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Problem solving ability of seventh grade students viewed from geometric thinking levels in search solve create share learning model

Kristina Wijayanti [a,*], Aizzatun Nikmah [a], Emi Pujiastuti [a]

[a] *Universitas Negeri Semarang, D7 Building First Floor, Sekaran Campus Gunungpati, Semarang 50229, Indonesia*

** E-mail address: kristinawijayanti@mail.unnes.ac.id*

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Abstract

The purposes of this study was to find out whether the student's problem solving ability on SSCS and PBL learning models achieve the mastery learning ; to compare the the student's problem solving ability on SSCS and PBL learning models; to describe the problem student's solving ability on SSCS learning model viewed from geometry thinking levels, and to know the quality of SSCS learning models. The method used was a mixed method. The population of this study was all students of SMP N 10 Semarang. The sample was chosen by simple random sampling technique and class VII D as control class and VII G as experiment class.The quantitative data were analyzed by z-test to and the equivalence of two means. The qualitative data were analyzed through the validity test, data display, data reduction, and conclusion. The results of this study indicated that both SSCS and PBL learning models have achieved the mastery learning of problem solving ability test but there was no difference between students' problem solving ability in the SSCS and PBL learning models. Students with prerecognition and visual cannot fully identify the properties of figure, so it is difficult for them to solve the problem. Students with analysis level solve problem used the properties of certain figures.

1. Introduction

Problem solving ability is one of student's competencies that should be owned. As explained by National Council of Teachers of Mathematics (NCTM) 2000 which sets out five standards which students must possess, they are as follows, problem solving, communication, connection, reasoning, and representation skills. In addition, one of the latest curricula in mathematics learning is about understanding the concepts and problem-solving ability (Handayani *et al*., 2013; Elliott, 2014). Further, Hosnan (2014) also emphasizes the importance of problem-solving skills. He states that fworld guidance in the future requires every child to have the abilities to think and learn, one of them is the problem solving skill.

Problem solving affects students in solving problems using several stages, they are thinking process and how they apply their problem-solving skills in a positive environment (Savitri *et al*., 2013; Ersoy, 2016).

Based on the above explanation, it can be concluded that the problem-solving ability is an important thing that must be developed and owned by students. However, in the reality, there are many students who have difficulty in developing and improving problem solving ability. Many students have difficulty in the troubleshooting process. This is because problem solving skills in math are rarely taught in the classroom (Bradshaw & Hazell, 2017).

Based on the experience of Preservice Teaching at SMP Negeri 10 Semarang in August-October 2016, the students have low ability in problem solving. This is also supported by interviews conducted at SMP Negeri 10 Semarang with Mr. Miftahudin as one of the mathematics teachers on January 19, 2017. He stated that students are not yet accustomed to complete the questions that demand to use the stages of strategy, reasoning, or student creativity. The following figure is an example of student work related to problem solving skills.

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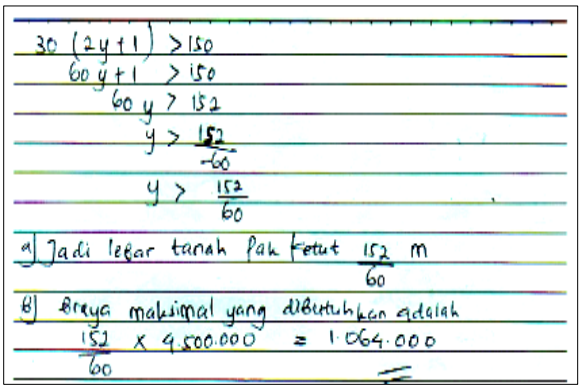

Figure 1. Example one of Student's work related to Problem Solving Ability

Based on Figure 1, there are several indicators of problem-solving abilities that have not been met. Students are unable to develop or use problem-solving strategies. It can be seen from their errors when performing operations related to inequality. In addition, there is still an error in the interpretation of the answer for those who have not solved the problem yet. Therefore, learning activity in the classroom should be structured in order to develop students' problem-solving skills. Through the learning effort, students can solve problems more effectively (Nugraheni *et al*., 2018). One of the learning models suggested in the 2013 curriculum, especially in developing problem solving skills, is the Problem Based Learning model (PBL). PBL encourages knowledge construction by starting each learning experience with a complex real-life problem which is typically presented to a small group of students in a tutorial setting (Smith & Harland, 2009). Research conducted by Jo & Ku (2018) on the use of Problem Based Learning using real time data shows that students can develop problem-solving skills, creativity, self-regulation, if the model is used consistently in the classroom.

SMP Negeri 10 Semarang itself is a school that has implemented the 2013 curriculum, including the model Problem Based Learning. In addition, another effort which is expected to develop student's problem solving abilities is learning by Search, Solve, Create, and Share (SSCS) model. According to Pizzini & Sphedarson (1988), the SSCS model has the advantage to provide opportunities for students to practice and develop problem solving skills. Furthermore, stages of learning from SSCS model includes four phases of search, solve, create, and share phases. In addition, Rahmawati *et al*., (2013) in a study entitled The Effectiveness of Learning Model SSCS Assisted Problem Cards on Students Problem-Solving concludes that the mathematics problem solving ability of with SSCS-assisted learning model of problem cards reached mastery learning. Further, problem solving ability of mathematics students with application of model SSCS-assisted learning problem cards are better than students' mathematical solving abilities in control class. Indeed, SMP Negeri 10 Semarang itself, especially in the subject of mathematics has never applied the Search, Solve, Create, and Share learning models.

One of mathematics branch that requires problem solving was geometry. Geometry learning is highly important in critical thinking and reasoning, and the ability of logical abstraction. It is one of problematic topics in mathematics (Sugiarto *et al*., 2012; Adulyasa & Rahman, 2014). The percentage of material mastery ability to build geometric problem is still low especially in SMP Negeri 10 Semarang. In 1959, Pierre van Hiele Gandalf explain a theory that reflects the level of thinking in geometry which is now known as the level of geometry of Van Hiele. Burger & Shaugnessy (1986) in his research explains that the level of van Hiele geometry thinking can be used to describe the thinking process of students in polygon problems. The level of Van Hiele thought coversvisualization, analysis, informal deduction, deduction, and rigor.

Talking about mathematics especially in the scope of education, I discuss about the quality of learning that occurs inside there. Quality and competence of learning are one of the most frequently evaluated factors in the education system (Jepsen *et al*., 2015). Lester (1994) suggests that the role of teacher, interaction between teacher-students, students-students, should be the next agenda of problem solving research.

With regard to above explanation, this study aims to determine: (1) do the problem solving ability of students in the experimental class using Search, Solve, Create, and Share (SSCS) learning model and student problem solving skills in control class using model Problem Based Learning achieve mastery learning?; (2) is there any difference in students' problem-solving ability between experimental classes using Search, Solve, Create, and Share (SSCS) and control classes using Problem Based Learning models? (3) How is student problem solving ability for each level of van Hiele geometry thinking on Search, Solve, Create, and Share (SSCS) learning model ?; (4) What is the quality of learning model Search, Solve, Create, and Share (SSCS) in developing students' problem solving skills?

2. Research Methods

This research was mix method research with concurrent embedded design. The concurrent

embedded method is a research method that combines both qualitative and quantitative research methods by mixing the two methods which are unbalanced (Sugiyono, 2015). The researcher chose true experimental design with Post test only with control design. According to Sugiyono (2015), in this design, there are two groups selected randomly. After two randomly selected groups, the first group (experimental group) was treated X that is the SSCS learning model while the other group (control group) was given a Problem Based Learning study. Then, post-test was given to both selected groups. Post test values were compared to determine treatment outcomes. Qualitative research method is a research method based on postpositivism philosophy, used to examine the condition of natural objects, (as opposed to experiments) which the researchers are as a key instrument, the data collection is done purposively, collecting techniques uses triangulation (joint), analysis data is inductive/qualitative, and the results more emphasize on the meaning of generalization (Sugiyono, 2010).

This research was conducted in SMP Negeri 10 Semarang. The population in this study is all seventh grade students. The sample of this research was class VII G and VII D. It used simple random sampling technique. It is done without considering strata in population (Sugiyono, 2015). The use of simple random sampling technique in this study with the consideration that the population is normally distributed and has the same or homogeneous variance. Subjects in this study consisted of 6 students who were selected based on geometry thinking level.

Furthermore, methods of data collection are the documentation, tests, observations and interviews. Documentation method is used to collect data about the students' early ability in order to be the object of research. The test method is used to determine students' problem solving ability and geometry thinking level for each student. Observation method is used to collect data about student and teacher activity on learning process of SSCS model. While interview method is used to determine problem solving ability based on each level of geometry thinking.

3. Data Analysis

3.1. Quantitative Data Analysis

Quantitative data were obtained based on the problem-solving test responses. In assessing students' responses to problem-solving skills, problem-solving indicators are used based on the appendix of education and cultural ministry's regulation No.58 about Curriculum 2013 SMP / Mts Level. These indicators include: understanding problems, organizing data and selecting relevant information in identifying problems, presenting problem formulation mathematically in various forms, choosing appropriate approaches and strategies for solving problems, using or developing problem solving strategies, interpreting the results of answers obtained for solve problems. In assessing the student's response to a geometry level test, the correct criteria at each level are three true answers to five questions. To test the hypothesis, the researcher use z-test to determine the mastery learning of both SSCS and PBL class. Meanwhile, to test the mean difference between the SSCS class and the PBL class, the researcher used independent sample t-test with $\alpha = 0.05$.

3.2. Qualitative Data Analysis

Qualitative data is data obtained based on observations during the learning process occurs and through interview. Data analysis of interview results consist of data reduction and data presentation. Furthermore, the data obtained from the interviews were compared with the data from the problem solving test results to explore the thinking process of the students based on the geometry level of thinking. In determining the learning quality of SSCS model, the researcher uses learning planning validation sheet, observation sheet of teacher and student activities, and the results of problem solving test.

4. Results and Discussion

4.1. Mastery Learning of SSCS and PBL Class

Table 1 shows a summary of z-test on SSCS and PBL classes. Based on the proportion test, it can be concluded that the SSCS class achieves mastery learning $[z_{count} > z_{(0,5-\alpha)}, z_{(0,5-\alpha)} = 1{,}64]$. In addition, the PBL class also achieves mastery learning $[z_{count} > z_{(0,5-\alpha)}, z_{(0,5-\alpha)} = 1{,}64]$. Based on these results, it can be concluded that both SSCS and PBL learning models achieve the mastery learning in problem solving test.

Table 1. Summary of Z-Test for Problem SolvingSkill Test by Learning Models

Class	α	$z_{(0,5-\alpha)}$	z_{count}
SSCS	0,05	1,64	1,92
PBL	0,05	1,64	1,85

The results are in line with previous research conducted by Irwan (2011) and Rahmawati *et al.*, (2013) which notes that Search, Solve, Create, and Share learning model is effective in developing problem solving abilities. SSCS is a questioning

learning models, because this learning is done by asking questions that lead students to understand the subject matter in order to achieve learning objectives.

Again, the results of this study are also in line with the research of Jo & Ku (2011) which shows that students can develop problem-solving skills, if the PBL is applied consistently in the classroom. In addition Amaluddin *et al*., (2016) in his research also reveals that Problem Based Lerning is effective against problem-solving abilities.

Some factors which lead to the mastery learning is a problem based learning models which helps the learners to integrate the concept of circumference and the area of triangle and quadrilateral in real problems. The syntax in PBL learning helps students to practice problem-solving skills. This is in accordance as Mayer (1985) says that the problem solving ability of students will develop if they are trained continuously. Further, the training of problem solving ability can be through giving example problems which one of them is a real problem.

4.2. Equivalency of Groups

Based on independent sample-t test, it can be concluded that the problem solving test result between PBL and SSCS classes is homogeneous. The results of the independent sample t-test show that there is no significant difference in problem solving ability between PBL and the SSCS class [Sig>0, 05; Sig= $0{,}421 > 0{,}05$].

The main difference between SSCS learning and other cooperative learning models is in the Search phase (Pizzini & Edward., 1988). In this phase, learners practice to determine the problem through question-making activities. However, in this study, the researcher limited the questions made by learners only within the scope of circumference and area. It is intended that the questions raised by the learners in accordance with the topics covered. In addition, to help learners in making inquiries, researcher has provided the word instructions provided in worksheets. This is based on the fact that students are not used to make a question. As Hosnan (2014) predicts that many students have not actively asked questions in the learning process. However, in the process of research even though learners have been given instructions in making the question,students still have difficulty in making questions, so they still need help from teachers. This caused the Search phase in learning become less optimal because the lacking of the role of students. Halat (2007) explains that a learning model cannot be applied 100% in one meeting. Jacobs *et al*., (2014) reveal that the main goal in the learning process in problem solving is not getting the right answer but developing students' mathematical thinking ability. It implies that the learner is independently required to solve the problem, so the role of the teacher is only to guide. However, the reality on the ground shows that students tend to directly ask the teacher before attempting independently in solving the problem

4.3. Problem Solving Ability Viewed from Geometry Thinking Level

Based on tests of van Hiele geometry thinking level implemented in the SSCS class, it was found that the distribution of geometric thinking levels only reached at Analysis level. This is in line with research that has been done by Burger & Shaugnessy (1986), Crowley (1987), and Fuys *et al*., (1988). The majority of learners in the SSCS class are at the Prerecogniton level. Although the existence of this level is not discussed by van Hiele, Clements (2006) defines the level of Pre-recognition is the children's early perception of geometry, but only limited to the shape of visual characteristics.

4.4. Problem Solving Ability Viewed From Pre-Recognition Thinking of Levels

Students with a PreRecognition level of thinking are already able to understand a problem that has a level. However, the students are unable to organize the data and select the relevant information in identifying the problem, students with the PreRecognition thinking level still have difficulty in determining the base and height of the triangle and quadrilateral builds. This causes students get difficulty in solving problems. Krawec (2014) also explains that students who have difficulty in solving problems due to the inability to choose relevant information in the problem. In addition Burger & Shaugnessy (1986) also explain that students choose less relevant traits in identifying and describing a figure. The frequency of students in doing some exercises plays a role in the ability to choose the right approach and strategy for solving problems. However, they are unable to do this indicator. This is because students are still having difficulty if they have to solve problems that not only consist of one figure but several figure ups which are attached. Again, Krawec (2014) also explains that in solving problems consisting of several issues that are linked together, students must understand each issue separately. Students' ability to use problem-solving strategies can be seen in how students operate the strategies that have been previously selected. Students have not been able to use or develop problem-solving strategies. This is because in some questions, students can not enter the value of the triangle or rectangular elements because the value is not directly explained in the problem. Although there is a problem which the

student can enter the length of the base or diagonal, but there is still an error when they perform the operations involved. This is due to the lack of accuracy. Prerecognition students have been able to interpret the results of answers obtained to solve the problem.

Criteria for solving problems can be seen from students' ability to understanding problems, planning problem-solving strategies, implementing problem-solving strategies, and check out the results of problem solving. Based on the results of problem solving skills and interviews, it can be concluded that students are unable in solving the problem. This is based on the ability to understand the problems which are still lacking where the ability of students in understanding the problem still depends on the picture, students are still difficult to understand the problem if there is no picture in the question sheet. The next ability is to plan a problem-solving strategy, in general his or her ability is still not good yet if you have to plan a problem-solving strategy if the figure has more than two figures and must be linked. Their ability to execute problem-solving strategies can be seen from their ability to include each of the lengths and how students carry out the operations involved. The next student ability is the ability of students in checking the results of problem solving, based on the results of problem-solving skills test, there are still errors in the process of implementing the strategy of problem solving and understanding the problem. The dominant factor that determines the student does not check the result of problem solving due to time constraint. This is in accordance with the opinion of Lester (1985) which explains that whether students check computing or not, it depends on the time provided.

4.5. Problem Solving Ability Viewed from Visual Thinking of Levels

Students with visual level of thinking have been able to understand the problem. In addition, students can also mention waking up what is contained in the problem and the absence of misinterpretation in understanding the problem. Students with the level of Visual thinking has been able to identify a figure even in a position or a complex orientation (Fuys *et al.*, 1988). Students are not yet fully capable of organizing data and selecting relevant information to identify problems having sufficient criteria. This is because students are able to organize data about the length of the other side in determining the base or height of a triangle. However, the student has not been able to organize the data and select the relevant information on the particular figure. This is what Mayberry (1983) suggests that in the thinking level of van Hiele's geometry students can be at different levels of van Hiele in different concepts. Students have not been able to organize data on other figure-up areas to identify the length of the diagonal on the other. Students in presenting the problem formulation in the form of drawings there are still shortcomings. Students still can not identify which is the base, height, or certain elements of a figure. This is because students are not able to identify the elements and traits contained in the figure of the students and the level of visual thinking is only able to draw or imitate the image but is limited to a simple image (Fuys & Geddes, 1984).

Students are able to choose the approach and strategy used in solving the problem. Students tend to be able to use the right approach when mastering rectangular or triangular material. Jitendra *et al.*, (2013) explains that if the mastery of the material is less then the students have difficulty in determining the problem solving solution. However, students still have difficulty in determining the right strategy if the illustrations of the problem have not been presented in the form of drawings.

The ability of students with visual van Hiele geometric thinking level has not been fully capable of using or developing problem-solving strategies. In some cases, students can use and develop formulas from triangular or rectangular areas if the required elements are known clearly. In addition, students can perform the operation properly as well. However, there are still errors in determining the base, height, or other necessary elements if not explained in the problem. Students still have difficulty in determining the base of a triangle if the base must be obtained by linking the other figure. Students with visual thinking levels of van Hiele geometry have not been able to analyze the components of a build based on other waking properties (Fuys & Geddes, 1984). However, they have been able to interpret the results of answers to solve the problem although there is still a mistake in the results obtained in the answers. Criteria of students in solving problems can be seen from the students' ability to understand the problem, plan the problem solving strategy, implement the problem solving strategy, and check the problem solving result. Based on the results of the problem-solving test students can show understanding of the problem by writing and explaining what is known and asked. In addition, students can also organize the figure to identify problems. However, there are some problems where misinterpretation occurs in understanding the problem. The next ability is the ability to plan a problem-solving strategy. Students tend not to be fully capable in planning problem solving strategies. They write strategies based on what the students

understand. The next capability is the ability to execute problem-solving strategies. In this case, the student has not been able to do so because of a mistake in developing a strategy that includes the required length size. This causes the results of the answers obtained also have not solved the problem. Students with a level of Visual geometric thinking tend not to check for problem solving because they are out of time and or do not understand the strategies used to solve the problem.

4.6. Problem Solving Ability Viewed from Analysis Thinking of Level

The following figure is an example of student problem solving test result with van Hiele geometry thinking level. The annalysis is based on seven indicators of problem solving ability.

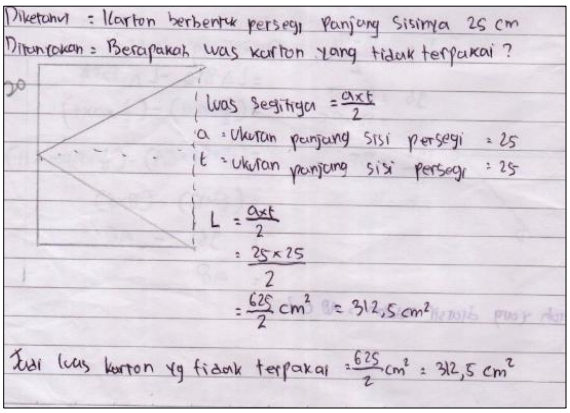

Figure 2. Subject Analysis's Work of Problem Solving Task

Based on the figure above, the student understands the problem by writing what is known and asked. He also mentions that there is a triangle as the area of unused cardboard. He fully writes the formulation of the problem in the form of images and symbols. Shortly, he is able to show the intended triangle area along with the base and height image. Thus, he uses the information about the size of the sides of the square to determine the base and height of the triangle. The next problem solving indicator is choosing the right approach and strategy for solving the problem. Based on Figure 2, it clearly can be seen that he uses a broad triangle area approach to calculate the area of unused cardboard. Based on the approach, he has entered the value of the length of the base length of 25 cm and the height of the triangle is 25 cm obtained from the indicators data organizing and relevant information in identifying the problem. He completes the calculations and results 312.5cm^2. Based on the results of the answer, he has interpreted 312.5 cm^2 as an unused cardboard area. Besides, the seventh KPM indicator is the ability to solve problems viewed from the ability to understand problems, plan problem-solving strategies, implement problem solving strategies, and check out the results of problem solving. Based on these four skills it is suggested that the student is able to solve the problem.

With regard to above explanation, students with a geometric thinking level Anal Analysis have been able to write down what is known and asked based on the problem. In addition, students can also mention the figure which is contained in the problem and there is of misinterpretation in understanding the problem. Students are also able to organize data and select relevant information. They also have been able to organize data in this case to relate a figure or more to determine the length of the other side. This is because they are able to know the characteristics of the particular figure and how it relates to another. This is in accordance with Fuys *et al.*, (1988) say that students with geometry thinking level Analysis can identify the characteristics of a figure that can be applied to other figure. Students also have been able to present the problem formulation mathematically in various forms. While in the form of pictures, students have been able to present the problem completely. They also paint the high line and the base if the problem is about the area of triangle area. Students can interpret verbally or symbolically a statement and apply the symbol. (Fuys & Geddes, 1984). In the form of figures, students present the formulation of the problem based on what is understood by the students themselves. Students' abilities associated with these indicators are influenced by how often students do the exercises. This is in line with what Mayer (1985) says that students' problem-solving skills will increase if they are trained continuously. Based on the results of problem-solving skills tests, students can enter the values of the required elements correctly. However, there is still an error in the calculation process associated with the problem. The results of student answers obtained by students are interpreted based on what is understood by the student. Students are able to interpret the results obtained answers. The results of the answers obtained can solve the problem. Criteria of students in solving problems can be seen from the students' ability to understand the problem, plan the problem solving strategy, implement the problem solving strategy, and check the problem solving result. Students can understand the problem, organize the data and select the relevant information in identifying the problem and able to arrange the problem mathematically in various forms. The next ability is the ability to plan problem-solving strategies, in this stage the students have good criteria due to being able to plan the right strategy. The next ability is the ability to execute problem solving strategies that can be seen

from the calculation process related to the problem. The next criterion is the ability of students in checking the results of problem solving. Students can solve problems because of knowing the properties of the figure. This corresponds to one indicator of the student with a level of analytical thinking that in solving the problem, students use the properties of the figure (Fuys *et al*., 1988). Based on the results of problem-solving test, there are still errors in the calculation process associated with the rectangular or triangular. Based on the description above, it can be concluded that the students are able to solve the problem.

4.7. The Summary of Problem Solving Ability Viewed From Geometric Thinking Levels

Table 2 shows the summary of Problem Solving Ability Viewed From Geometric Thinking Levels

Table 2. Summary of Problem Solving Ability Viewed From Geometric Thinking Levels

PS Indicator	PreRecognition	Visual	Analysis
1	√	√	√
2	-	-	√
3	√	√	√
4	-	√	√
5	-	√	√
6	√	√	√
7.	-	-	√

Note

√ : able to fully the indicator

\- : unable to fully the indicator

Problem Solving Indicators in this research consist of (1) understanding the problems; (2) organizing data and select relevaninformation; (3) formulating problems in several forms; (4) choosing appropriate approach and strategy to solve the problem; (5) using or improving problem solving strategy; (6) interpreting the result to solve the problem; and (7) solving the problem.

4.8. The Quality of Search Solve Create and Share Learning Model

Based on the research result, the learning quality of SSCS model has a plan with valid criteria. The implementation stage can be seen from the activities of teachers and students which have good criteria. While, at the evaluation stage, the problem solving test results show the mastery learning.

The SSCS learning begins with the Search phase, where students propose issues and relevant information related to the issue. This is in line with what is presented in the attachment of Regulation of Education and Cultural Ministry Number 58 about the 2013 curriculum which explains that the implementation of mathematics learning is expected to guide the students in the process of problem solving (problem posing) and problem solving.

In the Solve phase, the teacher guides the students in completing the problem-solving test questions in several stages. The instruction should be gradually and slowly given to the students in order to develop problem-solving skills especially for them who have weaknesses in math (Rosenzweig *et al.*, 2011; Peltier & Vanest, 2016). Indeed, problem solving is a difficulty for students when it is compared to other routine questions (Riccomini *et al.*, 2016).

Before the learning is finished, the teacher reflects on the ongoing learning activities. The reflection activities can be either motivation or strengthening in learning. As Tricomi & DePasque (2016) reveal that reflection activities can play an informative role and also be a motivation for students.

Moreover, based on the evaluation of learning, the number of students who have reached KKM, more than 75%. It shows that SSCS learning model can be used as a learning model to develop problem solving ability. However, there are still some students who have not been able to achieve the expected mastery. Since there are differences in students in the process of responding to learning. As what Halat (2007) explains that students have diversity in interest, ability, and intellectual so they have different responses to the learning process.

5. Conclusion

There are some conclusion that can be drawn based on the previous findings explanation, they are as follows, (1) Both Problem Based Learning and Search Solve Create and Share can achieve learning mastery but there is no significant difference between problem solving ability between PBL class and SSCS class, (2) Students with pre-recognition and visualization can fully identify the nature of a figure yet difficult in solving the problem. While the students with the level of analysis thinking can solve the problem by utilizing the properties contained in a figure, (3) the quality of the learning model SSCS has good criteria. Therefore, the learning model can be used to develop problem solving skills.

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