with a Goal Free Problems* strategy Quadratic Equation . These conclusions can be described as follows. (1) The mathematical creative thinking ability of class X mathematics and science students in terms of *Habits of Mind* in PBL with a *Management System with a Goal Free Problems* strategy achieves the minimum completeness criteria, namely 68; (2) The mathematical creative thinking ability of class X mathematics and science students in terms of *Habits of Mind* in PBL with a *Management System with a Goal Free Problems* strategy achieves classical completeness criteria, namely 75% of many students who achieve minimum completeness criteria; (3) The average mathematical creative thinking ability of class X mathematics and science students in terms of the *Habits of Mind* in PBL with a *Management System with the Goal Free Problems* strategy is higher than the average mathematical creative thinking ability of students in class X mathematics and science in PBL learning; (4) The proportion of completeness of mathematical creative thinking ability test results in terms of *Habits of Mind* in PBL with a *Management System with a Goal Free Problems* strategy is higher than the proportion of mathematical creative thinking ability test results for students of class X mathematics and sciene in PBL learning; (5) Mathematical creative thinking ability in terms of *Habits of Mind Persisting* category meets the indicators of fluency, elaboration, originality as well as fluency and elaboration. Mathematical creative thinking ability in terms of *Habits of Mind* category *Thinking about Thinking* meets the indicators of fluency, elaboration, originality as well as fluency and elaboration. Mathematical creative

thinking ability in terms of *Habits of Mind for Thinking Flexibly* category each meets the indicators of fluency, elaboration, and originality. Mathematical creative thinking ability in terms of *Habits of Mind* in the category of *Applying Past Knowledge to New Situations* each fulfills indicators of fluency, elaboration, and authenticity.

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