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Research Article

Analysis of students' mathematical connection abilities in solving problem of circle material : transposition study

Nanang Diana[1], Didi Suryadi[2], Jarnawi Afgani Dahlan[3]

[123] *Study Program of Mathematics Education, School of Postgraduate Universitas Pendidikan Indonesia, Bandung, Indonesia and* [1]*STKIP Taman Siswa Bima, NTB, Indonesia*

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Abstract

This study aims to describe the ability of students' mathematical connections in solving problems in the circle equation material through transposition studies. The method in this research is a descriptive qualitative approach, the techniques used in the study are tests, interviews, and documentation to explore data in research. Test and interview techniques were carried out in order to find out more about the ability of connections and generate knowledge about the transposition in making mathematical problem solving designs. The test is given to 3 students who have high ability, medium ability and low ability. Analysis of the data in this study is through the provision of problem solving tests and interviews using time triangulation, which provides tests and interviews for each student with a different time. The results in this study indicate that highly capable subjects have excellent mathematical connections and didactic knowledge is well utilized and able to provide alternative answers that differ from researchers so that a didactic transposition is formed, that is knowledge to be taught with knowledge, subjects of mathematical ability are able understand the problem well but are not careful enough in solving problem so that previous knowledge is underutilized, the subject of low mathematical ability is not able to understand the problem well and is unable to solve problems in the form of algebra so that the initial knowledge possessed is not well connected.

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Introduction

Geometry is a part of mathematics that deals with points, lines, fields, and space (Travers, 1987). Geometry deals with abstract concepts that are given symbols. Some of these concepts are formed from several elements that are not defined according to the deductive system. Geometry is one of the systems in mathematics that begins with a basic concept, namely the point. The dots are then used to form lines and lines will form a plane. The plane will be able to construct various types of flat and multi-faceted shapes. Multi-faceted shapes can be used to arrange three-dimensional shapes.

Learning geometry is a unit of mathematics learning that is classified as difficult, among others it can be seen that students still find it difficult to recognize and understand geometric shapes and elements (Saragih, 2008). This is supported by (Idris, 2011) who argues that the difficulties of students in learning geometry are closely related to the ability to solve mathematical problems. Learning geometry should be adjusted to the mathematical abilities of students including the level of thinking of students in geometry and the mathematical connections students have. Abilities that are adapted to students' thinking abilities and connection abilities possessed by students will increase student intellectual involvement so that they can improve their understanding of analytic geometry learning.

[1] Study Program of Mathematics Education, School of Postgraduate Universitas Pendidikan Indonesia, Bandung and STKIP Taman Siswa Bima, Indonesia. E-mail: (diana.nanang@yahoo.com), ORCID ID: 0000-0001-9458-1990
[2] Study Program of Mathematics Education, School of Postgraduate Universitas Pendidikan Indonesia, Bandung, Indonesia. E-mail: (ddsuryadi1@gmail.com) ,ORCID ID:0000-0003-0871-8693
[3] Study Program of Mathematics Education, School of Postgraduate Universitas Pendidikan Indonesia, Bandung, Indonesia. E-mail: (afgani_lan@yahoo.com), ORCID ID:0000-0002-9290-7755

Thinking skills are skills in combining attitudes, knowledge, and skills that enable a person to be able to shape his environment to be more effective. Thinking skills can also be defined as cognitive processes broken down into concrete steps which are then used as thinking guides. One example of thinking skills is drawing conclusions, which is defined as the ability to link various clues and facts or information with the knowledge they have to make a prediction of the final outcome formulated.

Mathematics plays an important role in building human scientific thought patterns and attitudes. (Hendriana, H & Sumarmo, 2014) states that the vision of mathematics learning has two directions of development, namely to meet the needs of the present and the future. First, direct the learning of mathematics for understanding mathematical concepts and ideas. Second, direct the learning of mathematics to provide opportunities for the development of logical, systematic, critical, careful, creative, reasoning ability to develop self-confidence, and develop an objective and open attitude. In line with this, (Harel, 2008) views mathematics as a way of thinking and ways of understanding. The role of mathematics as a whole is also included in the 2013 curriculum (Ministry of Education and Culture, 2016). Therefore, the view of mathematics as a science that is rigorous and neatly structured shifted to the view that mathematics is an activity of human life (Turmudi, 2010).

One of the mathematical material that plays an important role in developing students' connection and thinking skills is the equation of a circle and tangent of circles. Equation of a circle and tangent of circle is one of the mathematical material included in analytic geometry. Analytic geometry is the result of blending material between algebra and geometry (Gantert, 2008). Algebraic thinking can be used to solve geometry problems and geometric ideas can provide a source of insight for algebraic problem (French, 2004). The most important thing in learning analytic geometry is how to harmonize students' knowledge about geometry and algebra. However, in fact, understanding algebra and geometry in analytic geometry is isolated in the minds of students (Recegnova, 2005). Therefore, we need the connection ability to connect knowledge between the previous material with the knowledge they have now that been appreciated into the knowledge to be taught so as to form a didactic transposition of students (Charles, R & O'Daffer, 1997) state the purpose of teaching problem solving in learning mathematics is to: (1) develop thinking skills, (2) select and use strategies in problem solving, (3) develop attitudes and beliefs (4) develop the ability to use interconnected knowledge, (5) monitor and evaluate his own thinking and the results of his work during problem solving, (6) solving problems in a cooperative learning environment, (7) finding the correct answers to various problems. Problem solving requires their initial cognitive development so that they are able to build logical reasoning at a smaller age and produce solutions to complex problems using their creativity (Getzels, Jacob & Jackson, 1962). Spatial-visual ability is a feature that distinguishes gifted and talented children from their friends and differs from their friends in the creation of shapes thanks to this ability (Gardner, 1983; David, 2015).

In learning mathematics, a student's connectivity is very necessary because mathematics connection is one of the abilities that is the goal in learning mathematics. Mathematics consists of various topics that are interrelated to one another. The linkage is not only inter topic in mathematics, but also the relationship between mathematics and other scientific disciplines and the relationship between mathematics and daily life. This connection is called a mathematical connection. The ability of a person to associate one topic to others in mathematics, associate mathematics with other sciences, and with life is called the mathematical connections ability. It is in accordance with the opinion of who states that the ability of mathematical connections is the ability of someone to show the internal and external relations of mathematics, which include connections among mathematics topics, connections with other disciplines, and connections with everyday life.

Active, creative, effective and fun learning conditions for students can be created by applying the right learning approach. To achieve these expectations, a teacher must be skilled in choosing the right approach with the subject matter presented and student characteristics. Experienced instructors will have better abilities in choosing learning in accordance with the subject matter to be taught and the needs of students. This fact implies that an educator must create learning situation for students so that learning becomes meaningful. One way to anticipate learning barriers, reduce or eliminate the difficulties that arise during the learning process, the instructor must design a situation which accommodate student responses cognitively and affective, indeed, the expected competencies can be achieved in accordance with the expected goals (Diana & Suryadi, 2020).

Thought experiments are cognitive tools commonly used by students as well as experts (philosophers, scientists) for purposive scientific problem solving (Clement, 2006, 2008, Rainer, 2006). There are a lot of studies in the literature about how thought experiments revealed students' many traits such as imagination, creativity and problem solving skills (Reiner, 1998, Reiner, 2003, Reiner & Gilbert, 2000, Stephens & Clement, 2006, Matthews, 1994, Helm

et al. 1985; Lattery, 2001). Obviously, the development of creativity, imagination and problem-solving skills in the differentiated education of gifted students is also an important goal (Tortop, 2018).

Mathematics is one of the subjects that has an important role in developing students' mathematical abilities. This is in line with the learning objectives of mathematics formulated in the Education Unit Level Curriculum (Depdiknas., 2006:346) which states that mathematics is aimed at making students have the following abilities:

- Understanding mathematics concepts, explaining the interrelationships between concepts or logarithms in a flexible, accurate, efficient, and precise manner in problem solving.
- Using reasoning on patterns and properties, carrying out mathematics manipulation in making generalizations, compiling evidence or explaining mathematical ideas and statements.
- Solving problems that include the ability to understand problems, design mathematical models, solve models, and interpret the results.
- Communicate ideas with symbols, tables, diagrams, or other media to clarify the situation or problem.
- Have an attitude of appreciating the usefulness of mathematics in life, namely having curiosity, attention and interest in learning mathematics, as well as being tenacious and confident in problem solving.

In line with the Education Unit Level Curriculum (KTSP), the National Council of Teachers of Mathematics (NCTM, 2000) formulates the objectives of mathematics learning which consists of five basic mathematics abilities that are standard namely problem solving, reasoning and proof, communication, connections, and representation. By referring to the five NCTM ability standards, the mathematics learning objectives set out in the 2006 curriculum issued by the Ministry of National Education essentially cover (1) connections among concepts in mathematics and their use in problem solving, (2) reasoning, (3) problem solving ,(4)communication and representation, and (5) affective factors. In both documents, the mathematics connections ability is a strategic ability that is the goal of learning mathematics.

In classroom learning, mathematical connections among concepts in mathematics should be discussed by students, the connection among mathematics ideas explicitly taught by teachers does not make students understand them meaningfully Hiebert & Carpenter, (1992) summarized by (Bergeson, 2000:37). Appropriate learning is not only through talk and talk, but students must actively make their own connections. In this case, students should not be seen as passive receivers of ready-made mathematics (Hadi & Fauzan, 2003) but instead students are considered as active individuals who are able to develop their own mathematical potential.

The emphasis on mathematical connections helps students understand how different mathematical ideas are interconnected. Through this mathematical connection, students learn to make estimation and develop their minds using insights in a particular context to test a conjecture in another context (Romli, 2016). Bell (1978) states that not only are mathematical connections important but the awareness of the need for connections in learning mathematics is also important. The connection among topics in mathematics can be understood by children if children experience learning that practice their connection skills, one of which is through meaningful learning. Connections between processes and concepts in mathematics are abstract objects. It means that these connections occur in the minds of students, for example students use their minds when connecting between symbols and their representations (Hodgson, 1995).

This research will examine how the process of mathematical connection ability of students in solving analytic geometry problems of circle material based on didactic transposition studies. Didactic transposition is the fact that the knowledge taught at school comes from other institutions, which are built by real practices in a collection of certain objects, where the knowledge taught comes from other scientific institutions (Chevallard, 2013). The process of transposition refers to the transition of an object or subject of knowledge when knowledge is produced, selected and designed to be taught in a particular education. Therefore, in this study, it is necessary to redesign a geometric concept on the circle taught in an institution so that the mindset of students is more capable to develop mathematical understanding and thinking as well as mathematical connections of student directed in learning geometry. The steps in the didactic transposition process are as follows:

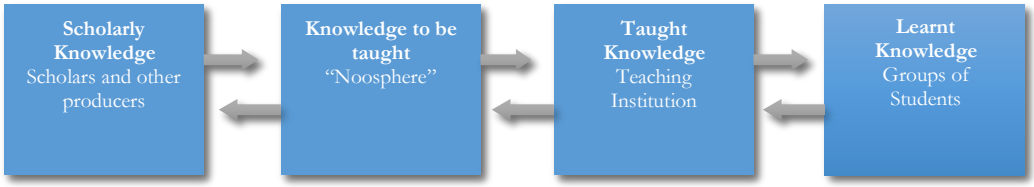

Figure 1.
Diagram of the Process of Didactic Transposition (Bosch & Gascón, 2006)

Based on the diagram above, it shows that the didactic transposition process starts with scientific knowledge (Scholarly Knowledge) generated by scientists in determining regional, local or point praxeology and starting from what tasks are needed. Then, the knowledge is transferred by noosphere (curriculum designers, book authors text) becomes knowledge to be taught (knowledge to be taught) and transferred to knowledge that is taught (taught knowledge) in educational institutions/institutions (schools/teachers), which will eventually be learned by a group of students (learnt knowledge). Didactic transposition theory is based on statements on the body of knowledge, with a few exceptions, designed not to be taught but to be used. Knowledge learned by students is a long process in a didactic transposition process.

Didactic knowledge transposition is the transposition of knowledge which is considered as a tool to be used as knowledge to be taught and learned (Chevallard, 1989). Therefore, any modification of knowledge under instructional objectives can also be called a didactic transposition. Didactic transposition aims to produce scientific analysis of the didactic system and is based on the assumption that knowledge determined as an object of teaching, usually has pre-existence as scientific knowledge. Therefore, the connection ability in solving circle material problems will be described based on the didactic transposition study by comparing knowledge to be taught with learning knowledge (learning received by students) in the analytic geometry of circle material so that a didactic transposition is formed. Didactic transposition is used to find out the differences between researchers and students so that researchers know in which parts of students are not able to complete the stages of the problem. Then, it is used as an evaluation material for further learning. In this research students are expected to be able to use mathematical connections well, namely by making connections between mathematics lessons and what mathematicians are currently doing or by solving life problems (breathe life) into mathematics (Johnson & Litynsky, 1995). NCTM, formulates that when students are able to connect mathematical ideas, their understanding of mathematics becomes deeper and more durable. Students can see that mathematical connections play an important role in topics in mathematics, in contexts that connect mathematics and other subjects, and in their lives. Through learning that emphasizes the connectedness of ideas in mathematics, students not only learn mathematics but also learn to use mathematics (2000: 64).

The problem in this study is the lack of students' connections in solving mathematical problems, where students have only solved problems originating from books taught without using prior knowledge and without using deep understanding in understanding problem solving problems. The knowledge acquired through good understanding and connection should be the basis for developing new knowledge and useful as a new solution in solving unfamiliar problems. When students have gained conceptual understanding in mathematics, they will see the connection between concepts and procedures and also provide arguments for why some facts are a consequence of other facts. The more they understand, the better their ability to connect mathematics (Kusmanto & Marliyana, 2014)

Besides that the problem in this research is that the ability of students to receive mathematics subject matters is limited to receiving it from lecturers. In addition, the other obstacle of students is that they do not understand the purpose of the subject matters being studied because they only accept a number of subject matters provided by the lecturer. Whereas in mathematics, a subject matter is always related to other subject matters, a concept is related to other concepts. It means that mathematics has connections or relationships between concepts, material, or other fields of study, so that there is a shift in knowledge (didactic transposition) obtained by students in understanding the connections between interrelated material in solving mathematical problems starting from the knowledge they had before until they connect the new knowledge they have gained.

The problem formulation in this research is to analyze how students 'mathematical connections in solving circle material problems in high, medium and low ability students based on transposition studies, so the purpose of this study is to describe the ability of students' mathematical connections in solving circle material problems in high ability students , medium and low based on transposition studies.

Method

Research Design

In this study, researchers used a descriptive qualitative approach. Descriptive analysis method is an approach to describe and analyze data related to student learning needs in solving mathematics problems based on student transposition processes. The hallmark of qualitative research is analyzing data describing text to interpret meaning (Creswell, 2012). Qualitative research is not only an attempt to describe the data but also conduct valid data collection through in-depth interviews, observation and documentation, so this research described the ability of mathematical connections in problem solving on the material of the circle equation and the equation of circle's tangent.

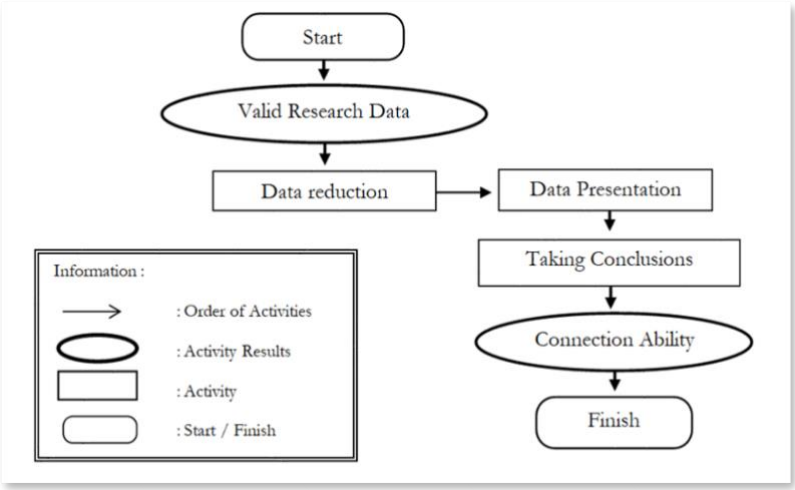

Figure 2.
Data Analysis Technique Procedure

Participants

The subjects in this study were the third semester students who joined in analytic geometry courses with the number of students given problem-solving questions totaling 10 students. In the interview process, 3 students were taken to represent the research data. Students are chosen based on their high mathematics abilities, moderate mathematics abilities, and low mathematics abilities.

Data Collection

Collecting data in this study was to use the test method and interview method. The test used mathematics problems solving question in the material equation of the circle and circle's tangent with the aim of knowing the ability of student connections in solving problems in terms of transposition studies. Meanwhile, the interview method is used to get clearer information about the connection skills possessed by students in finishing problem solving questions. The interviews were recorded with audiovisual as researcher's documentation material for data analysis purposes.

Data Analysis

Analysis of the data in this study were; (1) Data analysis about mathematics problem solving questions, which is done based on the truth of problem solving done by the research subject guided by the problem-solving instructions made by the researcher. Based on the answers of the research subjects, the problem-solving stages described by students were analyzed, ranging from understanding mathematics problems, solving problem and being able to draw conclusions in problem solving. (2) Data analysis of the results of interviews is conducted to dig up information from subjects that have not been revealed in the answer to the problem-solving solution. Data analysis was performed by data reduction, data presentation and conclusion drawing (Miles & Huberman, 1992). Data reduction is defined as the process of selecting, focusing, simplifying and transforming the rough data that arises from the notes that appear in the field. Presentation of data is to classify and identify the data obtained that aims to facilitate understanding what happened, and plan further work for drawing conclusions. Drawing conclusions is to summarize data and check the truth of data collected. In this research, time triangulation is used, which is a data validity checking technique that utilizes something else (Moleong, 2011). Time triangulation is used in the context of testing the credibility of the data (degree of trust) which is carried out by checking interviews, observations, or other techniques in different times or situations.

Results and Discussion

The findings in this study were obtained from tests of mathematical problem-solving questions and student interviews as follows:

Mathematical Connection Capabilities of High Ability Students

Problem-solving Question 1 Subject ST

Determine the equation of the circle through the points (3, -1), (5,3) and (6,2). Then also determine the center and radius of the circle!

From the above questions the students' answers are as follows

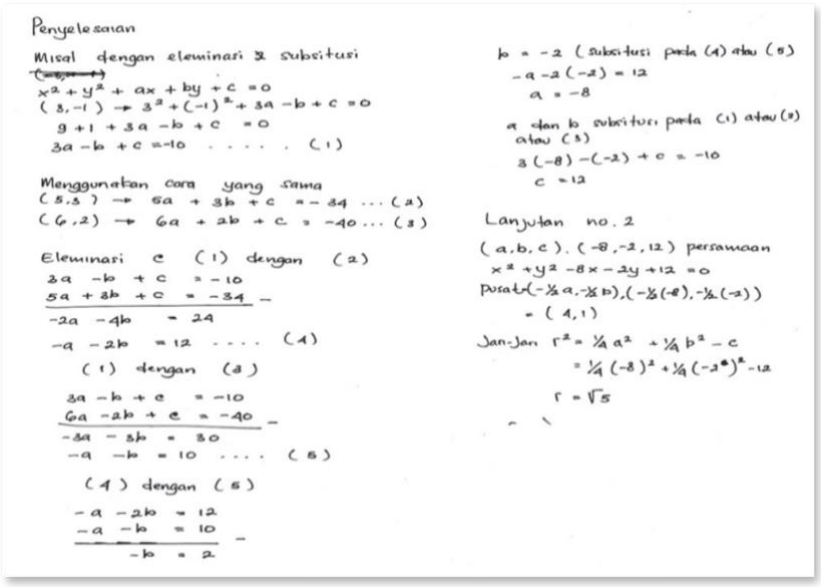

Figure 3.

Problem-solving Question 1 Subject ST

Through the results of tests on the first problem solving question, it is known that the subject immediately writes down the completion steps without writing down the required information, namely what is known. The subject immediately solved the problem by doing an example with the steps of elimination and substitution. In solving this question, the subjects can solve well by their connection ability using the algebraic process that has previously been studied or knowledge that was previously owned by the subjects. Besides, the subject can calculate it systematically so that the answer is correct by determining the center and radius of the circle through the formula of the circle equation.

Based on the results of tests and interviews, it can be seen that the subject can remember the material that was taught before so that the subject can finish the questions correctly. Then, it can be said that the subject connects among ideas in mathematics, this is the first mathematical connection indicator. Indicator of mathematical connection ability refers to the ability of students to be able to connect ideas in mathematics itself, so that students are easier to remember lessons that have been learned before.

Problem-solving 2 the Subject ST

A cruise ship placed at coordinates (5, 12) has a radar with a range of 45 km in all directions. (a) Write an equation that models the maximum range of the ship's radar, and (b) use the distance formula to determine whether the radar can detect other ships at coordinates (50, 25).

Based on the above questions, the students' answers are as follows:

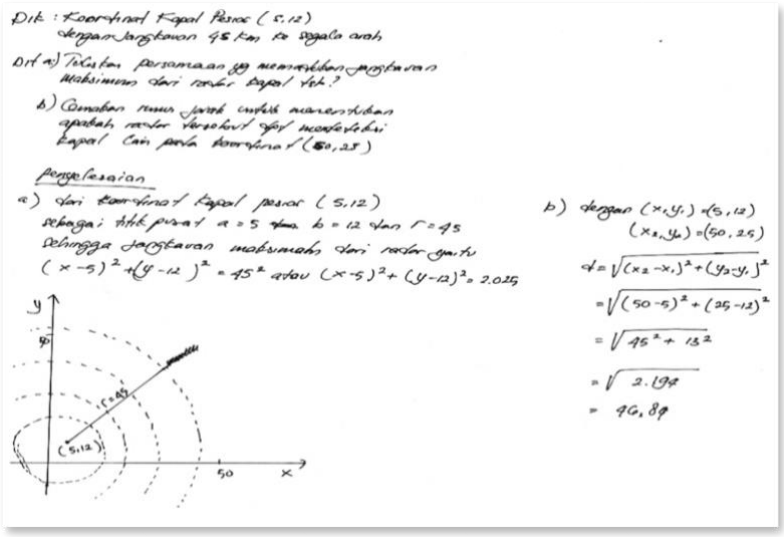

Figure 4.
Problem-solving Question 2 Subject ST

Through the results of the second problem solving test, it is shown that the subject is able to find the right information in the problem and can imagine the sound of the problem by describing the form of radar. In addition, the subject wrote an example of what became a question in the problem.

Based on the results of tests and interviews, the subject can be said to have met the second indicator which is able to connect mathematics ideas with daily life, it is supported by students' answers in the interview process that question number two is the application of material in daily life.

Problem solving Question 3 the subject ST

Determine the equation of circle's tangent through the point (-1,1) on the circle

$$x^2+y^2-4x+6y-12=0$$

From the above questions the students' answers are as follows

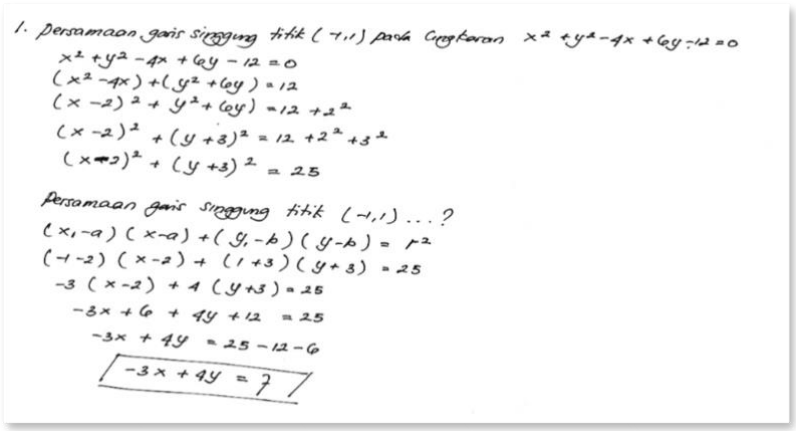

Figure 5.
Problem-solving Question 3 Subject ST

Through the results of the third problem solving question test, students immediately solve the problem with the steps they understand without knowing what information is known. This can be seen when students solve tangent equation problems by directly pairing the value of the equation through point (-1.1).

In the process of solving problems, students solve different ways that researchers previously knew, the solution is from the above problem, it is known that the equation of the circle is $x^2+y^2-4x+6y-12=0$ with A = -4, B = 6 and C = -12 and$x_1 = -1$, y_1 =1 Tangent Equation is

$$xx_1+yy_1+\frac{A}{2}(x+x_1)+\frac{B}{2}(y+y_1)+C=0$$

$$x(-1)y(1)-\frac{4}{2}(x-1)+\frac{6}{2}(y+1)-12=0$$

-3x+4y-7=0

So, the tangent line equation is 4y=3x+7

Based the knowledge that students know, students solve problems used the general equation formula circle not the general formula equation of circle's tangent. By adding some numbers that they thought can find the equation of the circle's tangent.

Based on the results of interviews, the subject did inaccuracy in solving problems by using other methods by having other formula thought in finding solutions to the problems of the circle's tangent. The subject can be said to have fulfilled the ability of the second mathematical connection that is the student is able to connect and write one idea with another idea and the second aspect which is able to connect mathematics in other fields of knowledge.

Mathematical Connection Capabilities of Average Ability Students

Problem-solving Question 1 the Subject SS

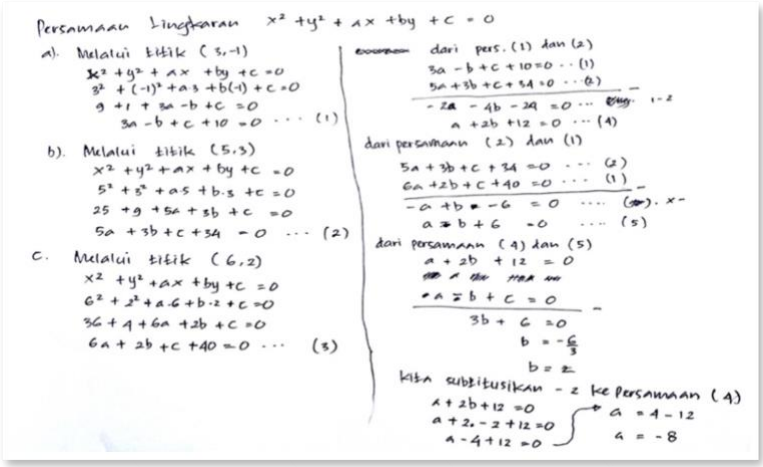

Figure 6.

Problem-solving Question 1 Subject SS

Through the test results on the first problem solving problem it is known that SS writes the form of each equation from the known point by solving using the general equation form circle $x^2 + y^2 + ax + by + c = 0$, so we get the equation form from each point is known by substituting another form of equation.

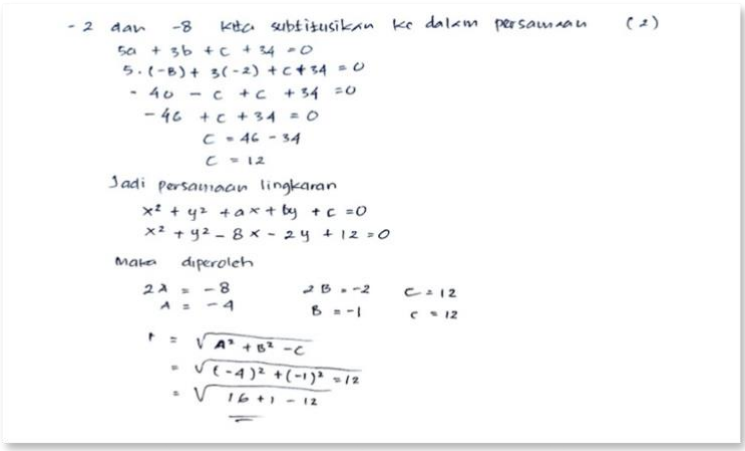

Figure 7.

Advanced Problem-solving Question 1 subject SS

Furthermore, by using the SS algebra process has a very good connection ability in solving problems by finding the value of each variable to form the circle equation that is asked, from the circle equation obtained then the SS looks for the radius of the circle using the value of the variable already obtained, with a value of a = -4, b = -1, c = 12, then to obtain the value of the SS radius using the formula $r = \sqrt{A^2 + B^2 - C}$, so the value of r = √5 is obtained.From the results of tests and interviews it can be seen that the subject can remember the material that has

been taught before and solve the problem correctly even though several times thinking about how to solve it with some streaks done by SS subjects.

Problem-solving Question 2 the Subject SS

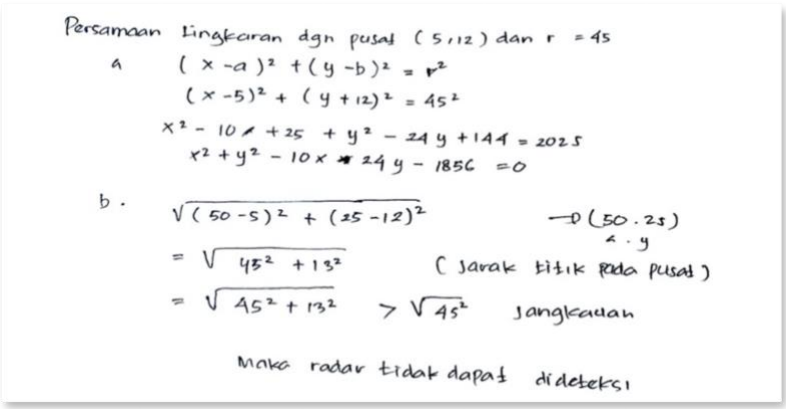

Figure 8.
Problem-solving Question 2 Subject SS

In solving the second problem solving problem in part (a) the SS subject writes the circle equation $(x-a)^2+(y-b)^2=r^2$with center (5,12). The subject can write the equation well and understand in algebra, but the subject is less careful in the final result of writing the equation of the circle obtained from the center and the radius of the problem. Whereas in part (b) the subject immediately writes the value $\sqrt{(50-2)^2+(25-12)^2}$without mentioning the formula from distance and then in the final result the SS subject does not continue adding the root from $\sqrt{45^2+13^2}$ immediately concluded that $\sqrt{45^2+13^2}$ was less than $\sqrt{45^2}$,but the final conclusion was correct namely the radar could not be detected.

Based on the results of tests and interviews that the SS subject can be said to have fulfilled the second indicator which is able to connect between mathematical ideas with daily life, evidenced in the subject's understanding in solving the given story problem, but the subject is less careful in writing the final equation that is asked for the part problem (a) and then in part (b) SS subjects can deduce correctly the distance to detect ships.

Problem-solving Question 3 the Subject SS

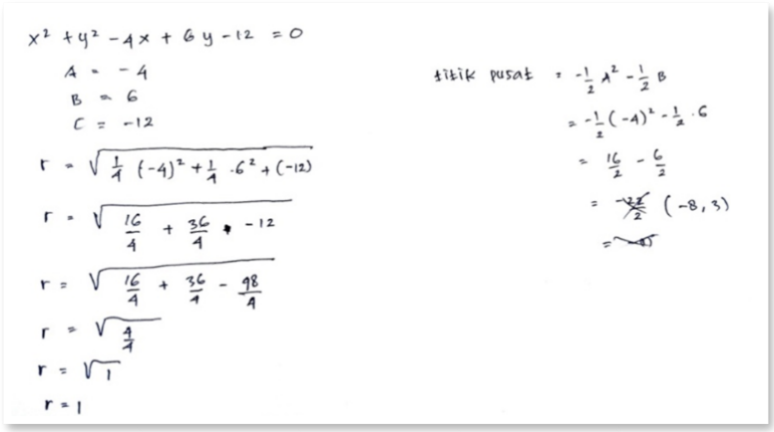

Figure 9.
Problem-solving Question 3 Subject SS

Through the test results of problem solving the three subjects write the equations given, but in problem solving the subject uses the formula radius r= $\sqrt{\frac{1}{4}(-4)^2+\frac{1}{4}(6)^2+(-12)}$ do not use the formula tangent circle tangent, the subject has difficulty thinking of ideas in solving the third problem.

Based on the results of the interview the subject was not careful in understanding the problem so that the difficulty in solving the problem, what he thought immediately wrote without thinking about other ideas. After the interview took place the subject realized that what he was doing a lot wrong in his understanding.

Mathematical Connection Capabilities of Low Able Students

Problem-solving Question 1 the Subject SR

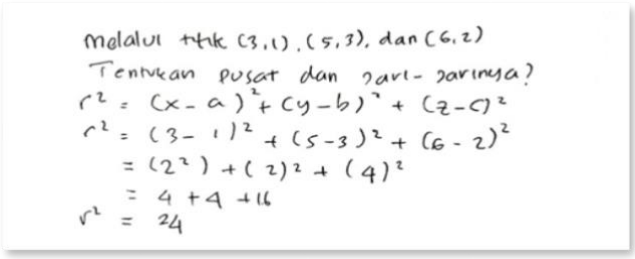

Figure 10.

Problem-solving Question 1 Subject SR

In solving problem 1 SR is not able to recognize and write formulas correctly, what is in his mind immediately written down, lack of understanding in finding ideas to solve problems correctly so that the results obtained are less understood. From the results of tests and interviews, it can be seen that the subject cannot solve problem solving correctly because during the learning process takes less attention and memory is lacking in some formulas in the circle material.

Problem solving Question 2 the subject SR

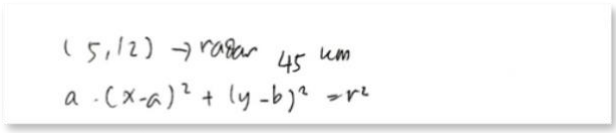

Figure 11.

Problem-solving Question 2 Subject SR

In the second problem solving part (a) the SR subject is only able to remember the circular equation formula and then cannot continue the problem solving problem in the form of a story problem and also in part (b) the subject is unable to continue solving the problem because of forgetting the distance formula.

Problem-solving Question 3 the Subject SR

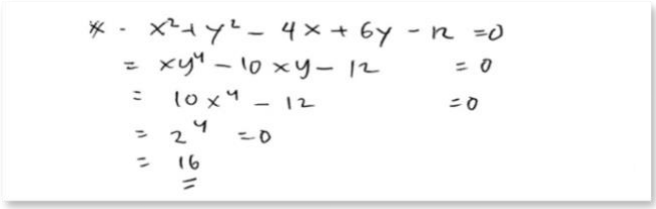

Figure 12.

Problem-solving Question 3 Subject SR

In solving the problems of the three SR subjects write the form of the equation that is known, but the subject is not able to complete the algebraic form properly seen from the form of rank by adding rank to different variables. Based on the results of interviews the SR subjects lack understanding in solving algebraic forms in the problem.

Discussion and Conclusion

Mathematical connection does not only consist of connection mathematical issues with each other, but also includes associations with different disciplines and daily life. If examined there are no topics in mathematics that stand alone without any connection with other topics. Children can understand connections between topics in mathematics if children experience learning that trains their connection skills, one of which is through meaningful learning (Kaur & Lam, 2012). Connections between processes and concepts in mathematics are abstract objects, meaning that these connections occur in the minds of students, for example students use their minds when connecting between symbols and their representations. With a mathematical connection the mathematics lessons seem to be more meaningful, many students view mathematics as a static science because they feel the mathematics they learn is not related to their lives. Very few students regard mathematics as a dynamic science, especially since more than 99% of the mathematics they learn was discovered by experts before the eighteenth century.

Mathematical connection is the relationship between two equivalent representations, and between the process of solving each representation. Students should have the opportunity to observe the relationship of mathematics with other subjects and everyday life. To fulfill it, mathematics teachers must involve other subject teachers to actively participate in exploring mathematical ideas/concepts through problems that arise in the courses given to students (Özgen, 2013). Integrating mathematics into contexts that give practical meaning to symbols and processes is a central goal of the overall standard. This allows students to see how a mathematical concept can help them understand others, and illustrate the usefulness of mathematics in problem solving, depicting and modeling real world phenomena, and communicating complex thinking and information in a fast and precise way. The following are the results of the discussion of mathematical connection skills of high-ability, medium-ability and low-ability students based on transposition studies:

Connection ability of high-ability students in solving mathematical problems

Based on the description of the data, it shows that ST subjects are able to understand the problem well, in ST subjects' answers can mention the concepts used to solve problems and ST subjects can give reasons for the relationship of each concept in solving problems with logical reasons. The results showed that the mathematical connection ability of highly capable students is able to think mathematical ideas well, can understand questions well, be able to work on problems with the correct form of algebra, be able to find the right information, be able to use other ways of solving problems and be able to represent mathematical ideas (Maker, 2004; Tortop, 2018). In this level, one of the most essential points in mathematics education is to acknowledge the different aspects ability of highly capable, understand them and prepare convenient education teaching environment for them. In the results of this study also highly capable subjects have very good connections so that the didactic knowledge possessed can be utilized properly in problem solving. Maker (1982), who has important studies in gifted education, states that gifted students are the best problem solving students. He emphasizes that teaching designs for them should be based on real life problems. It even has put forward a model about it. The effectiveness of teaching based on real life problems for high-ability students was found to be high (Maker et al. 2015).

Connection ability of students with medium-ability in solving mathematical problems

Based on the description of the data on students' ability is showing that the SS does not understand the problem well but can mention the concepts used to solve the problem although it is incomplete and the subject SS cannot give a reason for the relationship of each concept in solving the problem with logical reasons. The results showed that capable students were able to understand questions well, were able to use algebraic processes but were unable to connect one idea with another and were also mistaken in using formulas so that they could not continue some parts of problem solving. the initial knowledge possessed by SS subjects is used well in problem solving although there are some mistakes made in solving the given problem.

Connection ability of students with low-ability in solving mathematical problems.

Based on the data description shows that SR cannot mention the concepts used to solve problems and SR subjects cannot give reasons for the relationship of each concept in solving problems with logical reasons. The results showed that students who have low ability are not able to understand the questions well, are not able to work on questions in the form of algebra, and are not able to dig up information and understanding material previously studied, so that the didactic knowledge of SR subjects cannot be utilized properly.

The ability to connect students in each subject has a connection ability that is almost the same. As in ST subjects who are highly capable research subjects having good mathematical connections. Whereas SS subject is subject who have mathematical ability and has sufficient mathematical connection ability and for SR subject has mathematical connection ability that is lacking. Even so, each subject has the same good, enough and less abilities that are not the same for every indicator of mathematical connection ability. As in the subject ST from the high group really has a good mathematical connection ability in each indicator of the ability to connect mathematics, but the subject ST has only a good ability in the indicators to interconnect various representations of concepts or procedural, using mathematical ideas to understand other mathematical ideas that go further, and use mathematics in everyday life. Whereas for indicators aware of the relationship between topics in mathematics, ST subjects have sufficient abilities.

Then for medium group subjects who have sufficient mathematical connection ability, also have differences in each indicator of mathematical connection ability. For SS subjects, the ability of the group is right to have sufficient mathematical connection skills in each indicator of the ability to connect to mathematics, but SS subjects only have sufficient ability in the indicators to interconnect various representations of concepts or procedures, being aware of

the relationship between topics in mathematics , and have a good ability to use mathematical ideas to understand other mathematical ideas further, while for indicators of using mathematics in daily life, SS subjects have less mathematical connection ability.

For low group subjects, mathematical connection ability is lacking, it is seen that SR subjects have low ability on each indicator of mathematical connection ability, which means that SR subjects have less ability in indicators to interconnect various representations of concepts or procedural, aware of the relationship between topics in mathematics, and using mathematical ideas to understand other mathematical ideas further, and indicators using mathematics in everyday life, SR subjects have less mathematical connection abilities.

According to these studies, it can be concluded that each person has his own stages of resolution and his own opinions, the stages that students go through have a variety of differences even though the problems being solved are the same. The student is asked to start learning a new subject by associating it with their pre-learning, with other disciplines or with daily life practice. In this study, researchers compared knowledge to be taught (learning to be taught) with learned knowledge (learning received by students) in the analytic geometry of circle material to form a didactic transposition. Didactic transposition is used to find out the difference between the researcher's answer and the student's answer so that researchers know in which parts students are not able to complete the stages of the problem. Then, it is used as an evaluation material for further learning.

In this study, didactic transposition is also used to see the level of success of students' mathematical connections in answering questions. Students' mathematical connections can already be seen at the beginning of the answer about the elements that are known and asked. Students are able to summarize the three alternative answers into one concept of knowledge to facilitate students to proceed in the next process. Making connections for both teachers and students is an important activity in creating mathematical meaning (Mousley, 2004). The difference is not too significant, because researchers assume that this learning can be well received by students. This is evidenced by students who are able to solve problems correctly in accordance with prior knowledge. He stated that mathematical associations help students to remember and use many ideas, and that associative and mathematics learning can be strengthened (Bosse, 2003).

In knowledge to be taught, researchers also suspect that students are able to solve problems with the feelings they have. Students who are able to use feeling in solving problems are students with high mathematical connection abilities because not all students are able to use feelings in solving mathematics problems or look for material elements that are interconnected with one another. According to the research results obtained, mathematical connections are needed by students in finishing problems solving questions because with high mathematical connections, students are able to finish problem solving questions on the material equation of the circle and the equation of the circle's tangent. Making connections between objects, events, situations, and thinking about where and how they affect each other is one of the basic elements of mathematical thinking.

From some previous studies, researchers only examined aspects of some of the students' mathematical connections in solving mathematical problems, so they did not explore students' abilities in detail in accordance with their knowledge so that students' didactic transpositions can be well connected and directed and also researchers did not provide some stimulus to provoke knowledge and understanding of the students only but there needs to be a good understanding connection because a deep understanding of mathematical knowledge is needed but it is not enough to teach mathematics (Turnuklu & Yesildere, 2007; Bingöbali & Coşkun, 2016).

Recommendations

For Further Studies

This study examines the connection ability of students who have high, medium and low abilities in solving geometry problems using transposition studies, transposition studies regulate how students connect the abilities needed previously using problem solving solutions and tangent relationships.

Factors that influence students' mathematical connections are concept understanding, procedural fluency, supported strategic competencies, student memory, problem solving abilities, students' ability to see the relationship between concepts and rules in mathematics and policy reinforcement, so that in the learning process educators need to increase workmanship questions that require mathematical connection skills and pay attention to indicators of connection ability based on transposition studies. for further study of the connection and understanding of knowledge needed previously the knowledge gained from connections and good understanding will be the basis in

the development of new knowledge, while also studying the ability of students' connections by providing more problem-solving solutions to better support their connections.

For Applicants

As a result of this study, students' connection skills relate to previous students' knowledge, the better the ability they have before, the better the students' connection skills in solving mathematical problems, so that with more practice in problem solving will teach students the talent better in problem solving mathematics.

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Biodata of the Author

Nanang DIANA, S.Pd., M.Pd, Was born in Tambe-Bima July 25, 1985. Bachelor degree was taken in 2004-2008 in the mathematics education program IKIP Mataram, Master degree was taken in 2011-2013 in the mathematics education study program at Surabaya University and is now completing a doctoral program in mathematics education at the Indonesian Education University in 2017. Working as a lecturer in the Mathematics education study program at STKIP Taman Siswa Bima and is able to take a course in Real Analysis, Plane and Three-Dimensional analytic geometry, and Transformation Geometry. Books that have been published and possess IPR are Buku Teori Bilangan (Numbers Theory Books) and Buku Model-Model Pembelajaran (Learning Models Books). **Affiliation:** Student Indonesian Education University, Bandung and Lecture STKIP Taman Siswa Bima **E-mail:** diana.nanang@yahoo.com nanangdiana_mathematics@upi.edu. **ORCID number:** 0000-0001-9458-1990 **Phone:** (+62) 82340516464 **SCOPUD ID:** - **WoS ID:** -

Prof. Dr. Didi SURYADI, M.Ed**,** was born in Tasikmalaya on February 1, 1958. He had graduated from his Bachelor degree at IKIP Bandung in 1978-1983, Master Degree at La Trobe University in 1994-1996 and completed his Doctoral Program at the Indonesian Education University in 2001-2005. He served as a Lecturer at the Indonesian Education University and currently served as a chairman of senate of Indonesian Education University. Some researches and services have been published and several books have been published, one of the most recent is DDR research. Finally, in November 2019, he won an award as the Academic Leader from Kemenristekdikti. **Affiliation:** Indonesian Education University, Bandung **E-mail:** ddsuryadi1@gmail.com **ORCID number:** 0000-0003-0871-8693 **Phone:** (+62)8122417773 **SCOPUD ID:** 57190302080 **WoS ID:** -

Dr. Jarnawi Afgani DAHLAN, M.Kes. Was born in Sumedang on May 11, 1968. Undergraduate education at IKIP Bandung in 1985-1990, S2 at Airlangga University in 11996-1998 and completed his Doctoral program at the Indonesian Education University in 1999-2004. Now serves as a Lecturer of Civil Servants at the Indonesian University of Education in the Indonesian Education Study Program. Aside from being a teacher, he also focuses on various researches that have been widely publicized. **Affiliation:** Indonesian Education University, Bandung **E-mail:** afgani_lan@yahoo.com/jarnawi@upi.edu **ORCID number:** 0000-0002-9290-7755 **Phone:** (+62)8156089141

SCOPUD ID: 57193867557 **WoS ID:** -

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