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The mathematical problem solving ability of student on learning with Thinking Aloud Pair Problem Solving (TAPPS) model in term of student learning style

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Abstract

The purposes of this research were to find out the mathematical problem solving ability on learning with TAPPS model and to find out how the description of mathematical problem solving ability on TAPPS model in terms of learning style. This mixed methods research used concurrent embedded design. The population in this research was eighth-grade students of SMP N 4 Kudus in the academic year of 2016/2017. The sample was chosen by using random sampling technique, it obtained that VIIIA as experimental class and VIIIB as control class. The results of the research showed that (1) the mathematical problem solving ability on learning with TAPPS model achieved classical mastery, (2) the mathematical problem solving ability on learning with TAPPS model was better than expository model, (3) the students' ability in mathematical problem solving with a visual learning style had good category at the stage of devising a plan and the other stage had enough category, otherwise students with an auditorial learning style had enough category at the stage of looking back and another stage had good category, and students with a kinesthetic learning style had good category at the stage of understanding the problem and the other stage had enough category and less category.

1. Introduction

Mathematics is a science that is able to form and advance the attitudes and power of human mind underlying the development of modern technology. Mathematics is learned in every level of education, ranging from kindergarten, elementary school level to college. To know and create technology in the future, strong mathematics is needed early on (Peraturan Menteri Pendidikan Nasional Nomor 22 Tahun 2006). Therefore it is natural that the mathematics subject plays an important role in all areas of human life.

According to BSNP (2006), the purpose of studying mathematics is to be able to make the students have the ability, such as: (1) understanding the concept of mathematics, explaining the interconnection between concepts and applying concepts or algorithms flexibly, accurately, efficiently and appropriately, in problem solving, (2) reasoning in patterns and traits, performing mathematical manipulations in generalizing, compiling evidence, or explaining mathematical ideas and statements, (3) solving problems including the ability to understand problems, design mathematical models, solving models and interpreting solutions obtained, (4) communicating ideas with symbols, tables, diagrams or other media to clarify circumstances or problems, (5) having an appreciation of the benefit of mathematics in life, that is to have curiosity, attention, and interested in learning mathematics, and a tenacious attitude and confidence in the solution problem. In addition, the objectives of learning mathematics according to the National Council of Teachers of Mathematics (NCTM, 2000) are: (1) learning to communicate (mathematical communication), (2) learning to reason (mathematical reasoning), (3) learning to solve problems mathematical problem solving), (4) learning to associate ideas (mathematical connections), (5) the formation of positive

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attitudes toward mathematics (positive attitudes toward mathematics).

Based on the purposes of learning mathematics, problem solving ability is one of the abilities that must be possessed by students in learning mathematics. According to Manalu, as quoted by Nugroho et al (2013), the ability to solve mathematical problems is very important for everyone, not only because most of human life will deal with the problems that need to be solved, but solving problems, especially those that are mathematical, can also help someone to improve their analytical power and to solve problems in other situations.

Students can be said to have problem solving skills if the student is able to meet the four indicators that exist in the problem solving that are the ability to understand the problem, the ability to plan the problem, the ability to solve problems, and the ability to interpret the solution. Therefore, problem solving skills are a very important part of mathematics learning.

However, in fact the ability to solve mathematical problems has not been maximally developed at the schools in Indonesia, one of them is SMP Negeri 4 Kudus. Problem-solving skills can be seen as one of the learning processes and outcomes. Based on observations and interviews with mathematics' teachers at SMP Negeri 4 Kudus, most of them said that students' mathematical problem solving skills was still not enough. According to the researcher of observation during the Praktik Pengalaman Lapangan (PPL) at SMP Negeri 4 Kudus, when students were given the story related to mathematics, the students tend not to solve the problems. This shows that students' ability in solving mathematical problems was still low. This was also affecting the final test result in first semester at the eighth grade in the academic year of 2016/2017 which showed the students' average score was only 57.31 out of standard minimun criteria (75). And then only 40 students who passed the standard minimun criteria from 313 students total.

There are several factors that influence the high and low mathematical ability of the students, including internal factors and external factors. Internal factors include the level of intelligence, students' early skills, student attitudes, talents, interests, student motivation of a lesson, activities, and ways (style) of learning. While external factors include learning environment, supporting infrastructure, teachers, and teaching methods provided. These factors are often inhibiting and supporting the success of students, including students' learning styles.

According to Unaifah & Suprapto (2014), learning styles have an effect on opinion (2014), the reason researchers review the learning style, because each student has a different way of thinking in solving the problem, this is allegedly influenced by the learning style. This study uses the learning style of DePorter (2008) which is a visual learning style, auditorial, and kinestetik or commonly known as VAK. In relation to learning, learning style research is necessary to determine appropriate models, approaches, strategies, and learning methods to accommodate the overall learning style of the students.

Efforts to improve student's mathematical problem solving skills can use Thinking Aloud Pair Problem Solving (TAPPS) model. The TAPPS model incorporates two instructional models namely problem-solving learning model and cooperative learning model to enable students to produce excessive understanding.

One of the research that supports the selection of TAPPS model as an appropriate strategy to help students improving their mathematical problem solving skills is Handayani et al (2014) study, which concludes that the ability of mathematics communication of students of grade XI IPA SMAN 10 Padang who were using Think Aloud Pair Problem Solving (TAPPS) was better than students' mathematical communication skills who using conventional learning methods. One of the advantages of the TAPPS model based on the listener role mentioned by Stice (1987) can be concluded that the TAPPS model provides monitoring for students in practicing problem-solving strategies through pairs of activities. In addition to the hard thinking activity, TAPPS model provides an opportunity for students to practice verbal skills, thoroughness in solving problems, and foster courage to express their thoughts.

The students' mathematical problem solving skills that are still low need to be studied further. Especially when it is viewed from different learning styles of students. For that reason, there is a need for further research on students' mathematical problem solving abilities in learning with Thinking Aloud Pair Problem Solving (TAPPS) model in terms of student learning style.

The formulation of the problem in this research are: (1) Is the students' mathematical problem solving ability with TAPPS learning model can achieve mastery? (2) Is the student's mathematical problem solving ability with TAPPS learning model better than the student with Expository learning model? (3) How is the student's mathematical problem solving ability with TAPPS learning model in terms of student learning style?

2. Methods

The research method used in this research was the combination research or mixed methods. According to Sugiyono (2016), combination research method is a research method that combines quantitative method and qualitative method to be used together in a research activity, so that the obtained data are more comprehensive, valid, reliable and objective.

The research design used concurrent embedded design (unbalanced mixture). According to Sugiyono (2016), the combination method of concurrent embedded design is a research method that combines both qualitative and quantitative research methods by mixing the two unbalanced methods. In this study, the probability of using quantitative methods was 70% and 30% for qualitative methods. Basically the study of the combination of qualitative data was used as complement of the quantitative data.

The population used in this research were the students of class VIII SMP Negeri 4 Kudus of the academic year 2016/2017. Sampling in this research was done by simple random sampling technique. It was obtained from two classes as a sample class, namely class VIII A as experimental class given learning with TAPPS model and class VIII B as a control class given learning with Expository model.

The methods used to obtain the data were questionnaires, interviews, tests, and documentation. The questionnaire method was used to know and obtain data about the students' type of learning style. Interview method was used to collect data about students' mathematical problem solving abilities with TAPPS model in terms of learning style. The test method was used to get data about students' mathematical problem solving skills either by using TAPPS model or with Expository model. Documentation method was used to obtain written data or drawings about student's list of names, number of students, photos of student activities and other data which were used for research purposes.

The steps which were undertaken in this study was taking the score of mathematics final exam semester gasal class VIII year 2016/2017, then analyzing with two-equity test average to know that students had the same ability before the research. Before conducting the learning in the experimental class and control class, the students' were tested on mathematical problem solving skills in the experimental class to know the validity of the item, the reliability of the problem, the difficulty of the item, and the differentiator. Afterwards the learning in the experimental class and control class was carried out. At the beginning of the meeting in the experimental class at break time, a questionnaire was filled with learning style questionnaires. After conducting the learning, the students were tested on mathematical problem solving abilities in the experimental class and control class. Furthermore, the test results of students' mathematical problem solving ability were analyzed by z test and t test. z test was to find out whether the students 'mathematical problem solving ability with TAPPS model reached a total of 75%, and t test to find out whether students' mathematical problem solving ability with TAPPS model was better than expository model. After it was done, the data analysis of type of learning style questionnaire of experimental class students obtained students group who have visual, auditorial, and kinesthetic learning styles. Then the subject of research was determined, ie 2 students for each learning style. Further interviews were conducted on each subject. After that, the written test subject data with interview data were compared. Lastly, making analysis to draw the conclusions and describe student's mathematical problem solving abilities with TAPPS model in terms of learning style.

3. Results and Discussion

Analysis of preliminary data is done to determine the initial state of the sample class whether it comes from the same state. The preliminary data is taken from the final test semester of mathematics at the eighth grade of SMP Negeri 4 Kudus in the academic year of 2016/2017 for experimental class, control class, and experiment class. The preliminary data analysis contain all the tests performed on preliminary data i.e. normality test, homogeneity test, and equality test of two averages.

Based on preliminary data analysis, it is known that the two sample groups have the same initial capability. Further experiments or treatment. The treatment given in the experimental class is the learning with the TAPPS model. While in the control class is learning with expository model. After all the treatments have been done, students are given a problem-solving test. The data obtained from the test results are then tested to determine whether the results match the expected hypothesis. The result of descriptive analysis of the data test of mathematical problem solving ability on the surface area and prism volume as well as the upright peak can be seen in Table 1.

From the calculation of normality test the final data of the experimental class obtained results ${X^2}_{result} = 4{,}94$ and ${X^2}_{table} = 11{,}1$, then ${X^2}_{result} < {X^2}_{table}$ meaning that the experiment class data is normally distributed. From the calculation of normality test, the final data of the control class obtains results and , then , meaning that the control class data is normally distributed.

Homogeneity test gives results ${X^2}_{result} = 0{,}898$ and ${X^2}_{table} = 3{,}84$. Because ${X^2}_{result} < {X^2}_{table}$, the final data has the same or homogeneous variant.

Furthermore, the hypothesis test is performed by the test of completeness using one-party proportion test, this test is to find out whether the problem solving ability of mathematical students who are taught using TAPPS model can achieve classical mastery or not. In this case, it is said to fulfill classical completeness if more than 75% of the students in the class get the score at least or more than 75.

The criteria uses rejected if $Z_{result} \geq Z_{0,5-\alpha}$. Based on the results of the study, for $= 5\%$, obtained $Z_{0,5-\alpha} = 1{,}64$. Because $Z_{result} \geq Z_{0,5-\alpha}$ then $2{,}57 > 1{,}64$ so H_0 is rejected and H_1 is accepted. So the students' mathematical problem-solving abilities with the TAPPS model have reached a classical mastery.

To find out whether the mathematical problem solving ability of the students with TAPPS model is better than the expository model, we test the difference of two average and test the difference of two proportions. A two-averaging difference test was performed to determine whether the average mathematical problem-solving test results of the students' flat-sided learning materials taught using the TAPPS model were better than those taught using the expository model.

Criteria testing accepts H_0 if $t_{result} \geq t_{table}$ ($\alpha = 5\%$ and $dk = n_1 + n_2 - 2$). Based on the research results obtained $t_{result} = 2{,}098$ and $t_{table} = 1{,}99$. Because $t_{result} \geq t_{table}$ then H_0 rejected. So the average grade of mathematical problem solving ability of the TAPPS model class is better than the average grade of mathematical problem solving ability of the expository model class students.

Table 1. Descriptive Research Results

No	Descriptive statistics	Experiment Class	Control Class
1	Number of Students	34	34
2	Highest Value	92,72	90,9
3	Lowest Value	65,45	58,18
4	Average	83,04	80,26
5	Standard deviation	5,85	6,91
6	Variance	34,28	47,71

Whereas the difference test of two proportions are to find out whether the completion percentage of mathematical problem solving ability of building the flat side room of the students taught using TAPPS model is bigger than the students who are taught using expository model have been done.

The criterion which is used is rejected H_0 if $Z_{result} \geq Z_{0,5-\alpha}$ with significance level $\alpha = 5\%$. Based on the research results, obtained value $Z_{result} = 1{,}79$ and $Z_{table} = 1{,}64$. Because $Z_{result} > Z_{table}$ that is $1{,}79 > 1{,}64$ then H_0 rejected. So the percentage of students' completeness in the class using the TAPPS model is greater than the students in the class using the expository model.

Based on the calculation of the test difference of two mean and test difference of two proportion obtained by conclusion shows that student's mathematical problem solving ability with TAPPS model is better than student with expository model.

Filling the questionnaire learning style by the experimental class students is conducted for the purpose of classifying the learning style of students. The event was held at the first meeting on Saturday, May 6, 2017 at the first hour break. Students who followed the questionnaire as many as 33 students, because 1 student was outside the class to follow other activities. Furthermore, for one student was asked to fill out a questionnaire at second break time. Before carrying out the questionnaire, the teacher gave the direction of filling the questionnaire. After the students completed the questionnaire of each learning style, the teacher asked again to collect the learning style questionnaire.

Data obtained from learning style questionnaires are analyzed in accordance with the learning style questionnaire assessment guidelines. The following table presents the experimental class learning outcomes in Table 2.

Based on Table 2, it is found that there are students who occupy each visual, auditorial, and kinesthetic learning style. Students who have visual learning style are 9 students (26.5%), students who have auditorial learning style are 10 students (29.4%), students who have kinesthetic learning style are 12 students (35.3%), students with a visual-kinesthetic learning style are 2 students (5.9%), and whereas students who have auditorial-kinesthetic learning style is 1 student (2.9%).

After knowing the learning styles of students, researchers determine the subject of research at the beginning of learning. Selected subjects are 20% of each learning style, 2 subjects for visual learning styles, 2 subjects for auditorial learning styles, and 2 subjects for kinesthetic learning styles.

Interviews are conducted to obtain information about student's mathematical problem solving abilities. The interview is conducted on the basis of agreement between the research subjects and the researcher on Monday, May 29, 2017 and on May 30, 2017 break time and after school, so as not to interfere with teaching and learning activities in the classroom.

At the time of the interview, the research subjects are able to explain their way of good thinking and accompany with clear reasons. So that it can obtain the information about mathematical problem solving ability of each research subject.

Analysis of mathematical problem solving abilities of each subject is based on the stages of mathematical problem solving skills that have included indicators of mathematical problem solving abilities. A summary of the problem-solving abilities of mathematical learning styles is presented in Table 3.

The description of students mathematical problem solving abilities with TAPPS model in terms of visual learning styles at the understanding stage of the problem; students with incomplete visual learning styles write down information that is known and asked, but has been able to explain the problem of using the language and sentence itself. So students with visual learning styles are still in enough categories to understand the problem. At the planning stage of completion, students with visual learning styles are able to write the plan correctly and completely. So students with visual learning styles are including in the good category for planning the settlement. At the stage of carrying out the completion plan, students with visual learning styles are quite capable in implementing problem-solving steps and formulas that have been planned but are incomplete and incorrect. So students with visual learning styles are still in enough categories to implement the completion plan. This is in accordance with research Tiffani (2015) that someone with visual learning style write down the initial results of information processing but because the processing is less precise then result in the end is wrong. At the re-examining stage, students with visual learning styles have not done a re-examination of the plans and calculations that have been done but are able to write down the conclusions obtained. Therefore, students with visual learning styles are still in enough categories to check back.

The description of students' mathematical problem solving abilities with TAPPS model in terms of auditorial learning style at understanding comprehension stage; students with auditorial learning styles are able to write down information that is known and asked correctly and completely, also able to explain problem using language and sentence. So students with auditorial learning styles are already in good category to understand the problem. This is in accordance with Indrawati's (2017) study that a person with an auditorial learning style can correctly state what is known from the problem by using his own language. At the planning stage of completion, students with auditorial learning styles are able to write the plan correctly and completely. So students with auditorial learning styles are included in the good category for planning the settlement. At the stage of carrying out the completion plan, students with auditorial learning styles are capable in implementing well-planned and complete troubleshooting steps and formulas. So that the student with the auditorial learning style is already in the good category to implement the settlement plan. At the re-examining stage, students with auditorial learning styles have not done a re-examination of the plans and calculations that have been done but are able to write down the conclusions obtained. Therefore, students with auditorial learning styles are still in enough categories to check again.

The description of students' mathematical problem solving abilities with the TAPPS model in terms of kinesthetic learning style at the understanding stage of the problem; students with kinesthetic learning styles are able to write down information that is known and asked correctly and completely, also able to explain the problem with the language and the sentence itself. Therefore, students with kinesthetic learning styles are already in good category to understand the problem. This is in accordance with DePorter & Hernacki (2008) that a person with a kinesthetic learning style will use his finger as a guide in reading. So he is able to name the information that is known completely. At the planning stage of completion, students with kinesthetic learning styles are able to write down plans but are incomplete. As a result, students with kinesthetic learning styles are still in the sufficient category to plan the settlement. At the stage of carrying out the completion plan, students with kinesthetic learning styles are capable of implementing problem-solving steps and formulas that have been planned but are incomplete and incorrect. As a result, students with kinesthetic learning styles are still in enough categories to implement the completion plan. At the re-examining stage, students with kinesthetic learning styles have not done a re-examination of the plans and calculations that have been done but are able to write down the conclusions obtained but incorrectly. Therefore, students with visual learning styles are still in the category of less to check back.

4. Conclusions

Based on the result of the research and discussion, it is concluded that (1) the students’ ability of solving the mathematical problem by learning the model of Thinking Aloud Pair Problem Solving on the building of the flat side of the prism and the upright limas can achieve standard minimun criteria, so that at least 75% of students get score more than or equal to 75 with the percentage of completeness is 94.12%; (2) students' mathematical problem-solving abilities was taught by the Thinking Aloud Pair Problem Solving model are better than those taught by expository models; and (3) students' mathematical problem-solving skills with each learning style can be categorized (1) adequately categorized visuals at the stage of understanding the problem, implementing a settlement plan, and re-examining, and categorizing both at the planning stage of completion; (2) auditorial categorized either at the stage of understanding the problem, planning the problem, and implementing the settlement plan, as well as sufficient categorizing at the re-check stage; and (3) kinesthetic categorized either at the stage of understanding the problem, sufficient categorization at the planning stage of completion and implementing the settlement plan, and categorized less at the re-check stage.

Table 2. Result of Question of Class VIII-A

Learning Styles	Total students
Visual	9
Auditorial	10
Kinesthetic	12
Visual-Kinesthetic	2
Auditorial-Kinesthetic	1
Total	34

Table 3. Summary of Troubleshooting Capabilities Mathematically Reviewed from Style Learning

Problem Solving Stage	Visual	Auditorial	Kinesthetic
Understanding The Problem	Enough	Good	Good
Devising a Plan	Good	Good	Enough
Carrying Out The Plan	Enough	Good	Enough
Looking Back	Enough	Enough	Less

Suggestions that can be recommended by researcher are (1) SMP Negeri 4 Kudus mathematics teacher can use TAPPS model as one of alternative learning in improving students' mathematical problem solving ability on construct of flat side side of prism and upright peak; (2) the TAPPS model should be used in other mathematical material that has the same characteristics as the flat-side building material so that students can improve their mathematical problem solving abilities; (3) at the beginning of learning using the TAPPS model the teacher should explain the learning stage in detail to the students so that students are not confused during the learning process; and (4) in this study, the researcher finds the fact that the level of achievement of students' mathematical problem solving abilities with different learning styles have different achievements, so it is suggested to do further research that discussion to improve the ability of problem solving mathematically.

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

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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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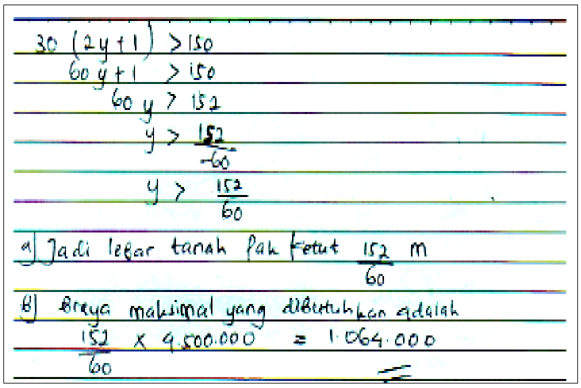

Figure 1. Example one of Student's work related to Problem Solving Ability

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 α = 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.

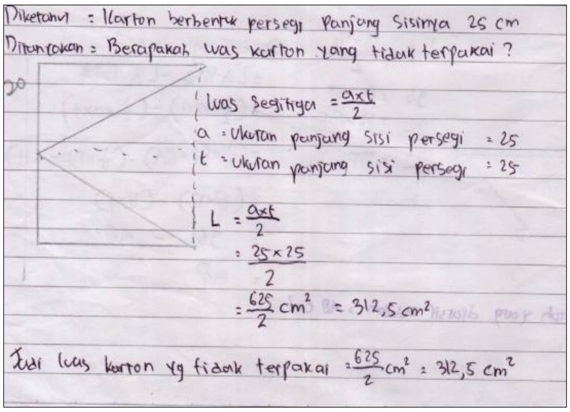

Figure 2. Subject Analysis's Work of Problem Solving Task

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 $312.5 cm^2$. 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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The effectiveness of auditory intellectually repetition learning aided by questions box towards students' mathematical reasoning ability grade XI SMA 2 Pati

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Abstract

The objective of this study is to determine does the AIR learning is effective towards students' mathematical reasoning ability grade XI SMA 2 Pati on the sequence and the series material. The population in this study is all students grade XI SMA 2 Pati Academic Year 2016/2017. The method used in this study is quantitative method. While the data collection includes test methods, questionnaires, and observations. The results showed that: (1) the mathematical reasoning ability of students grade XI SMA 2 Pati who learn with AIR learning model is reaching the mastery learning; (2) the mathematical reasoning ability of students grade XI SMA 2 Pati who learn with AIR learning model aided by Questions Box is reaching the mastery learning; (3) the mathematical reasoning ability of students grade XI SMA 2 Pati who learn with AIR model aided by Questions Box is better than the mathematical reasoning ability of students who learn with AIR learning model and expository learning model; (4) the mathematical reasoning ability of students grade XI SMA 2 Pati who learn with AIR model aided by Questions Box is better than the mathematical reasoning ability of students who learn with AIR learning model and expository learning model for each group, either low, medium or high. Based on the four results of the above research, it can be concluded that the AIR learning aided by Questions Box is effective towards students' mathematical reasoning ability grade XI SMA 2 Pati on the sequence and series material.

1. Introduction

Mathematics is a science derived from the results of human thought and learned by reasoning. Depdiknas, as quoted by Shadiq (2004), states that mathematical material and mathematical communication and mathematical reasoning have a very strong and inseparable linkage. Mathematical material can be understood and communicated through reasoning. While reasoning is understood and enhanced through learning mathematical material.

Regulation of National Education Ministry (Permendiknas) number 22 in 2006 states that the mathematics lesson goals are students are expected to have ability: (1) to understand the concepts of mathematics, explain correlations and apply concepts of algorithms, flexibly, accurately, efficiently and appropriately solve the problems; (2) use reasoning in patterns and traits, performe mathematical manipulations in generalizing, collecting evidences, or explaining mathematical ideas and statements; (3) solve the problems that include the ability to understand problems, design mathematical models, solve models and interpret the solutions obtained; (4) communicate the ideas with symbols, tables, diagrams, or other media to clarify circumstances or problems; and (5) have an appreciative attitude to the use of mathematics in life, and also a curiosity, attention, and interest in learning mathematics, as well as a tenacious attitude and confidence in problem solving.

According to Mueller & Maher (2009), reasoning is a process that allows to review and rebuild previous knowledge in order to build new arguments. Ross (in Lithner, 2000) says that one of the most important goals of mathematics course is

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to teach student a logical reasoning. In fact, Ball, Lewis & Thamel (in Burais, Ikhsan, & Duskri, 2016) add that mathematical reasoning is the foundation for the construction of mathematical knowledge. With the ability of mathematical reasoning, students can also decide better decisions by collecting the facts and considering the consequences of the various options (O'Connell, 2008). Therefore, students' reasoning which is one of the abilities that must be possessed by students in learning mathematics, should be more paid attention by the teacher.

The indicators of mathematical reasoning ability used in this study are (1) the ability to find patterns or properties of mathematical phenomena to generalize; (2) the ability to file conjectures; (3) the ability to arrange the proof, give a reason or proof to the truth of the solution; (4) the ability to do mathematical manipulation; (5) the ability to make a conclusions from the statements; (6) the ability to check the validity of an argument (Wardhani, 2010).

According to TIMSS data in 2015, Indonesia was ranked 45 from 50 countries with a score of 397. While according to PISA results in 2015, Indonesia was ranked 62 from 70 countries with a score of 386 (OECD, 2015). Based on two results, it is shown that Indonesian students' mathematics skills for Elementary School (SD/MI) and Junior High School (SMP/MTs) are not satisfactory on the international level. Again, according to Wardani & Rumiyati (2011), the results of TIMSS and PISA's low evaluations are certainly caused by several factors. One of them is Indonesian students are generally poorly trained in solving the problems tested in TIMSS and PISA, which are contextual, demanding reasoning, argumentation and creativity in the settlement. It means that students in SD/MI and SMP/MTs have not been able to optimally engage their mind and creativity, so that they have difficulties in solving problems related to reasoning.

With regard to above explanation, if the mathematics ability of students in elementary and junior high school is still low, it is assumed that students' mathematics ability in the next education level is also low due the basic concept of mathematics builds hierarchy in a more complex structure (Suyitno, 2014). In addition, its learning follows spiral method which means that in each new mathematical material introduction, it is necessary to pay attention to what previous students have learned. A new knowledge is always associated with what has been learned (Suherman, 2003). This is also expressed by Hudojo (2005), who adds that learning is an active process in gaining experience or new knowledge from what has been previously learned.

Based on the result of mathematics national exam of SMA 2 Pati for three years in a row, it means that the average value has decreased significantly as presented in the following table 1.

Table 1. The average value of mathematics national exam

Study Program	Academic Year		
	2013/2014	2014/2015	2015/2016
Science	77,00	66,26	65,32
Social	75,00	76,24	64,61

Based on the observation results, the teacher has given enough stimulus, yet in fact the students are still difficult to present an assumption and draw conclusions from the stimulus-stimulus given. As a result, when they are asked to solve problems that require reasoning, the teacher must lead them back in the process. In fact, from the interview results, students are only oriented to the results of learning regardless of their reasoning abilities in solving problems and still focused on the formula. This indicates that the indicators of ability to guess, the ability to perform mathematical manipulation, and ability to draw conclusions have not been found in the students of SMA 2 Pati. Therefore, a mathematics learning model is needed to support the indicator.

One model that allegedly can motivate, encourage, and support the achievement of students' mathematical reasoning abilities in a lesson is the Auditory Intellectually Repetition (AIR). AIR model is one of the learning models that emphasizes three aspects, namely auditory, intellectually, repetition. First, the auditory implies that in the learning process, students use the five senses in terms of listening, giving opinion, and responding to the results of the discussion. Second, intellectually implies that the ability to think, need to be trained through the process of reasoning, creating, solving problems, constructing, and applying. Third, repetition implies that in learning needs a repetition in order the concept which is taught easily to be accepted and deeply understood through the work of questions, assignments or quizzes (Latifah & Agoestanto, 2015).

Moreover, in the AIR learning model syntax, there are several stages that must be implemented so that the learning objectives can be achieved, including the delivery stage, the training phase and the result presentation (Dave, 2002). At the delivery stage, teachers provide contextual issues that stimulate students to guess. In the training phase, teachers direct and facilitate students to engage in intellectual activity packaged in group discussions (3-4 students) and in which students have the opportunity to express opinions, gather information, problems (auditory and intellectually). While at the results presentation stage, students are asked to conclude and apply new knowledge which is gained through the work of the problem individually (repetition). Therefore, by using the AIR model, it is also expected being able to improve students' mathematical reasoning abilities.

In addition, the use of varied media is also required by teachers when teaching process. Syahlil (2011) argues that the Questions Box is one of media which is expected to help students during the learning process to stimulate students' emotional and intellectual involvement in proportion. Basically, learning activities using Questions Box media is divided into three stages: group orientation, work in group, and collective evaluation (Syahlil, 2011). In the work in group stages, students conduct discussion activities to solve problems according to the questions which are taken from the Questions Box. While the teacher only acts as a facilitator for each group. He/she monitors the student's learning activities, provides assistance when it is necessary, fosters the student's skills in guessing, manipulating mathematics, and estimating the appropriate strategy as the solution of the question.

Above all, the objective of this study is to determine does the AIR learning is effective towards students’ mathematical reasoning ability grade XI SMA 2 Pati on the sequence and the series material.

2. Method

The method of this study is quantitative method. The data collection includes test methods, questionnaires, and observations. Furthermore, this study used the experimental design of True Experimental Design with Posttest-Only Control Design. In this design, there are three groups selected randomly. The first group received treatment in the form of AIR model learning as the 1st experiment class. The second group received treatment in the form of learning with AIR model with the help of Questions Box as the 2nd experiment class. While the third group did not get special treatment or commonly referred to as control class. After getting different treatment, the three classes were given posttest to know the students' mathematical reasoning ability in the three samples.

The study was conducted at SMA 2 Pati academic year 2016/2017. The population in this study were all students of class XI with XI-Science 2, XI-Science 3, and XI-Science as 4 study samples. The sampling was done by cluster random sampling technique. While the statistical test used is the proportion test π one tailed, one way anova test and LSD advanced test with the help of SPSS 16.0 program.

3. Result & Discussion

The data processing is conducted in order to know the effectiveness of AIR learning through Questions Box on students’ mathematical reasoning ability which is done in three steps. The first step is to test the proportion of a student to test his/her mathematical reasoning ability by using AIR learning model along with Questions Box. The second step is to test one way anova and further continued by LSD test to find out the difference of students’ mathematical reasoning ability who learn with AIR learning along with Questions Box, with AIR learning model, with expository learning model. Eventually, it is done to know which one is the best. The last step is to test one way anova and LSD advanced test to find out the difference of students’ mathematical reasoning ability who learn with AIR learning model along with Questions Box, with AIR learning model, with expository learning model for each group based on initial ability mathematics level and in the end to know which one is the best.

The π proportion test is done by using the Ms Excel program. The results of this test can be seen in the following table.

Table 2. The Result of The π Proportion Test

Class	$z_{(0,5-\alpha)}$	z_{calc}	Conclusion
1st experiment	1,645	1,981	$z_{calc} > z_{(0,5-\alpha)}$
2nd experiment	1,645	2,363	$z_{calc} > z_{(0,5-\alpha)}$

Based on the table, the z_{calc} value for the 1st experiment class is 1,981 and the z-count for the 2nd experiment class is 2,363. While the value of z_{table} is found by using standard normal distribution table with the level of significance (0, 5- α). It is obtained that z_{table} value is 1,645. Because $z_{calc} > z_{(0,5\ -\ \alpha)}$, then H0 is rejected. It means that the percentage of the 1st experiment class and the 2nd experiment students who achieve a mastery are over 75%. Meanwhile, one way anova test and LSD is assisted by SPSS 16.0 for windows. Its results can be seen in the following table.

Table 3. The Result of One Way Anova Test

ANOVA

VALUE	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1.820,96	2	910,48	15,74	,000
Within Groups	6.074,03	105	57,85		
Total	7.894,99	107			

Table 4. The Result of LSD Test

Comparison of Sample Group	Mean Difference	Sig.	Decision
2nd experiment > 1st experiment	4,833	0,008	significant
1st experiment > control	5,222	0,004	significant
2nd experiment > control	10,056	0,000	significant

Based on tables above, the significance value in the anova test is 0,000. Since the significance value is less than 0, 05, then H_0 is rejected. It means that there is a significant average difference between the control class, the 1st experiment class, and the 2nd experiment class. To find out which one is the best, then the LSD advanced test is done. The result of the test shows that the average value of mathematical reasoning ability of the 1st experiment class and the control clas are significantly difference. The average value of mathematical reasoning ability of the 2nd experiment class and the control class are also significantly difference. Meanwhile, the average value of the mathematical reasoning ability of the 1st experiment class and the 2nd experiment class are also significantly difference. It shows that students' mathematical reasoning abilities using AIR learning model along with Questions Box are better than students' mathematical reasoning abilities using AIR learning models and expository learning models. In other words, the use of the AIR learning model along with Questions Box can improve students' mathematical reasoning abilities.

To find out whether students' mathematical reasoning ability who learn with AIR learning model along with Questions Box, with AIR learning model, and with expository learning model for the low, medium, and high groups, further one-way anova and LSD-test are also tested. From the calculation result of one way anova test for each group, the value of significance in anova table is 0.001; 0,000; and 0,001. Because the significance value of each group is less than 0.05, then H_0 is rejected. It means that there is a significant mean difference between the control class, the 1st experiment class, and the 2nd experiment class for the low, medium, and high groups.

Besides, to find out which the best learning model of mathematical reasoning ability for each group, LSD test is done and it is obtained that the average value of mathematical reasoning ability of 1st experiment class and control class are significantly difference, so the 2nd experiment class and the control class are. Meanwhile, the mean value of the mathematical reasoning ability of the 1st experiment class and the 2nd experiment class are significantly difference. It applies to low, medium, and high groups as presented in the following Tables 5, 6 and 7.

Table 5. The Result of LSD Test for Low Group

Comparison of Sample Group	Mean Difference	Sig.	Decision
2nd experiment > 1st experiment	8,833	0,016	significant
1st experiment > control	7,167	0,043	Significant
2nd experiment > control	16,000	0,000	Significant

Table 6. The Result of LSD Test for Medium Group

Comparison of Sample Group	Mean Difference	Sig.	Decision
2nd experiment > 1st experiment	3,583	0,042	significant
1st experiment > control	4,958	0,006	significant
2nd experiment > control	8,542	0,000	significant

Table 7. The Result of LSD Test for High Group

Comparison of Sample Group	Mean Difference	Sig.	Decision
2nd experiment > 1st experiment	5,833	0,011	significant
1st experiment > control	4,333	0,049	significant
2nd experiment > control	10,167	0,000	significant

Based on the tables above, it can be concluded that students' mathematical reasoning abilities using AIR learning model along with Questions Box is better than the AIR learning model and expository learning model. Not only as a whole but also for low, medium and high groups.

Based on the students' test results from the three classes, there are also differences in how and the results of the test questions of mathematical reasoning ability are. The assessment of students' mathematical reasoning abilities is based on predetermined indicators which had been made in the lattice making. After analyzing student test result based on indicator of mathematical reasoning ability, it is obtained that the percentage of students who meet the six indicators of mathematical reasoning ability is the higher is 2nd experiment class than control class. While, the 1st experiment class is shown in the following table.

Table 8. The Result of Students Posttest Analysis in Control Class, 1st Experiment Class, and 2nd Experiment Class Based On The indicators of mathematical reasoning ability

Indicator	Control	1st experiment	2nd experiment
1	84,19%	87,18%	88,68%
2	87,96%	88,89%	90,28%
3	67,36%	79,17%	80,21%
4	75,84%	84,40%	85,86%
5	78,70%	85,65%	87,50%
6	66,78%	70,95%	80,44%

Meanwhile, the causing factors of the students' average mathematical reasoning abilities difference who received learning with AIR learning model along with Questions Box, AIR learning model, and expository learning models were in both experiment classes, the activities were more centered on the students. They are stimulated at the beginning of learning with challenges about problem solving and activities that lead them to discover a concept, such as arranging matchsticks with different arrangements and cutting folded paper into pieces. As the result, they have prepared the previous learning, so the learning is more effective with the students' readiness. It is line with Hudojo (2005) that the failure or success of learning depends on the students, such as how students' ability and readiness to follow the learning activities of mathematics. While the activities in the control class more focused on the teacher. It means that they are more instrumental in delivering the material.

Based on the analysis of student activity on the observation sheets, it is obtained that the percentage of students in answering the prerequisite question posed by the teacher is less than 50%. It shows that students' readiness to the subject matter still lakes. In addition, in the 1st experiment class and the 2nd experiment class, students are more involved in group discussion activities consisting of 3-4 students. With group discussion activities, they absorb more knowledge, increase the intensity of the thinking process, and have the learning experience to be used as new knowledge. This is in line with the opinion of Vygotsky (Rifa'i & Anni, 2011), that is cognitive abilities derived from social and cultural relations. While in the control class, the discussion that occurred just a discussion between students when the teacher asked something.

Basically, the learning model used in the 1st experiment class and the 2nd experiment class is the same that is the AIR model. AIR learning model is a learning model that optimally involves students' sense and emotional tools and emphasizes on three important aspects of learning, namely auditory, intellectually and repetition. Dave (2002) found that aspects in intellectually in learning will be trained if students are involved in problem-solving activities, analyzing experiences, working out strategic planning, creating creative ideas, searching and filtering information, finding questions, creating mental models, applying new ideas, creating personal meaning and predict the implications of an idea. The difference is only in the learning media used. The 2nd experiment class uses LKS and Questions Box which requires students' activeness to understand and find the concept of sequence and series and apply the concepts in solving complex and varied problems, so they are constantly encouraged to be actively thinking by practicing different reasoning problems and resolution strategies, differ from the Questions Box. While the 1st experiment class only uses LKS only and focuses on the discovery of concept and application of the concept of one problem only. This is in line with Bruner's learning theory (Slameto, 2010) that it requires the active participation of each student through exploration activities, new unknown discoveries or similar notions of familiarity, and a well-recognized diversity of abilities. Thus, the reasoning activity is more formed in the 2nd experiment class.

4. Conclusion

Regarding to above-mentioned description of analysis, it can e concluded that (1) students' mathematical reasoning ability grade XI SMA 2 Pati who learn with AIR learning model has eached the mastery learning; (2) students' mathematical reasoning ability grade XI SMA 2 Pati who learn with AIR learning model along with Questions Box has reached the mastery learning; (3) students' mathematical reasoning ability grade XI SMA 2 Pati who learn with AIR model along with Questions Box is better than those who learn with AIR learning model and expository learning model; (4) students' mathematical reasoning ability grade XI SMA 2 Pati who learn with AIR model along with Questions Box is better than those who learn with AIR learning model and expository learning model for each group, either low, medium or high; (5) the AIR learning along with Questions Box is effective towards students' mathematical reasoning ability grade XI SMA 2 Pati on the sequence and series material.

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Mobile technology in a mathematics trail program: how does it works?

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Abstract

The aim of the study is to explore the potential of the use of mobile technology for supporting mathematics trail program. An explorative study was conducted in of Semarang, Indonesia involving 30 students of SMPN 10 Semarang. The study consisted of an introduction session, a mathematics trail activity supported by the use of mobile phone application session, and a debriefing session. The data collection was done through participatory observation, students' work, and interviews. Afterwards, the results of this study indicate that mathematics trail programs supported by the use of mobile phones have promoted the engagement of students in mathematical activities. The use of mobile technology has the potential to support the program. Mobile app has been able to play a role in guiding students in mathematics trail activities with features offered, such as: navigation features, help buttons, and direct feedback.

1. Introduction

In recent years, several countries have seen an increase in interest in the development of outdoor and adventure education (Fägerstam, 2012; Higgins & Nicol, 2002). Various educational programs conducted outside the classroom are specifically designed to improve student achievement. In addition, integrated programs are also being developed to combine outdoor learning advantages with learning in the classroom. This type of educational program is not a new one. In 1984, Dudley Blaine had developed the concept of mathematics trails as one form of outdoor education by creating a mathematical trail in the centre of Melbourne, Australia (Shoaf et al., 2004). Math trails bring students into the outside the classroom to discover mathematics in the environment with its aim to create the atmosphere of challenge and exploration.

Although the math trail project is not new, the idea of this program supported by mobile technology which is new. This idea is facilitated by the fact that in recent years, developments in mobile technology and mobile phone have significantly improved (Cisco, 2016). These improvements are followed by many mobile phone applications (apps), including those which intend to be used for outdoor activities. However, up until now, most mobile technology apps for mathematics learning have only been employed in regular teaching settings (Trouche & Drijvers, 2010). Even though, in learning activities, mobile devices could be employed to promote the learning in the outside of the classroom (Wijers, Jonker, and Drijvers, 2010).

By combining the concept of math trails with advanced technology in a modern learning environment, we develop a mobile math trail as a new approach to an already well known idea. This approach aims to engage students in mathematics on a math trail programs supported by the use of GPS in mobile phones. Therefore, the overarching aim of the study is to explore the potential of the use of mobile technology for supporting math trail program.

This study is supported by the concept of the math trail program and the use of mobile technology for supporting the math trail program.

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1.1. Math trail

A math trail is a planned route that consists of a series of stops which trail walkers can explore mathematics in the environment (English et al., 2010; McDonald & Watson 2010; Shoaf et al., 2004). It is constructed to improve an appreciation and pleasure of mathematics in daily settings (Blane & Clarke, 1984). Further it can be used as the media for experiencing characteristics of mathematics (Shoaf et al., 2004), namely communication, connections, reasoning and problem solving (National Council of Teacherss of Mathematics, 2000).

Moreover, math trails are designed for everyone, cooperative activities, focusing on the process of problem solving, self-directed, voluntarily, adaptable, and not permanent (Shoaf et al., 2004). Along the trail, the walkers can employ mathematics concepts and discover the varied real problems related to mathematics in the environment (Richardson, 2004, p. 8). They also gain experiences which connect mathematics with other subjects, such as engineering, architecture, geography, art, history, science, economics, etc.

Math trail walkers explore mathematics by following a designed path and solving outdoor mathematical tasks related to what they encounter along the path (English et al., 2010). Such participants need a math trail map or guide to lead them to places where they formulate, discuss and solve interesting mathematical problems (Shoaf et al., 2004). A math trail guide, such as a math trail map or a human guide, also informs walkers about the math trail task stops and shows walkers the problems that exist at each location. A guide also describes the tools needed to solve the problems, so that they are prepared before starting to walk on a trail. Then, on the trail, they can simultaneously solve mathematical problems encountered along the path, make connections, and communicate and discuss ideas with their teammates, as well as use reasoning and skills in problem solving (Richardson 2004).

With the rapid development of mobile technology (Cisco, 2016), it is possible to collect the tasks and design a math trail guide based on a digital map and database. Mobile devices can be used to integrate learning environments and real-life environments which learning can occur in an authentic situation and context (Silander, Sutinen, & Tarhio, 2004). Furthermore, the potential of mobile technology to support outdoor mathematics educational programs must be exploited (Wijers, Jonker, & Drijvers, 2010).

1.2. Mobile technology

In recent years, rapid developments have occurred related to the scope, uses and convergence of mobile devices (Lankshear & Knobel, 2006). These devices are used for computing, communications and information. Cisco (2016) estimates that the total number of smartphones will comprise nearly 50 per cent of all devices and connections globally by 2020 (p. 3). Mobile devices are portable and usually easily connect to the internet from anywhere. These properties make mobile devices ideal for storing reference materials and supporting learning experiences, and they can be general-use tools for fieldwork (Tuomi & Multisilta, 2010).

The portability and wireless nature of mobile devices allow them to extend the learning environment beyond the classroom into authentic and appropriate contexts (Naismith, Lonsdale, Vavoula, & Sharples, 2004). Wireless technology provides the opportunity for expansion beyond the classroom and extends the duration of the school day so that teachers can gain flexibility in how they use precious classroom activities (Baker, Dede, & Evans, 2014). However, in mathematics education, the use of mobile devices is still in the early stages and it is not yet a common practice (Rismark, Sølvberg, Strømme, & Hokstad, 2007).

The use of mobile devices in mathematical activities is expected to occur not only in regular teaching and learning settings, as is the current trend as stated by Trouche & Drijvers (2010), but also outside the classroom setting, as recommended by (Wijers, Jonker, and Drijvers, 2010). Thus, it is necessary to explore the potential of this recent trend in technology use in mathematics learning. Hence, students are engaged in meaningful mathematical activities, such as math trail activities.

In many places around the world, there are special locations where mathematics can be experienced in daily situations and used for math trail activities. However, there are also many places where mathematics problems are hidden in secret. By taking advantages of this benefit of mobile technology, math trail tasks can be localized with GPS coordinates and pinned onto a digital map through a web portal (Jesberg & Ludwig, 2012).

The trail walkers can then access the tasks and run the math trail activity with the help of a GPS-enabled mobile application. The app can be designed as a guide for trail walkers to find the task locations and help them in solving the mathematical problems faced. It shows that this tool can act as a representative of the presence of teachers in facilitating the learning process of mathematics (Cahyono & Ludwig, 2017).

1.3. Statement of research question

Regarding to the background and theretical framework, the research question of this study is how can the mobile technology be used as a supporting tool for running math trail program?

2. Methods

An explorative study was conducted in of Semarang, Indonesia involving 30 students of SMPN 10 Semarang. This study is a part of development research on the MathCityMap-Project for Indonesia. There were two main phases in this research, namely the design phase and the field experimentation phase. There are several studies in both phases.

This study is a part of a study in the second phase that focuses on the exploration of the potential of the use of mobile technology for running math trail activity. The study consisted of an introduction session, a math trail activity supported by the use of mobile phone app session, and a debriefing session. Data were gathered by means of participatory observation, students' work, and interviews.

3. Results & Discussions

In the first phase of the MathCityMap-Project study in Indonesia, technical implementation of the project was formulated, and a mobile app was also created to support the program (Cahyono & Ludwig, 2014). Thirteen math trails containing 87 mathematical outdoor tasks were also designed around the city of Semarang (Cahyono, Ludwig, & Marée, 2015). The authors found mathematical problems that involved objects or situations at particular places around the city. Then they created tasks related to the problems and uploaded them to a portal (www.mathcitymap.eu). In this portal, the tasks were also pinned on a digital map and were saved in the database.

Each task contained a question, brief information about the object, the tools needed to solve the problem, hint(s) if it is necessary, and feedback on answers given. Math trail routes can be designed by connecting a few tasks (6-8) in consideration of the topic, level, or location. In designing the trails, it is also necessary to consider several factors such as: safety, comfort, duration, distance, and accessibility for teachers who would observe and supervise all student activity.

Figure 1. App interfaces (Map: ©OpenStreetMap contributors)

Figure 1 shows the examples of the app's interfaces including an example route, task, feedback, and hint. Math trail routes can be accessed by students via the mobile app, a native app that was created by the research team as part of this project. Installation of a file in *.apk format was uploaded to the portal as well as the Google PlayStoreTM. From there, students could download and install the app which works offline and runs on the Android mobile phone platform.

Further, they can carry out math trail activities. There are several roles of the mobile app in this activity. Through this app, they follow a planned route displayed in the app, discover task locations, and answer task questions related to their encounters at site, then move on to subsequent tasks. The app informs them of the tools needed to solve the problems, the approximate length of the trail, and the estimated duration of the journey. On the trail, the app, supported by GPS coordinates, aids the users in finding the locations. Once on site, users can access the task displayed in the app, enter the answer, get the feedback directly form the system, and ask for hints if needed.

As the groups trekked the trail, teachers observed and supervised student activities but were not expected to provide assistance because all the necessary information was to be provided by the app. Once the activity was completed or maximum time allowed for the activity had passed, the students moved to the next task. After completing the trail, each group returned to class, then had a discussion with the teacher about the task solutions and what they learned along the trail. The illustration of the technical implementation of the activity is shown in Figure 2.

In the second phase, field experiments were conducted in several locations involving students from several schools, one of which is in SMP 10 Semarang, a junior high school in Semarang, Indonesia. In this school, the activity was conducted with 30 students. They were divided into groups of six members. The activity was conducted in the school area during normal school hours over two 45-minute periods beginning with the teachers giving a brief explanation of the learning activities and goals. The groups then began their journeys, each from a task location that was different from the others (Group I started at task I, Group II from task II, and so on).

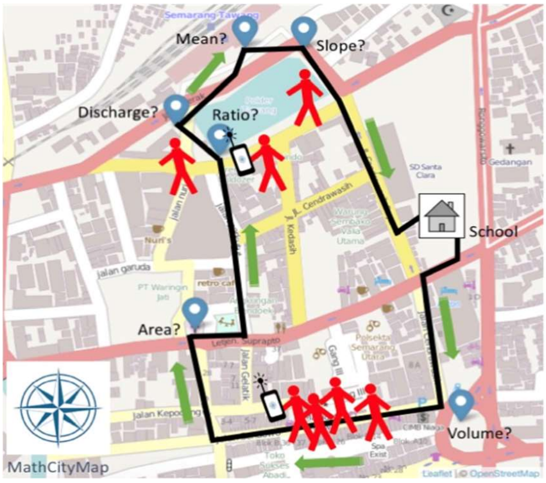

Figure 2. Illustration of technical implementation (Map: ©OpenStreetMap contributors)

Then, students worked together in teams. Generally, in a team, one student operated the mobile device, two or three students were measuring the object, and others were calculating the results. Then, they rotated the job positions for every task. In solving the task, they had understood that they were not competing to get better grades than the other group, because there is no assessment and this is not a competition. They knew that the goal of this activity is to learn mathematics, and not to test their skills though.

Most students actively involved in the activities and expressed positive feelings (93%) and had no problems in carrying out the math trails, including the use of the app. Through follow-up questions, we have investigated about what made them happy and interested in these activities. About 27% of students who were asked, mentioning learning outside the classroom as a reason, 26% said the use of advanced technology or mobile phone, 21% argued for the application of mathematics in the environment or in daily activities, 12% for collaborating with friends in learning or team working, while 11% mentioned other reasons (such as: the novelty of the activities and the break from their daily routines). Some negative feelings were also mentioned: fun but bad weather/tiring/shy/difficulties/technical problem (3%) and no reason (0%). This result indicates that mobile app usage has been one of the biggest factors affecting student engagement in the activity.

In accordance with its purpose, this study focuses on a deeper discussion of the role of mobile phones in this program. Results of observations and interviews show that there are three features that were commonly reported as attractive and useful features for the students. First, the students were interested in the use of a GPS-based mobile application as a navigation tool in the math trail activity. Working in the environment to find the hidden task location was interesting and challenging for the students. Here, students recognized the importance and attractiveness of utilizing a GPS-based mobile app as a navigation tool in the math trail activity.

Second, the availability of the hints-on-demand feature was also an attraction for the students carrying out these activities. The students did not have to leave the task without any results. They could still learn and acquire new knowledge from the task, even with assistance. Third, the students also reported that the direct feedback from the system was very useful for checking whether they had completed the task correctly or not. If their answer is correct, then they can continue the trip to the next station. If the students' answer is not correct, they had the opportunity to look back to determine what error they had made and to repeat the process of problem solving, if time permitted.

Here, there is an example of the activities and roles of the mobile app. In the school area there is a math trail route (Figure 3a) with six tasks. The tasks are placed in a hidden location and even students do not think there are such objects, or they do not think if those objects are related to math, though they often see it or touch it. An example is a task of the area of a small park in the backyard of the school hall, called the Toga Garden (Figure 3b).

Figure 3. (a) SMP 10 math trail route; (b) The Toga Garden Task

With the help of GPS feature and photos displayed in the app, users can find this object, then they get a problem: *"Calculate the area of the grass field. Give the result in m²!"* To solve this problem, students must identify the shape of the grass field, then look for the concept in mathematics accordingly. Some groups have difficulty when it comes to determining what formulas can be used to calculate the area. The role of mobile app in this situation is to offer help if users need it. The first aid is to invite students to think about how students use the mathematical concepts they have learned in class to solve the real problem. First Hint is *"Divide the area into shapes you know"*. The purpose of this hint is to direct students to acquire geometric shapes, for example: a rectangle and two semicircles.

By this hint, they are expected to be able to determine the area of each part, because the formulas have been studied in the previous class. Unless, there are students who have no idea, then the app offers a second hint, namely: "One possibility is to divide the area into a rectangle and two half-circles". The third hint is *"Calculate the area of the rectangle with the formula $L = p \times l$ and calculate the area of the circle with the formula $L = (22/7) \times r^2$"*. The app also inform that students can take advantage of the existence of the paving sections that surround the garden to help in measuring the length, in case their ruler or measuring tape is unable to measure the length. One of the student work results in problem is presented in Figure 4.

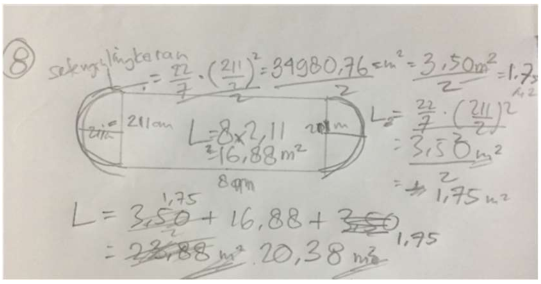

Figure 4. An example of students' work

The work of the students shows that they have completed the work to solve this problem well. Interviews showed that they used some hints. The advantage of using this feature is that they do not leave the task even if they do not have an idea to solve it. The mistakes made (can be seen in the correction of work by crossing out some parts) are not careful, they calculated the area of each semicircle into a full circle. After entering the answer, the system directly gives feedback, so they check their work before leaving the location. The system will also provide the following solution so that students can find out one alternative of the correct way in solving this problem.

Alternative solution:
If you divide the area into a rectangle and two half-circles:
$V_{rectangle} = 8.00 \text{ m} \cdot 2.10 \text{ m} = 16.80 \text{ m}^2$
$V_{HalfCircle} = ((2.10/2)^2 \cdot \pi)/2 \approx 1.73 \text{ m}^2$
So, $V_{GrassFiled} = 16.80 + 2 \cdot 1.73 \text{ m}^2 \approx 20.26 \text{ m}^2$

The accepted answer as the correct answer is in the interval between 20.00 m² and 20.50 m². From the example above, the student's answer is 20,38 m² and included in the interval.

However, it is one case that can be an example. Generally, field findings have supported data obtained that mobile app has been able to play a role in supporting math trail activities with features offered, such as: navigation features, help buttons, and direct feedback.

In this section, researchers interpret data with observed patterns. Any relationships between experimental variables are important and any correlation between variables can be seen clearly. The researcher should include a different explanation of the hypothesis or results that are different or similar to any related experiments performed by other researchers. Remember that every experiment does not necessarily have to show a big difference or a tendency to be important. Yet negative results also need to be explained and probably are important to change the research.

4. Conclusion

In brief, our findings indicate that generally math trail programs supported by the use of mobile phones have promoted the engagement of students in mathematical activities. The results of this study also show that the use of mobile technology has the potential to support math trail program. Some features offered in this application in accordance with the concept of math trail and play a role in guiding students in performing math trail activities. However, the reports from students also show that outdoor activity factors are more dominant than other factors, including the use of mobile devices. It leads to suggestions for future development research that mobile phone use for outdoor activities needs to be more optimized by exploring the latest developments of mobile technology.

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The enhancement of students' ability in problem solving and mathematical disposition aspect through brain-based learning model

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Abstract

The main purpose of this research is to analyze the achievement and the increasing of students' problem solving ability and students' mathematical disposition as the result of learning application through Brain-Based Learning model and conventional learning comprehensively. This research uses the mix method with concurrent triangulation. The research results show that: (1) The students' ability of problem solving using Brain-Based Learning model reaches classical learning mastery, (2) the students' achievement of problem solving using Brain-Based Learning model is higher than that of using conventional learning, (3) the students' enhancement of mathematical disposition using Brain-Based Learning model is the same with the achievement of using conventional leaning, (4) there is a few correlations between the achievement of problem solving ability and mathematical disposition, as well as their enhancement. To get comprehensive and accurate representation about the enhancement of mathematical disposition through Brain-Based Learning, it is necessary to conduct the future similar study with the same objects yet longer duration.

1. Introduction

Education has an important role in the process of creating a good quality human resource due that it can create knowledge and human characteristics to be better. One of required lesson in the elementary and high education curriculum is mathematics. Mathematics is important to give to students to assist them with the ability of problem solving as well as the ability of logical, analytical, critical, creative, and associative thinking. Those abilities are needed by students as assistance to prepare themselves to face real life.

One of mathematical abilities which are needed by students based on Indonesian National Professional Certification Department is the ability of problem solving. National Council of teacher of Mathematics (NCTM, 2000) also states that problem solving is one of basic abilities in mathematics learning. Indeed, it is an essential mathematical ability to help students to apply and compile some mathematical concepts as well as to take decision (Tambychik & Thamby, 2010). The problem solving ability is needed in the society (Bell, 1978) likewise in the mathematics learning. There are several problems solving steps, as follows: (1) understanding the problem, (2) arranging strategy in problem solving, (3) doing strategy to solve problem, (4) looking back the result, and (5) making conclusion.

Besides the cognitive aspects, the affective aspect are also needed to have by students since by having affective attitudes in mathematics learning, students will have respectful attitude toward mathematical advantages in daily life so that they have senses of happiness, curiosity, attention, and interest in learning mathematics, as well as diligent and confident attitude in solving mathematical problem. Those attitudes in the affective aspects are the attitudes as the base of students' mathematical disposition development. Based on NCTM as stated by Sumirat (2013) that mathematical disposition is an interest and a

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respect toward mathematics. The indicators of mathematical disposition are (1) confident while solving mathematical problem, communication ideas, and giving reasons; (2) flexibility in expressing mathematical ideas and trying many alternatives idea to solve problem; (3) persevering to finish mathematical tasks; (4) interest, curiosity, and ability in mathematics; (5) tendency to monitor and reflect the thinking process and self-work; (6) valuing mathematical application in other fields in daily life; and (7) rewarding toward mathematics' cultural role and mathematics' good value as language tool.

Moreover, mathematical disposition will be developed when students learn other aspects of competence. It also has a strong relation with one of mathematical basic abilities that is problem solving. As Polya's statement cited by Merz (2016) highlights that developing disposition is a part of one's thinking behaviour in problem solving. Mathematical early ability is also needed to be given attention before starting learning since students' early ability influences their problem solving ability. It is in accordance with Jatisunda (2016) who argues that students' early mathematical ability has influence on their problem solving ability. The early ability also represents students' readiness in gaining learning given by the teacher (Lestari, 2017). In the process of learning, their mathematical disposition can be seen from their wishes to change its strategy, reflection, and analysis to gain a solution, for example in classroom discussion process (Kesumawati, 2017).

However, the importance of problem solving and mathematical disposition is not yet suitable for the SMP Negeri 1 grade VII students' problem solving and mathematical deposition abilities. Based on the interview with mathematics teacher and experience while holding Teaching Practice for Senior College Students (Praktik Pengalaman Mengajar or PPL), it is found that students ability in problem solving is low. They still find difficulties while solving problem in form of descriptive question given by their teacher. The low ability of problem solving of SMP Negeri 1 Boja students is also shown by the result of Odd Mid Semester Test (Ujian Tengah Semester Ganjil) assessment of grade VII students which was held on October 2017. There are 6 questions which measure problem solving ability. From the result of that test, it is gained score of 24 from maximum score 40 as the average score of VII grade students in the questions measuring problem solving. Followings are the example of students' answer in problem solving question (The price of a pair of shoes is 40% more expensive than the price of a pair of slippers. If the price of a pair of slippers Rp75.000, 00, then calculate the price of a pair of shoes!).

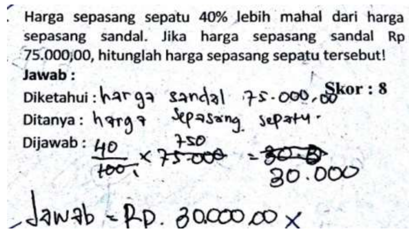

Figure 1. Example of Students' Answer 1

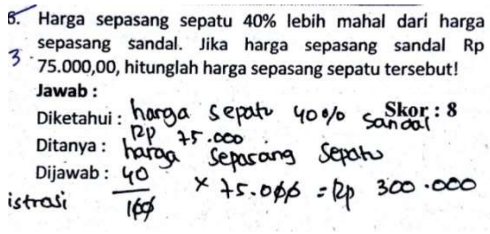

Figure 2. Example of Students' Answer 2

Based on the first figure, the student does not understand the question well which is shown when he does not completely write down what is known from the question and from the less correct answer. On the contrary, in Figure 2, student seems to write down what is known and asked well, although the answer is not completely correct. Actually, the wrong answer can be anticipated by reexamining the counting result gained.

Based on the interview and experience while doing in preliminary research, the researcher also found that most students did not know the use of mathematics in daily life. It seems to be the reason why many students have low learning motivation in mathematics which makes their mathematical disposition is low as well. From the students' explanation, most of them were not confident in doing mathematics in daily practice and test since they considered mathematics as a difficult subject, having too many complicated formulas, and hard to understand. Their less confidence was also showed in the mathematics lesson, they tended to be afraid to give opinion and ask question. The inactive and indifferent attitude was also showed when they got difficult question; they chose to stop working on the question. It also indicates their indifference and inactivity in finding how to work on unexplained questions in the classroom, even though they have many learning resources besides from their teacher to gain solution from their unexplained question such as from the book, internet, asking to their friends, relatives, or asking to teacher outside the lesson hour. From their explanation, the researcher notes that mathematical disposition of SMP Negeri 1 Boja students is quite low.

Based on the facts above, learning which can increase students' problem solving and mathematical disposition is needed. Learning used Brain-Based Learning (BBL) model is expected to fulfill this need. Jensen (2008) states that Brain-Based Learning is a learning adapting to how brain works and the presence of natural design which motivates students to learn. According to Jensen (2008: 484-490), Brain-Based Learning model has seven steps activity, as follows: (1) pre-exposition, (2) preparation, (3) Initiation and acquisition, (4) elaboration, (5) incubation and formation input, (6) verification and assurance checking, (7) celebration and integration. The explanation about the planning step of Brain-Based Learning will be explained in the next discussion. Further, Brain-Based Learning uses mind mapping and instrumental music to assist learning. Toward mind mapping, the student will easily comprehend and remember the lesson material, at the same time, music will help them to stimulate brain to work more and create better balance. Instrumental music is the kind of music which has the biggest role in the students' score achievement in the algebra material.

Learning using Brain-Based Learning gives opportunity to students to develop ideas and find strategy of problem solving. Adejare (2011) states that Brain-Based Learning makes students being able to solve mathematical problem. Another research done by Zaini et al (2016) and Shodikin (2016) which show that the problem solving ability can be increased. Though the increasing of students' achievement in the aspect of problem solving ability will also increase the mathematical disposition (Taufiq, 2016). Based on the preliminary research, a research about the increase of ability of problem solving and mathematical disposition through Brain-Based Learning model toward SMP Negeri 1 Boja grade VII students is necessary to conduct.

Regarding to above-mentioned explanation, the research problems are (1) does the students problem solving ability using Brain-Based Learning gain classical complete learning, (2) is the students' achievement of problem solving ability by using Brain-Based Learning model higher than those who use conventional learning, (3) is the students' enhancement of problem solving by using Brain-Based Learning higher than those who use conventional learning, (4) is the students' enhancement of mathematical disposition by using Brain-Based Learning model higher than those who use conventional learning, (5) is there any correlation between the achievement of students' problem solving ability and students' mathematical disposition, (6) is there any correlation between the enhancement of students' problem solving ability and the enhancement of students' mathematical disposition.

2. Methods

This research used the mixed method with concurrent triangulation strategy. Mixed method with concurrent triangulation is the mixed method in which its research procedures meet and compile qualitative and quantitative data to gain comprehensive analysis of research problem (Creswell, 2013).

The population of this research is students of VII grade of SMP Negeri 1 Boja of academic year 2017/2018 (Odd Semester). While the quantitative research design used in this research is the True Experimental Design with Pretest-Posttest Control Group Design Type. In this design, there are two groups which were experiment and control group were each chosen by using random sampling. The design of this quantitative design can be seen in Table 1.

Table 1. Quantitative Research Design

Group	Sample	*Pretest*	Action	*Posttest*
Experiment	A	O_1	X	O_2
Control	B	O_1	Y	O_2

Note:
A,B : random sample
O_1 : Pretest (before given action)
O_2 : Posttest (after given action)
X : Lesson using Brain-Based Learning
Y : Lesson using conventional learning model

Learning in the experiment group was held by using Brain-Based Learning model for three meetings. The material used is Linear Equation and Inequalities in One Variable Material. The variable of this research consists of two variables which are free variable and bound variable. The free variable is the learning using Brain-Based Learning model and conventional learning model, while the bound variable is the ability of problem solving and mathematical disposition.

Data compiling was done by using documentation method, test method, Likert scale method, interview method, and observation method. Documentation method was conducted to gain written data or pictures such as the list of students' names and the score of Odd Mid Semester Mathematics test assessment of students grade VII SMP Negeri 1 Boja. Then, students' activity photographs during research, as well as other data were also used for the sake of research. Test method used is problem solving ability test in the form of descriptive question. Then, Likert scale method was used to know students' mathematical disposition. While interview method was used to find problems to examine and know all details from the resources in the aspect of problem solving and mathematical disposition ability. Observation method was done by the researcher and the mathematics teacher to find out students' activeness during learning and ongoing learning process.

The choosing subject in the interview was done by using purposive sampling technique with consideration used is by choosing one high group subject, one medium group subject, and one low group subject based on students' posttest problem solving and mathematical ability score from the experiment and control classes with the categories shown in the following table:

Table 2. Grouping of Students Groups Based on Gained Score

Score	Category
Score $\geq$ 75%	High
55% < Score< 75%	Medium
Score $\leq$ 55%	Low

Adopted from Dewi (2017)

To analyze the data, this research used device trial analysis test, trial scale mathematical disposition, and research data analysis. Research data analysis was done through two steps, namely the early data analysis and final data analysis. Early data was gained from the students' score of Mid Semester Test assessment in the problem solving questions. Then, early data analysis was tested using normality test, homogeneity test, and two means equality test. As well as the final data, the normality test, homogeneity test, proportion test, gain test, one side mean equality test, and correlation analysis were also done.

3. Results & Discussions

Based on the early data analysis, it is found that early data of experiment and control class normally distribute and have homogeny variants. It shows that both samples come from population which has equal on the early condition. The data spread of students' early problem solving ability in the experiment and control classes can be seen from figure 3. The final data, whether the pretest and posttest of problem solving ability from both classes, also normally distribute and have homogeny variants, as well as the early score and final score of mathematical disposition.

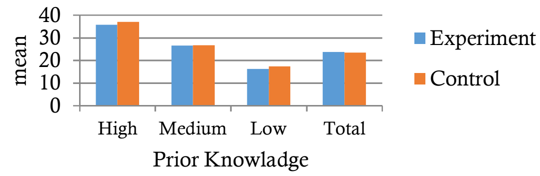

Figure 3. Students' Early Problem Solving Ability Spread Diagram

Hypothesis test 1 was done to find out that grade VII students' problem solving ability in the Linear Equation and Inequalities in One Variable Material using Brain-Based Learning model reaches classical completeness. Learning minimal completeness criteria are based on the minimal completeness criteria in the mathematics subject of SMP Negeri 1 Boja, which are from 71 students, the presentage of students who had reached KKM (compleness criteria) is minimally 71%. Based on right side proportion test it is gained value Z_{count}= 2,04 > Z_{table}= 1,64, so that H_0 is rejected while H_1 is accepted. It means that the students' problem solving ability in the Linear Equation and Inequalities in One Variable Material using Brain-Based Learning (BBL) has reached classical completeness.

The hypothesis test 2 was conducted by using test for right side means to examine whether the achievement of students' problem solving using Brain-Based Learning model is better than the using conventional learning. Data used were the posttest of students' problem solving ability score from two classes. From the test result, it is gained that t_{count}= 2,63 > t_{table} = 1,67, so H_0 is rejected which means that students' achievement of problem solving ability using Brain-Based Learning is better by using conventional learning.

Students' achievement of problem solving ability can be seen in the diagram in the following figure.

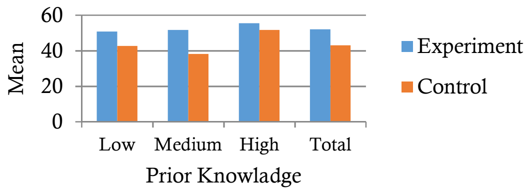

Figure 4. Problem Solving Achievement Diagram

Based on diagram above, it can be seen that the mean of students' achievement of problem solving in the low, medium, and high experiment class using Brain-Based Learning is higher than the means of students' achievement of problem solving with equal early ability. Then, students' achievement of problem solving ability in the experiment class is higher than that of control class.

While hypothesis test 3 was done by using test for right side means equality to examine whether the students' enhancement of problem solving ability using Brain-Based Learning is better than using conventional method or not. The data used was the score of 9 problem solving abilities enhancement gained from the students' problem solving pretest and posttest in two classes. From the test result, it is found that $t_{count} = 2{,}36 > t_{table} = 1{,}67$, so that H_0 is rejected which means that the students' achievement of problem solving ability using Brain-Based Learning is better than using conventional learning. Students' achievement of problem solving ability can be seen in the following diagram.

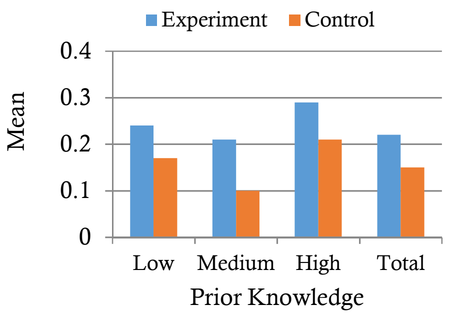

Figure 5. Problem Solving Enhancement Diagram

Based on figure above, it shows that students' achievement of problem solving with the low, medium, and high early ability in experiment class using Brain-Based Learning is higher than with conventional learning. In addition, the students' achievement of problem solving ability in the experiment class is higher than in control class.

The research result shows that early ability of problem solving in the high category has influence on the achievement and enhancement of problem solving. This is encouraged by Lestari' research (2017) which shows that there is another factor which influences students' learning result besides the early ability for instance, learning motivation, learning behavior, learning anxiety, and other external factors such as family, school environment, society, and economic situation.

Hypothesis test 4 was done through a test for one side means equality toward the students' enhancement of mathematical disposition. The data used was the score of mathematical disposition enhancement gained from early and final scores of mathematical disposition in the experiment class and control class. From the test result, it is found that $t_{count} = 0{,}12 > t_{table} = 1{,}67$, so that H_0 is rejected which means that the enhancement of students' mathematical disposition using Brain-Based learning model and conventional learning is equal.

Hypothesis test 5 was done to analyze the correlation between the achievement of problem solving and mathematical disposition ability and also to find out the portion of its relation. Tha data used were the posttest of problem solving ability data and students' final score of mathematical disposition in the experiment class. From the measurement result, it is obtained that correlation coefficient r is 0,113 with very low category, meanwhile, the determination coefficient is COPAA R^2=0,013=1,3% which means that the portion of influence of problem solving achievement toward mathematical disposition is only 1,3%, the rest 98,7% depends on the other factors.

The last, hypothesis test 6 was done to analyze the correlation between the enhancement of problem solving ability and the enhancement of mathematical disposition which aims to find out the relation portion between the students' enhancement of problem solving ability and mathematical disposition. The data used was the score of the students' enhancement of problem solving and the students' score of mathematical disposition in the experiment class. From the measurement, it is found that correlation coefficient r is 0,339 with low category, while the determination coefficient is R^2=0,115=11,5% which means that the influence size of problem solving ability toward the enhancement of mathematical disposition is only 11,5%, and the rest 88,5% is influenced by other factors.

3.1. The Result of Students' Work in the Problem Solving Ability Test

To find out the clear representation about the enhancement of problem solving ability, which is the part of the achievement and enhancement of problem solving will be presented based on the indicators.

Table 3. The Means of Problem Solving Based on Indicators

Indicators of Problem Solving Skill	Experiment			Control		
	Begin	Finish	⟨g⟩	Begin	Finish	⟨g⟩
Understanding Problem	3,94 (98,6%)	3,96 (99,1%)	0,33	3,80 (95%)	3,96 (99,1%)	0,82
Arranging strategy in problem solving	1,08 (27%)	2,26 (56,4%)	0,40	0,93 (23,2%)	1,52 (37,9%)	0,19
Doing strategy to solve problem	1,54 (38,4%)	2,82 (70,5%)	0,52	1,18 (29,5%)	2,13 (53,8%)	0,34
Looking back the result	0,08 (8,1%)	0,34 (34,4%)	0,29	0,12 (11,5%)	0,30 (30,3%)	0,21
Making conclusion	0,61 (30,3%)	1,03 (51,2%)	0,30	0,44 (22,1%)	0,71 (35,4%)	0,17
Total	7,25 (48,3%)	10,41 (69,8%)	0,41	6,47 (43,1%)	8,62 (57,4%)	0,25

The achievement of problem solving based on the indicators is presented in the following diagram.

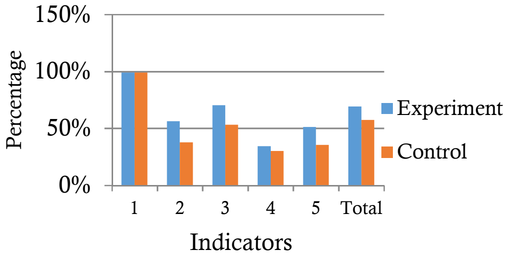

Figure 6. The Problem Solving Ability Achievement Based on the Indicators

The enhancement of problem solving based on the indicators is described in the following diagram.

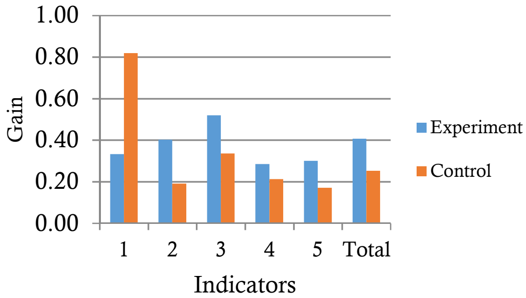

Figure 7. The Problem Solving Enhancement Ability Based on the Indicators

Based on the Figure 6, it can be seen that for 2nd, 3rd, 4th, and 5th indicators, students in the experiment class experience learning using Brain-Based Learning get higher achievement of problem solving ability than the control class which uses conventional learning. Then, for the first indicator which understands problem indicator, students in the experiment class and the control class experience the same problem solving achievement. Totally, students' achievement of problem solving ability by using Brain-Based Learning is higher than conventional learning.

While based on the Figure 7. it notes that for 2nd, 3rd, 4th, and 5th indicators, students in experiment class which were getting Brain-Based Learning gain higher achievement than students in the class control by using conventional learning. However, in the indicator of understanding problem, the control class students get higher achievement than the experiment class. In total, the students' achievement of problem solving ability using Brain-Based Learning is higher than conventional learning.

3.2. The Result of Students' Mathematical Disposition

To find out the clear representation of mathematical disposition achievement, it will be described based on indicators as seen in the following table.

Table 4. The Means of Mathematical Disposition Based on the Indicators

Indicators of Mathematical Disposition	Experiment			Control		
	Begin	Finish	⟨g⟩	Begin	Finish	⟨g⟩
Confident in using mathematics	2,42 (60,5%)	2,65 (66,2%)	0,15	2,68 (66,9%)	2,68 (67%)	0,00
Flexibility in doing mathematics	2,60 (65%)	2,94 (73,5%)	0,24	2,46 (61,4%)	2,74 (68,4%)	0,18
Persevering at mathematical task	2,75 (68,8%)	2,85 (71,2%)	0,08	2,58 (64,6%)	2,58 (64,5%)	0,00
Interest and coriosity	2,47 (61,9%)	2,60 (65%)	0,08	2,51 (62,7%)	2,95 (73,7%)	0,3
Monitor and reflect	2,81 (70,2%)	2,74 (68,6%)	-0,05	2,95 (73,8%)	2,83 (70,8%)	-0,12
Valuing application of mathematics	3,22 (80,4%)	3,23 (80,8%)	0,02	2,52 (63,1%)	2,91 (72,7%)	0,3
Appreciating role of mathematics	2,65 (66,8%)	3,14 (78,4%)	0,36	2,58 (64,5%)	3,06 (76,5%)	0,34
Total	2,64 (66,7%)	2,83 (70,7%)	0,14	2,62 (65%)	2,78 (69,4%)	0,12

From almost all indicators, the achievement and enhancement of mathematical disposition in the experiment class are higher than the control class, yet the interval of disposition, the achievement of both classes is not significant.

Based on the interview result, subject with low ability of problem solving finds difficulty in making mathematical model of the problem which causes the falseness in the next indicator as well. The same difficulty is also experienced by subject with high category of disposition because of the lack of practice in the Linear Equation and Inequalities in One Variable Material. In addition, subject with medium achievement of problem solving ability finds difficulty in manipulating mathematic completely although he was able to explain. Then, the other difficulty experienced is when he reexamined the result. The same difficulties are also experienced by subject with low and medium mathematical disposition. On the contrary, subject with high ability of problem solving does not find too many difficulties in performing problem solving.

However, the effort to increase problem solving ability through Brain-Based Learning can be seen in some lesson steps such as preparation, elaboration, incubation, and memory input, as well as the verification and assurance checking. The detailed explanation about the enhancement of problem solving ability through Brain-Based Learning Steps will be next explained.

In the preparation steps, students are introduced to the daily problems related to Linear Equation and Inequalities in One Variable Material. In this step, students are accustomed to understand problem about this material which is the indicator of first problem solving. The students' achievement using Brain-Based Learning in the problem solving indicator is 99,1%.

In the next step namely elaboration step, students discuss with group members. Based on the Vygotsy Learning Theory, learning which is done between students is effective in solving problem, emerging ideas and problem solving strategy. In the step of elaboration, the social interaction inside and outside the group happens.

The step of incubation and memory input also aims to increase the ability of problem solving by giving easy practice variation of questions. When they do the practice, they are led to the meaningful learning according to Ausubel Learning Theory. By doing practice, students apply the new fact and experience in the gained concept while they are discussing and doing textbook. Then, when verification and assurance checking, students are asked to do quiz of questions to check the concept of Linear Equation and Inequalities in One Variable Material which is learnt toward problem solving. Above all, it can be concluded that Brain-Based Learning facilitates students to enhance their problem solving ability.

4. Conclusion

From the research result, it can be concluded that: (1) the students' ability of problem solving using Brain-Based Learning model reaches classical learning completeness, (2) the students' achievement of problem solving using Brain-Based

Learning model is higher than using conventional learning, (3) the students' enhancement of problem solving using Brain-Based Learning model is higher than using conventional learning, (4) the students' enhancement of mathematical disposition using Brain-Based Leaning model is same with conventional leaning, (5) there is a very little correlation between the achievement of problem solving ability and mathematical disposition, (6) there is a low correlation between the enhancement of problem solving and mathematical disposition.
Based on the result of the research, it can be stated that Brain-Based Learning model can be used as one of alternative learning models, especially to increase students' ability of problem solving in the Equation and Inequalities in One Variable Material completely and properly, so it can make students accustomed to always check their result and create conclusion with correct reason. To get comprehensive and accurate representation about the enhancement of mathematical disposition through Brain-Based Learning, the next research needs to be done to the same subject with longer duration of research.

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Self-assessment on the achievement of the ability of mathematical proportional application in Meaningful Instructional Design (MID) learning viewed from student's learning style

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Abstract

This study aims to (1) test the students' mathematical proportional reasoning ability to achieve classical mastery, (2) to analyze the average achievement of mathematical proportional reasoning ability in Meaningful Instructional Design learning by applying self-assessment with the common learning model (3) to test the proportion of students' mastery in Meaningful Instructional Design learning by applying self-assessment which is better than the proportion of the common learning model and (4) to obtain a description of students' proportional reasoning abilities of visual, auditory, and kinesthetic style of learning style. The method used in this research is Mixed Methods Concurrent Embedded Design. The quantitative subject of this study is the students of class VIII B MTs NU Banat Kudus as the experimental class which use Meaningful Instructional Design, while the subject of qualitative research is 6 students of class VIII B consisting of 2 students with the high and low value on mathematical proportional reasoning test in each learning style group. Eventually, the results of this study are (1) the achievement of students' mathematical proportional reasoning ability is significant in MID learning, (2) there is difference of proportional reasoning ability in MID learning model with a common used learning model, (3) the proportion of students' learning mastery by using Meaningful Instructional Design model with Self-assessment is higher than those who use the common learning model and (4) the students with visual learning style are able to propose and perform mathematical manipulation by understanding and remembering the material ever seen and written, the students with auditory learning style are able to make guesses, present mathematical manipulations, and draw conclusions by understanding and remembering material discussed, while students with kinesthetic learning style are able to make guesses, perform mathematical manipulations, and draw conclusions by understanding and remembering material which is ever practiced.

1. Introduction

Mathematics is a must be taught lesson to students from elementary, junior high school, to university. The purpose of mathematics based on Regulation of National Education Ministry (Permendiknas) No. 22 of 2006 highlights that mathematics aims that students are able to: (1) understand mathematical concepts, explain interrelationships between concepts and apply concepts or algorithms, flexibly, accurately, efficiently and appropriately in problem solving, (2) use reasoning in patterns and characteristics, perform mathematics manipulation in generalizing, compile he evidences or explain mathematic ideas and statements, (3) solve problems that include the ability to understand problems, design mathematical models, solve models and interpret solutions obtained, (4) connect the ideas with symbols, tables, diagrams or other media to clarify the situation or problems, and (5) have attitude of appreciating the usefulness of mathematics in life,

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that is curiosity, attention, and interest in mathematics learning, as well as a tenacious attitude and confidence in problem solving.

As well mentioned in above explanation that one of the goals of mathematics learning is that students are expected to have the ability to use reasoning on patterns and characteristics, perform mathematical manipulations in generalizing, compile the evidence or explain mathematical ideas and statements. Above all, one of the most important reasons is a proportional reasoning.

Proportional reasoning is a mental activity in coordinating the two quantities associated with the relation of change (worth or turning of value) to a number of other forces (Irpan, 2009). It is the reasoning about the understanding of the similarity of two relations structure in proportional problems (Johar, 2006). Again, Behr et al. (1992) explain that proportional reasoning means being able to understand the inherent multiplication relationships in comparison situations. As well explained by Dole et al. (2009), proportional reasoning is an important reasoning in mathematics learning that fractions, percentages, ratios, decimals, scales, algebra, and opportunities which require proportional reasoning. Because there are abundance of mathematical material which involve proportional reasoning abilities, consequently if students' reasoning does not develop well, otherwise they will have difficulty in mathematics learning. As Walle (2010) argues that up until now students need to have the right thinking about the formers of ratios and proportions as well as in what context these mathematical ideas emerge. A statement on the importance of proportional reasoning is also developed by NCTM (2000) that is proportional reasoning is quite important, hence it deserves to get a lot of time and efforts which then should be used to ensure its development properly. Based on the above statements, it can be concluded that students' proportional reasoning ability is very important to be developed properly.

Furthermore, learning style is one of the important variables in the way students perceive the lessons in school. It is the tendency of a person to receive, absorb and process the information (De Porter & Hernacki, 2008). Each student has his/her own learning style which is different from others'. According to De Porter & Hernacki, it is divided into three types, namely visual, auditory, and kinesthetic learning style. These types of learning styles are distinguished by their tendency to understand and capture information which more easily by visually, auditory, or doing by their own. In addition, another thing that affects students' mathematical proportional reasoning abilities is the use of instructional models applied by teachers. Learning Meaingful Instructional Design is the basic strategy of constructivist learning. Ausubel (Dahar, 1996) explains that meaningful learning is a process of linking new information to relevant concepts which are contained in a person's cognitive structure. The learning process prioritizes the meaningfulness, so students will easily remember the materials that have been explained by the teacher or probably the new one. Meanwhile, in this case, the instruction does not only refer to the context of formal learning in the classroom whose main purpose is not only to acquire certain skills and concepts but also to pay attention to students' attitudes and emotions. Then, design is a process of analysis and synthesis that begins with a problem and ends with an operational solution plan. All of the above-explanations emphasize the students to be able to link the concepts both given and newly delivered, how students can get the concept with the skills they have, and how the process of analysis on the solution obtained.

Besides, there are factors that influence the achievement of mathematical proportional reasoning that is teacher's treatment to students who incidentally have learning styles and different levels of understanding between one another. Therefore, teachers need to apply a formula to support the achievement of mathematical proportional reasoning abilities. One of them is by applying self-assessment, so they are expected to be more open and confident about the measurement ability. Self-assessment is not only beneficial for the student but generally, it can also benefit for the teacher. Because the teacher will easily know the lack of students' understanding by the students themselves so that teachers can make appropriate handling to explore the potential and students' mathematical proportional reasoning abilities as a form of follow-up self-assessment.

Based on above description, the researchers are interested to conduct a study entitled "Self Assesment On Achievement of Mathematical Proportional Reasoning Ability in Meaningful Instructional Design (MID) Learning from Students' Learning Styles".

This study analyzes the ability of proportional reasoning of class VIII students in Meaningful Instructional Design learning by De Porter &

Hernacki. While the student learning style use questionnaire adaptation of Mamluatul Mufida (2015) that has been validated by experts, namely visual, auditory, and kinesthetic learning style. Then, the mathematical proportional reasoning indicator used is a mathematical reasoning indicator which is collaborated with proportional problems and strategies to solve proportional problems. The students are from MTs NU Banat Kudus Class VIII and the material analyzed is comparative material.

Regarding to above explanation, it can be drawn that the aims of this study are; (1) to test the students' mathematical proportional reasoning ability in the Meaningful Instructional Design learning model in order to achieve the classical mastery; (2) to analyze the average of achievement of mathematical proportional reasoning ability in Meaningful Instructional Design learning applying self-assessment with the usual learning model is done (3) to test the proportion of students' learning mastery in Meaningful Instructional Design teaching which applies self-assessment which is better than proportion of learning model (4) obtaining a description of students' proportional reasoning abilities of visual, auditory, and kinesthetic style learning style.

2. Method

This study used a combination method of a concurrent embedded model (unbalanced mix quantitative and qualitative). The combined method of concurrent embedded design is a research method that combines both qualitative and quantitative research methods by mixing the two methods unbalanced. This study emphasizes more on qualitative than quantitative (Sugiyono, 2013). In this study, collecting and analyzing quantitative and qualitative data are done simultaneously to answer the research problem formulation.

Quantitative method is used to test the students' mathematical proportional reasoning ability in class VIII in Meaningful Instructional Design learning to achieve classical completeness, analyze the average achievement of mathematical proportional reasoning ability in Meaningful Instructional Design learning by applying self-assessment with normal learning model and test proportion students' learning mastery in Meaningful Instructional Design learning by applying self-assessment which is better than the proportion of the common learning model. While the qualitative method is used to determine students' mathematical proportional reasoning abilities in terms of learning style V-A-K with Meaningful Instructional Design learning. Indeed, qualitative is obtained through interviews with participants in depth.

The general subjects in this study are students of class VIII B and VIII A MTs NU Banat Kudus which amounted to 44 and 47 students. The researcher determined 6 students as the subject in research about the ability of mathematical proportional reasoning of class VIII student on Meaningful Instructional Design learning. Meanwhile, in terms of student learning styles, in each learning style, there 2 chosen subjects with criteria of 1 high and 1 low student.

The data collection techniques in this study is a test of mathematical proportional reasoning ability and interview. The results of mathematical proportional reasoning abilities test refer to mathematical reasoning indicators according to National Education Department (Depdiknas).

Then, the data analysis technique in this study is quantitative and qualitative data analysis. The quantitative test uses the data normality test, the data homogeneity test, the average initial data equation test using Independent-Sample T-test with SPSS software, the one-party (right) average test, the one-sided (right) proportion test, while the analysis of qualitative data test is done with the following steps: data reduction phase, data presentation, verification and conclusion.

3. Research & Discussion

3.1. Findings and Discussion of Quantitative Research

In the analysis of mathematical proportionality test results, normality test by Kolmogorov-Smirnov was done by using SPSS 16.0 software which obtained that the data of class research results are normally distributed. While homogeneity test was done by using Levene test using SPSS 16.0 software which obtained the data of research class and control class are homogeneous or have the same variant.

Based on the calculation of hypothesis test 1, obtained $z_{count} = 1.741$ with a significant level of 5%, which obtained that $z_{table} = z_{(0.5-\alpha)} = z_{(0.45)} = 1.64$. Because $z_{count} > z_{table}$, so H_0 is rejected. It means that proportional reasoning ability of class VIII students MTs NU Banat Kudus in Meaningful Instructional Design learning achieves mastery learning in classical or at least 75% of the number of students in the class reached the value of 74.

Meanwhile, in hypothesis test 2 used the right-sided average test. The applicable test criterion accepts H_0, if $t_{count} < t_{(1-\alpha)}$ in which $t_{(1-\alpha)}$ is obtained from the distribution list t with dk = ($n_1 + n_2 - 2$) and probability (1-α) (Sudjana, 2005). Based on the calculation, it is obtained that $t_{count} = 2.663$ which is greater than $t_{table}=1.67$. It means that H_0 is rejected, while H_1 is accepted. Then, the average proportional reasoning ability of the experimental class by using self-assessment in Meaningful Instructional Design is higher than the average of mathematical reasoning ability of the control class with the common learning. In brief, there is difference reasoning ability of mathematical proportional of control class and experiment class.

While based on hypothesis test 3, it is obtained $z_{count} = 2.272$ with a significant level of 5% that obtained that $z_{table} = z_{(0.5-\alpha)} = z_{(0.45)} = 1.64$. Because $z_{count} > z_{table}$, so H_0 is rejected. It means that proportion of students' completion of experimental class using learning model Meaningful Instructional Design with self-assessment is higher than the proportion of students' mastery in control class by using the common learning model.

Regarding to above findings, it shows that the implementation of self-assessment in Meaningful Instructional Design learning can help students to achieve mastery learning.

3.2. Findings and Discussion of Qualitative Research

The questionnaire of learning style is used to identify individual learning styles. Then, to find the mathematics proportional reasoning, comparison test instrument was used. Meanwhile, to determine whether the students' mathematical proportional reasoning abilities which are obtained from the results of students' written tests are in accordance with the actual situation or not, the interview was conducted based on the interview guidelines that had been made before.

The results of filling the questionnaire of learning style of students class VIII B can be seen in the following tables.

Table 1. The Result of Class VIII B's Learning Style Questionnaire

Learning Style Type	Number of Students
Visual	10
Auditory	26
Kinesthetic	2
Visual auditory	3
Auditory Kinesthetic	1
Auditory Visual Kinesthetic	1
Total	44

In addition, the distribution of learning styles in class VIII B can be seen in the following diagram.

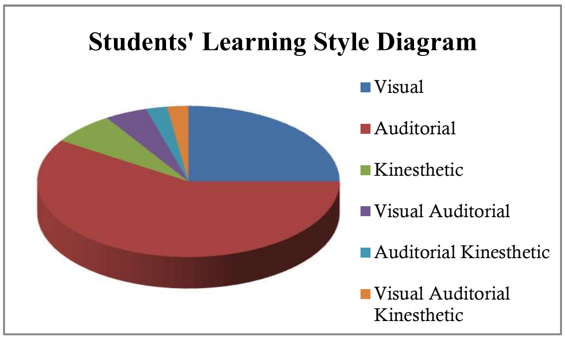

Figure 1. Distribution of Class VIII B Learning Style

Based on the results of research activities for the questionnaire learning style of students of class VIII B, it is found that there are students who occupy each learning style. The number of students who are classified as visual learning style type is 10 students (22.73%), auditory learning style is 26 students (59.09%), kinesthetic learning style type is 2 students (4.55%), auditory visual style is 3 students (6.82%), kinesthetic auditory style is 1 student (2.27%), and while visual kinesthetic auditory style is 1 student (2.27%). However, this study focuses only on three types learning, they are visual, auditory, and kinesthetic learning as well as in the opinion of DePorter and Hernacki. The percentage of the types of visual, auditory, and kinesthetic learning styles were (22.73%), (59.09%), and (4.55%), respectively. It means that the existence auditory learning style is higher than other styles, then followed by visual learning style and kinesthetic learning style.

The results of this study are similar to Rahayu's (2009) research findings that from 140 junior high school students, 66 students have visual learning style, 46 students have auditory learning style, and 28 students have kinesthetic learning style. It means that the visual learning style is the highest learning style. Sari (2014) also found that the type of kinesthetic learning style is a type that is rarely encountered.

Though Aditya (2015) finds that the percentage of student presence with an auditory style of learning style is higher than other learning styles. As Mulyati (2015) reveals that the types of visual and auditory learning styles are more dominant than the kinesthetic learning style.

Based on the results of questionnaire filling, then the selected research subjects can be seen in the following table.

Table 2. Research Subjects

Learning Style	Student's Code	
Visual	B-35	V1
	B-10	V2
Auditory	B-28	A1
	B-38	A2
Kinesthetic	B-11	K1
	B-18	K2

In this study, learning activities were conducted 4 times meeting in the experimental class. An observation of learning implementation was done in order to observe and assess the quality of researcher during the learning. It was done by using the observation sheet of researcher's ability to manage the learning by using Meaningful Instructional Design (MID) which was done by the observer that is mathematics teacher of class VIII B and class VIII A namely Nur Khusomah, S. Pd.

The learning process which was carried out during 4 meetings is in accordance with the RPP which has been prepared with the number of hours of study (jp) is 6jp. The first meeting was held on April 27th, 2017 with the number of lessons of 2jp, while the material is a direct proportion value. The second meeting was held on April 30th, 2017 with the number of lessons of 1jp, while the material is a matter of inverse proportion value. The third meeting was held on May 7th, 2017 with the number of hours of 1jp with the material was continuing the second meeting of the comparative inverse proportional value, and the fourth meeting was held on May 9th, 2017 with the number of hours of 2jp which is follow up of self-assessment by repeating the proportion of direct and inverse value by using a perfunctory of direct and inverse proportional.

The implementation of MID at the first meeting of draw on experience and knowledge stage, students are able to explore the prerequisite knowledge as an association material which is remembering previous material obtained. This circumstance shows that students are able to propose the conjectures.

In the Input stage, the teacher distributes LKPD with the help of visual aids to each group as a media for students to input information and mathematical concepts. At the first meeting, the students had difficulties in filling LKPD as for they rarely use LKPD assistance during the learning. In addition, they are still reluctant to write down the information that is known, asked and willing to immediately calculate the completion. However, because they are not used to dealing with the types of proportional reasoning problems, they find that it was difficult to determine which way they would use. Therefore, in reinforcement stage, they explore through exercise questions contained in LKPD to develop new understanding of students and teachers in order to guide individual and group investigation. The teachers give encouragement to students to really understand the problem first and get used to write down what is known and asked, and also provide guidance in preparing a completion plan.

Moreover, the application stage for the first meeting took a long time. Students tend to put each group to present the work in front of the class. Owing to the fact that they are less confident to show up in the front. However, this symptom can be resolved after the teacher provides understanding to the students. Finally, at the first meeting, the teacher appoints one of the groups to make a presentation regarding the discussion results and assigns a task to make a portofolio at the end of the lesson. Afterward, the learning was closed with conclusion, motivation, and assignment.

At the second meeting, the teacher invited students to observe the problems presented at the student orientation stage on the problem. They were able to name what is known and asked. They were also able to name a variety of proportionate problem solving strategies that were used in solving problems. Indeed, it did not take a long time to organize them in group. In the input stage, they have been used to write down the troubleshooting steps even though they were still getting difficulty . At the time of mathematical manipulation, they found that it was difficult because the numbers used in the problem were considered difficult. They have also been able to draw conclusions without the use of mathematical operations. At this second meeting, the presentation of the work does not take as much time as the previous meeting because they have already seen their friends complete it.

In the implementation of learning activities, the observation was conducted by the observer. The observation data of learning implementation obtained by the researcher are from observation of learning in the classroom at a current time.

Table 3. The Results of MID Learning Implementation Observation

Meeting	Assessment Score	Criteria
Meeting 1	85%	Excellent
Meeting 2	83,3%	Excellent
Meeting 3	81,25%	Excellent
Meeting 4	89,5%	Excellent
Average	84,76%	Excellent

Meanwhile, the teacher activity graph can be seen as in following Figure 2.

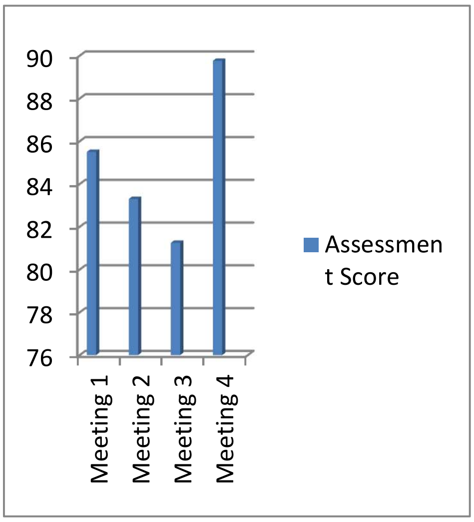

Figure 2. Student Activity Chart On Meaningful Instructional Design (MID) Learning

Student activity in MID mathematics learning generally shows excellent activity. It was observed during the learning process by filling the observation sheet provided (can be seen in the appendix) which was observed classically. Based on the results of observation on student activity classically during learning, the data obtained are as follows.

Table 4. The Results of Student Activity Observation

Meeting	Assessment Score	Criteria
Meeting 1	66%	Good
Meeting 2	78%	Good
Meeting 3	85%	Excellent
Meeting 4	87.5%	Excellent
Average	76,33%	Good

Table 4 shows that students' activity in the MID learning process conducted at each meeting has improved on the score.

The implementation of mathematical proportional reasoning abilities test was conducted on Thursday, May 11th, 2017 which was followed by 44 students. The mathematical reasoning test was followed by 91 students consisting of 44 experimental class students and 47 control class students. The results of descriptive analysis of the test of mathematical proportional reasoning ability in the proportional material are as follows.

Table 5. The Results of Mathematical Proportional Reasoning Ability Test

Class	N	Average	Highest Value	Lowest Value
Experiment	44	80,23	100	42
Control	47	73,34	100	43

Based on table above, it shows that the students' learning outcomes of the experimental class are better than the learning result of the control class. Then, the average of student test result with MID model is 80.23, while the usual learning is only 73.34. In other words, students' mathematical proportional reasoning skills with MID model are higher than those with common learning.

The hypothesis was conducted to find out the difference of students' mathematical reasoning achievement with MID model and the common learning model. From the hypothesis of analysis, it can be concluded that students' mathematical proportional reasoning with MID model is better than those with common learning.

After the students did mathematical reasoning ability test, then the interview was done toward the subject of research in order to get deep results about mathematical reasoning abilities of research subjects.

The description of the execution of the interview schedule of the research subjects is shown in Table 6.

Table 6. Implementation of Interview Schedule

Research Subject	Interview Execution
V1	Saturday, May 13th, 2017
V2	Saturday, May 13th, 2017
A1	Sunday, May 14th, 2017
A2	Sunday, May 14th, 2017
K1	Monday, May 15th, 2017
K2	Monday, May 15th, 2017

In this study, the research subjects for visual learning styles were V1 and V2. In the conjecture indicator, V1 and V2 wrote down what was known to the problem with sufficient criteria. They wrote down completely, yet too brief in giving information and not understanding the readers. However, they definitely understood what they wrote. It is in accordance visual learning style students' character according to DePorter and Hernacki (2000) that is in answering questions, they will answer with short answers. In this case, they are able to write down the known and asked questions in a complete but brief.

Further, V1 and V2 wrote the questions properly and correctly from the problems presented. They had sufficient criteria in writing the core formulas used in problem solving.

In the mathematical manipulation indicator, V1 and V2 had sufficient criteria in writing down the troubleshooting steps. Based on the results of interview with the teacher, they were not familiarized with writing down the troubleshooting steps in solving a math problem. V1 did not write down the solution steps because he was not used to writing it. However, V2 was able to write down the problem-solving steps well.

Besides, V1 and V2 have enough criteria in working according to the correct algorithm, completing mathematical operations and finding the answers from the problem. Yet, they were not able to complete the question number 2 as well as they could not find its answer. It is caused that they did not well understand the concept, consequently, they were not able to apply it to question number 2. As for question number 1, they complete question number 1 but with a step which was not sequential. However, he could find the final result requested matter. This is because question number 1 has ever given as an exercise during the learning, while number 2 has not.

The analysis of mathematical manipulation on subjects V1 and V2 is similar to visual learning style students' characteristic according to DePorter and Hernacki (2000) that is the students will have problems with remembering verbal instruction unless they write it. It means that students with visual learning style more easily remember something in written.

For more, V1 and V2 have sufficient criteria in the ability to draw conclusions from the problems presented. They wrote down the conclusions of the problems presented but there were some errors. These errors were found in the final result written on their conclusion.

Besides, the research subjects for auditory learning style are A1 and A2. In the conjecture indicator, they wrote down what was known from the problem with sufficient criteria. Subject A1 wrote things known to the problem completely and correctly. While the subject A2, in question number 2, wrote the known thing at the problem completely but still not clear yet. Consequently, the reader was confused to interpret it.

Then, A1 and A2 have good criteria in writing the asked problem which was presented. They have sufficient criteria in writing down the core formulas used in problem solving. A1 wrote the core formula used in problem solving. In question number 2, he wrote the core formula used in problem solving but not clearly described. Nevertheless, he was able to explain the core formula used orally well and correctly. While the A2 completely and correctly wrote the core formula used.

The results of the analysis of the ability to present conjectures on A1 and A2 are in accordance with opinion of DePorter and Hernacki (2000) that is auditory learning style students will have difficulty in writing, yet good in telling stories. It can be seen from students' written test answers which are brief, yet they are able to explain in the interview section.

In the mathematical manipulation indicator, A1 and A2 have good criteria for writing down the troubleshooting steps. They wrote down the problem-solving steps properly and correctly. Thus, they have enough criteria in working according to the correct algorithm and performing mathematical operations and finding the answers of the problems. Yet, they were not able to complete question number 2, consequently they could not find the results. It is caused that A1 and A2 have not understood the concept well. As for the problem number 1, they completed the question number 1 yet with a step that was not sequential. Nevertheless, they could find the answers of the question due to the problem number 1 had ever become as exercise in learning.

The analysis of mathematical manipulation ability on A1 and A2 is similar to auditory learning style students' characteristics according to DePorter and Hernacki (2000) that is they have problem with visualization work. Indeed, the matter of mathematical reasoning ability is the element of visualization. A1 and A2 could complete question number 1 because it has become an exercise in learning activities. While in question number 2 which has never been given during the exercise, they found that it was difficult because they are unable to visualize the concept. Thus, since they found difficulties with the visualization, as the result the errors occurred in performing mathematical operations.

However, A1 and A2 have sufficient criteria in the ability to draw conclusions from the problems presented. They wrote down the conclusions of the problems presented although there are some errors. These errors are in the final result written on their conclusion.

Furthermore, the research subjects for kinesthetic learning styles were K1 and K2 subject. In the conjecture indicator, K1 and K2 wrote down what was known with sufficient criteria. K1 wrote the known things from the problem completely and correctly. While K2, in question number 2, wrote the known thing from the question completely but not clear yet. Consequently, the readers are confused to interpret.

Again, K1 and K2 have good criteria in writing the questioned problem which was presented and the core formula used in problem solving. K1 and K2 wrote the question and the core formula used in problem solving completely and clearly.

In the mathematical manipulation indicator, K1 and K2 have sufficient criteria in writing down the troubleshooting steps. K1 wrote down the troubleshooting steps properly and correctly. While K2, on the question number, did not write down the troubleshooting steps. Nevertheless, he was able to explain verbally the number 1 troubleshooting steps.

Subjects K1 and K2 have enough criteria as the correct algorithm, performing mathematical operations and finding the answers of the questions. Yet, they were not able to complete the question number 2, as the result they could not find the result. Since they did not understand the concept well, they could not apply it to the question number 2. As for problem number 1, K1 solved problem number 1 yet not sequence. Nevertheless, he could find the final result of the problem since it had been used as an exercise in learning.

The results of the analysis of mathematical manipulation abilities in K1 and K2 are similar to kinesthetic learning style characteristics as well explained by DePorter and Hernacki (2000) that is they learn through manipulation. It means that students with kinesthetic learning are able to perform mathematical manipulations even though their manipulations are totally wrong.

Afterwards, K1 and K2 have sufficient criteria in the ability to draw conclusions from the questions presented. They wrote the conclusions of the problems presented yet there are some errors. These were found in the final result written on their conclusion.

4. Conclusion

With regard to description of analysis, there are several conclusion which can be drawn, They are as follows (1) the ability of mathematical proportional reasoning of the students of grade VIII B MTs NU Banat Kudus in Meaningful Instructional Design (MID) learning reached mastery in classical learning with proportion more than 75%; (2) the average of students' mathematical proportional reasoning ability in Meaningful Instructional Design (MID) learning which applied self-assessment is higher than those with common learning; (3) the proportion of students' learning mastery by using Meaningful Instructional Design model with self-assessment is higher than those with the usual learning model; (4) the classification of learning styles from 44 students of class VIII B MTs NU Banat Kudus obtained 11 students use visual type, 26 students use auditory type, 2 students use kinesthetic type, 3 students use visual auditory type, 1 student uses kinesthetic auditory, and 1 student uses visual auditory kinesthetic. (a) Visual learning type students are: (i) able to propose conjectures by writing down the known and asked things form the questions given, (ii) able to perform mathematical manipulations by solving the problem of proportional reasoning with the calculation strategy and (iii) unable to write conclusions correctly, (v) able to understand and recall material which have been ever seen and written. (b) Auditory learning type students are: (i) able to propose conjectures by writing the known and questioned things, (ii) able to do mathematical manipulation by solving the problem of proportional reasoning with equation strategy and finding the final results, (iii) able to write good and correct conclusions, (iv) able to understand and recall material discussed. (c) Kinesthetic learning students are: (i) able to conjecture and write down the known and asked things, (ii) able to perform mathematical manipulation by solving problems of reasoning proportional to operator strategy and finding the answers of the questions given, (iii) able to write good and right conclusions, (iv) able to understand and remember material that has been ever used.

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Mathematical literacy ability of 9th grade students according to learning styles in Problem Based Learning-Realistic approach with Edmodo

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Abstract

This study aims to determine the difference and increase of the mathematical literacy ability using PBL-PRS-E, PBL-PS and scientific approach, and to find out difference of the mathematical literacy ability between learning styles. This study belongs to quantitative research. The population in this study are 9th grade students SMP Negeri 1 Majenang, Cilacap academic year 2016/2017. This study uses a quasi-experimental design with pretest-posttest control group design. Then, methods of the study are test, questionnaire, and documentation. Data analysis was performed by one way anova, two way anova, and increase in the gain normalized. The results of the study are (1) the mathematical literacy ability of students in the experimental group 1 is better than the mathematical literacy ability of students in the experimental group 2 and control group, (2) there is no difference in the mathematical literacy ability between learning styles, (3) there is no interaction between the mathematical literacy ability based learning models and student's learning styles, and (4) ithe increase of students' mathematical literacy ability in the experimental group 1 is better than in the control group but less than the increase of stuednts' mathematical literacy ability in the experimental group 2. Eventually, this study suggests that 9 grade mathematics teacher in SMPN 1 Majenang can use PBL-PRS-E model to improve the learning result and mathematical literacy ability of students.

1. Introduction

Mathematics role in preparing students to enter the change in state of being developed with the act of basic as logical thinking, critical, rational, and accurate and can use mathematical mindset in studying various sciences or in daily life. Hence, it requires the development of materials and the learning process. Mathematics learning is learning that was built with attention to the important role of understanding students conceptually, providing appropriate materials and procedures of students' activity in the classroom (NCTM, 2000). Mathematics learning will be successful if the students can use the concepts, procedures and facts to explain a problem that occurs in daily life. In fact, students still have difficulty in fulfilling these criteria.

In Permendiknas 22 year 2006 about the aims of the mathematics subjects, there is understanding with the definition of mathematical literacy. Mathematical literacy helps a person to understand the role and use of mathematics in every aspect of life, and can be used to make the right decisions and reason as citizens who build, care, and think. These reasons make mathematical literacy becomes important for students to be considered because it can prepare students for the association in modern society (OECD, 2013). This is supported by Kusuma in Aini (2013), that living in the modern era, everyone needs mathematical literacy to against a variety of problems, because it is very important for everyone associated with the work and duties in daily life. Mastery of mathematics can help students to solve the problem. Therefore, it is expected that students have the literacy ability (Johar, 2012). According to OECD (2013), the literacy skills of mathematics

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consists of seven components used in the assessment process of mathematics in PISA: (1) communication, (2) mathematizing, (3) representation, (4) reasoning and argument, (5) devising strategies for solving problems, (6) using symbolic, formal, and technical language, and operations, and (7) using mathematical tools. Besides, based on the Program for International Student Assessment (PISA) report in 2003, Indonesia was ranked 39th out of 40 countries, in 2009 Indonesian students were ranked 61 out of 65 participating countries, in 2012 Indonesian students were ranked 64th out of 65 countries, while in PISA 2015, Indonesia was still ranked 63 out of 70 countries (Wardono *et al*., 2017).

PISA is an international scale assessment program that aims to determine the extent to which students (age 15 years) can apply the knowledge they have learned in school (Wijaya, 2012). Mathematical literacy in PISA focuses on students' ability to effectively analyze, justify, and communicate ideas, formulate, solve and interpret mathematical problems in a variety of forms and situations (Aini, 2013). According to Hayat (Maryanti, 2012), in measuring competence in mathematical literacy, PISA has divided into three parts, such as reproductive competence, competence, connection and reflection competence. PISA covers three major components of the domain of mathematics, namely the content, context, and competencies (OECD, 2009). According to Silva, et al (2011), content is divided into four parts: (1) space and shape, (2) changes and relationships, (3) Quantity, and (4) uncertainty and data. In this study, the content used is the space and shape of the material surface area and volume of the tube and cone. Mathematics context is divided into four topics: (1) personal, (2) employment, (3) social, and (4) scientific. While the mathematical literacy competencies are grouped into three groups, among others: (1) reproduction process, (2) connections process, and (3) reflection process (OECD, 2013).

The educational curriculum which is currently applied in Indonesia is the curriculum 2013. One of the main changes to the curriculum 2013 is a change in learning materials are developed based on competency that fulfills the suitability and adequacy, then the content accommodates local, national, and international, such as TIMSS, PISA, and PIRLS. Therefore, the questions used in the textbook curriculum in 2013 already contains mathematical literacy problems.

The report of Junior High School national exam results in 2015 shows that the average of mathematics scores of students is only 56.40. It is the lowest from other subjects. In addition, there were only 26.41% students who joined the exam and got the score above 7.00. Thus, it can be concluded that generally, mathematics learning has not been successful in Indonesia. At the national exam, there are questions related to daily problems, it can be concluded that students in Indonesia have not been able to solve problems with good mathematical literacy. The average of mathematics national examination, students' score of SMP Negeri 1 Majenang reached 76.29, but there are still 37% students who joined the exam got score below 7.00. Further, the school's rank is the 4th best Junior High School national examination results in Cilacap district. It indicates that mathematics learning process that has been implemented is minimized.

For more, the results of interview which was done in June 2016 with a 9th grade math teacher SMP Negeri 1 Majenang show that the teacher uses scientific approach in explaining the teaching materials which are combined with other learning models. By applying scientific approach, it is expected that it can improve students' learning outcomes. In fact, the student's ability to solve the problems is still low. It is proven by the data 9th grade students UTS in odd semester, it is only about 30% of students who can reach KKM math which is 70. Based on above explanation, it can be concluded that students' learning result is still low.

In dimensional matter, mathematics teacher of SMP Negeri 1 Majenang explains that students are still having difficulties to complete problems relating to the daily problems. The same thing happened to the curved-face three-dimensional object learning, the students have not been able to associate the subject matter to daily problems. They are confused to apply the concept related to the issue.

Seeing these conditions, the learning that can improve student learning outcomes especially mathematics literacy ability of students is highly necessary. An efficient learning can be achieved if the teacher uses appropriate learning strategies (Slameto, 2003). The strategy can be a learning model application in accordance with the existing situation. One of them is Problem Based Learning with Realistic-Scientific Approach (PBL-PRS). A learning through PBL-PRS which is applied is presumed can help students to be creative, independent, and improve students' mathematical literacy.

Indeed, PBL model is a learning approach which uses real problems as a context for students to learn about problem solving skills (Arends, 2007). It is also regarded as a model of student-centered learning that encourages them to develop their own knowledge (Huang & Wang, 2012). Through problem-based learning, students use a "trigger" which comes from problems or scenarios which determines their own learning goals (Awang & Ramly, 2008). Afterwards, the students solve the problem independently in which the learning is centered on them before returning to their group to discuss and choose the knowledge that they have had. Furthermore, it is an instructional model which is based on the many problems which require authentic investigation that is investigation that requires a real settlement of the real problem (Trianto, 2007). The realistic approach which uses reality and environment grasped by students is to facilitate the mathematics learning process to be better than the past. The reality means things which are real and concrete that can be observed and understood by students' imagination, while the environment means a student's environment in daily life (Turmudzi, 2004).

Furthermore, the learning with a realistic approach can increase the students' literacy skills that PISA refers to. It is in accordance with Wardono et.al (2016)'s research with PMRI PBL approach with Edmodo. It can improve the ability of mathematics literacy.

PMRI has various positive impact toward teaching and learning process in the classroom (Fauzan, 2002). Learning scientific approach is a learning process which has been designed in order students are able to actively construct concepts, laws, or principles through the stages of observing, formulating problems, proposing or formulating hypotheses, collecting the solution with a variety techniques, analyzing data, drawing conclusions, and communicating concepts, laws or principles which are found. It is expected can create learning conditions which aim to encourage them to find out from various sources of observation, and not only from the teacher (Daryanto, 2014). Above all, PBL realistic scientific approach is a combination of models and learning approaches that are considered suitable for solving problems related to daily problems.

At learning time, students have different learning styles in the material which is presented by teachers. There are students who focus on what the teacher says, to listen and then record it, and also to try or practice through physical objects as props. With regard to the fact that a student has a different learning style then how to solve the problem is also different. The differences will affect their mathematical literacy skills though. Teachers can use the understanding of learning styles to maximize students' learning outcomes and support effective learning by using teaching methods learning styles (Mousa, 2014). If they know their own learning styles, then the learning process in the classroom will run optimally. Likewise with the teacher, as an educator, he or she should be able to know students' learning style. By knowing it, he/she will process and carry out the learning in the classroom easily. He/she will choose the model, strategies, approaches, and methods to be used easily (Gokalp, 2013). Regarding to preliminary research, the researchers will identify the students' learning styles in learning mathematics literacy skills. Everyone has one or a combination of three types of styles of learning, namely visual, auditory, and kinesthetic learning style (DePorter & Hernaki, 2004).

The use of contextual issues must be supported by the media that can connect teachers and students to be better. The Internet can be a good learning media because it is cheap and can also be accessed anytime and anywhere. Internet use is highly recommended in a collaborative classroom learning (Kemendikbud, 2014). One of the social networks that has a variety of features to support the learning process is Edmodo. Edmodo is a social network which is designed for education. It provides a way to safe and comfortable learning both for teachers and students. It is operated as social media like Facebook. Teachers can post, send grades, assignments, quizzes, create a parameter, and gave the topic for discussion to the students (Pange & Dogoriti, 2014). Learning with Edmodo will make students will be more interested. Edmodo allows the students to interact with their teacher. Eventually, it will have a positive impact on students' learning outcomes.

Based on the background of the study, the problem in this study are (1) is the literacy skills of students with the mathematical model of PBL-PRS-E better than those with of PBL-PS and PS model; (2) is there any difference in mathematical literacy skills of students who have learning styles of visual, auditory, and kinesthetic; (3) is there any interaction between mathematics literacy skills with learning model based that is applied to the student's learning style, and (4) id the increase of students' mathematics literacy skills by using model PBL-PRS-E higher than by using model PBL -PS and PS. Rgarding to the problem statements above, this study aims (1) to prove that mathematical literacy skills of students with models of PBL-PRS-E is better than those who use PBL-PS and PS models; (2) to prove that there are differences in students; mathematical literacy skills who have a visual learning style, auditory, and kinesthetic; (3) to prove that there is interaction between mathematical literacy skills based learning model that is applied to the student's learning style; and (4) to prove that the increase in the literacy skills math student by using PBL-PRS-E model is higher than those who use PBL-PS and PS model.

2. Method

The population of this research is a 9 grade student SMP Negeri 1 Majenang. The sample is 9G as experiment group 1, 9E as experimental group 2 and 9F as a control group. The sampling technique is cluster random sampling. The research design is quasi-experimental design with pretest-posttest control group (Sugiyono, 2013). While the design was patterned after giving pretest, a different treatment, and posttest. This study used a control group and two experimental classes. In this study, the control group used scientific approach (PS), while the experimental group 1 uses PBL realistic-scientific approach with Edmodo (PBL-PRS-E), and the experimental group 2 used PBL scientific approach (PBL-PS).

Table 1. Pretest-Posttest Control Group Design

Group	Pre-test	Treatment	Post-test
$\mathbf{1^{st}}$ Experiment	O_1	X_1	O_2
$\mathbf{2^{nd}}$ Experiment	O_3	X_2	O_4
Control	O_5		O_6

Moreover, there are variables that study mathematics literacy ability of students. In collecting data, this study used method which consists of test, questionnaire, and documentation. Documentation methods used to obtain the required data, the value of the midterm grade odd 9E, 9F, and 9G SMP Negeri 1 Majenang academic year 2016/2017. The test method is used to obtain data on the results of the literacy skills of mathematics students on the material surface area and volume of the tube and the cone (Agus, 2007; Djumanta et al., 2008; and Kemendikbud, 2015), whereas the questionnaire method used to measure students' learning style.

In this study, the group obtained the surface area and volume of the tube and the cone. Before learning, pretest of students' mathematical literacy ability and learning styles classification was conducted by using the questionnaire. The questionnaire used was developed from the book Quantum Learning (DePorter & Hernaki, 2004) and Accelerated Learning (Rose & Nicholl, 2003). The learning activities were conducted three meetings, then continued by post-test to determine students' mathematical literacy ability. The test used has been tested and there were questions about which qualification that both based on reliability, validity, level of difficulty, and different power problems.

The results of the questionnaire, pretest, and posttest students' mathematical literacy ability are then analyzed to verify the research hypothesis. Analysis of these data include average difference test (one-way ANOVA test), two-way ANOVA test, and test an increase in the gain normalized.

3. Results and Discussion

The implementation of the learning process was conducted on three groups of samples. The treatment was given in the experimental group 1 is the PBL-PRS-E model, the experimental group 2 is the PBL-PS model, and the control group is the scientific approach. The meetings in the classroom for each group was five meetings, three meetings of learning, and two meetings to test students' mathematical literacy which consisted of pretest and posttest.

In the experimental group 1, students showed discipline and curiosity in both the discussion and determining contextual problem solving at LDS. The students can observe the contextual issues and continued with making questions which were submitted to the teacher. They actively discussed and found the information needed, in the presentation sessions some students explained the results of their discussion and the other students watched. They could draw conclusions and deliver learning outcomes. When the formative test was ongoing, students were working properly and orderly even though the outcomes were not satisfying. Some students who get less than the maximum value. Each teacher gave the assignment through Edmodo media.

In the experimental group 2, students showed discipline and curiosity character in both discussion and determining the settlement of problems in the LDS. The students can observe the problem and continued with making questions submitted to the teacher. They actively discussed and found the information needed, the presentation sessions some students explained the results of their discussion and the other students watched. Thye could draw conclusions and deliver learning outcomes. When formative test was held, they worked well although there were still some students who got less than the maximum value.

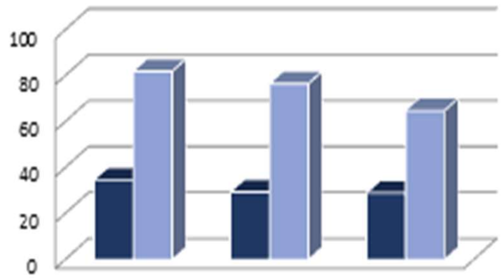
While in the control group, students showed discipline and curiosity in defining the problem-solving worksheets. The students could observe the problem and continued with making questions which were submitted to the teacher. During the presentation of their work results, they explained the results and other students watched. They could draw conclusions and deliver learning outcomes. When formative test was held, they worked well although there were still some students who got less than the maximum value.

3.1. The Result of Mathematical Literacy Ability Test

Based on the results of data analysis of pretest and posttest mathematical literacy skills, the data obtained from the third pretest and posttest study sample have a normal distribution and homogeneous variance.

Then, based on the results of mathematical literacy skills pretest, the experimental group 1 had an average of 34.68 with the highest score of 63 and the lowest score of 9, the experimental group 2 had an average of 29.35 with the highest score of 56 and lowest score of 9, and the group control has a class average 28.97 with the highest score of 60 and the lowest score of 9. Shortly, experimental group 1, the experimental group 2, and the control group were under the KKM.

Based on the results of mathematical literacy skills posttest, experimental group 1 had average grade of 81.91 with the highest score of 97 and the lowest score of 60, the results are satisfactory although there are 3 students whose score below the KKM. The experimental group 2 had average grade of 76.5 with the highest score of 96 and the lowest score of 60. The results are quite satisfactory although there are 3 students whose score below the KKM. Whereas the control group had an average grade of 64.85 with the highest score of 77 and the lowest score of 40. The result is less than satisfactory because there are 22 students who score below the KKM. The experimental group 1 and 2 have reached mastery learning while the control group has not.



$\mathbf{1^{st}}$ Experiment $\mathbf{2^{nd}}$ Experiment Contol

Figure 1. Graph of Result Test Mathematical Literacy Ability Students

3.2. The Result of Learning Styles Questionnaire

The process of determining student's learning style experimental group 1, the experimental group 2, and control group using a questionnaire is to measure students' learning styles which are developed from the book Quantum Learning (DePorter & Hernacki, 2004) and Accelerated Learning (Rose & Nichol, 2003).

Based on Table 2, it can be seen that a visual learning style students have better volume than auditory and kinesthetic learning style students. It shows that students tend to be happy to see or pay attention to what the teacher present during the lessons rather than listen or practice anything relating to learning.

Table 2. The Result of Learning Styles Questionnaire

Group	Visual	Auditorial	Kinesthetic
Experiment $\mathbf{1^{st}}$	16	8	4
Experiment $\mathbf{2^{nd}}$	16	7	2
Control	16	9	1

3.3. Result of Research

To find out whether there are differences in mathematical literacy skills of students between experimental groups 1, experimental group 2, and control group or not, average difference test (one-way ANOVA test) was used.

Based on the calculation results, it is obtained that $F = 41.554 > F_{table} = 3.09$, so H_0 rejected. It means that there are significant differences in the 9 grade students math literacy ability between the model-PRS-E PBL, PBL-PS, and PS. To know the difference, it needs further test. Further, the test used in this study is a further test of Tukey aided by SPSS 16.0.

Based on Tukey's test further research, it can be concluded that the average of students math literacy ability with the model PBL-PRS-E is more than those with PBL-PS models and more than those with PS.

Then, to find out whether there are differences in mathematical literacy ability of visual, auditory, and learning styles students, two-way ANOVA kinesthetic comparative test was used on posttest value of students' mathematics literacy ability which has been prepared based on the V-A-K learning style. The calculation of two-way ANOVA comparisons is shown in Table 3.

Table 3. The Result of Two Ways Anova

Sources of Variation	$F_{results}$	F_{table}	Sig
Group	10,539	3,12	0,000
Learning Model	0,080	3,12	0,923
Learning Model Groups	1,614		0,181

Based on Table 3, it is obtained $F = 0.080 < F_{table} = 3.12$, then H_0 is accepted. Thus, there is no difference in mathematical literacy skills in visual, auditory, or kinesthetic learning style students.

Furthermore, to find out whether there is an interaction between mathematical literacy ability based learning model that is applied to the student's learning styles, it is used two-way ANOVA comparative test on the value of the mathematical literacy ability posttest students who have been prepared based on V-A-C learning style. The calculation of two-way ANOVA comparisons is shown in Table 3.

Based on Table 3, it is acquired that $Sig > 0.05$, then H_0 is accepted. Shortly, there is no interaction between mathematical literacy ability based learning models that are applied to the student's learning style.

To determine whether there is an increase in the literacy skills of mathematics in the experimental group 1, the experimental group 2, and control class, the different test average pairwise, the increase the literacy skills of mathematics (test to gain normalized) test and the difference test in different average between pretest and posttest literacy mathematics were conducted.

Based on the test results of the average difference in pairs, it was concluded that an increase in students' mathematical literacy ability in model-PRS-E PBL, PBL-PS models, and learning happened by using scientific approach.

Table 4. The Result of Normalized Gaining Test

Experiment Group	$< g >$	$Criteria$
Experiment 1^{st}	0,72	High
Experiment 2^{nd}	0,67	Mid
Control	0,50	Low

Based on Table 4, it can be concluded that an increase in the experimental group 1 is in the high category, the increase in the experimental group 2 includes in the category, and the control group is in the category $3{,}12$ of increase. Besides, in average difference test of pretest and posttest in mathematical literacy skills, it is acquiredc$F = 35{,}152 > F_{table} = 3{,}09$. It means that there is a significant difference in the average difference between pretest and posttest os students' literacy ability on the surface and volume of the tube and cone material of 9th grade among the PBL-PRS-E, PBL-PS, and PS model. While to find out the difference, it is required to do a further test. It is a further test of Tukey aided by SPSS 16.0.

Furthermore, based on Tukey's test results, it can be concluded that an increase in os students' mathematical literacy ability with PBL-mode PRS-E is more than those with PS, but not more than those with PBL-PS.

3.4. Discussion of Research

Based on the results of preliminary research, it shows that students' mathematical literacy ability with the PBL-PRS-E model is better than those with PBL-PS model and better than those with PS. As Kusuma (2016) states that students' mathematical literacy ability in model PBL realistic-scientific approach with Edmodo is better than those with scientific approach. One of mathematics learning which gives positive impact on students' literacy ability is realistic mathematics learning which applies realistic approach. As the result, students' mathematical literacy ability can be improved.

Besides, the achievement of students' learning outcomes in the experimental class 1 is caused by several factors, as follows (1) using the PBL learning. Indeed, PBL model is considered as student-centered learning that encourages students to develop their own knowledge, find and solve problems independently (Huang and Wang, 2012). According to Arends (2007), the PBL learning consists of five phases namely providing an orientation about the problem, organizing students to examine, helping the investigation independently and groups, developing and presenting the artifacts and the exhibit, and the last is analyzing and evaluating. The PBL learning phase gives an orientation about the problem to the students in which they have to be actively involved in these activities. Then in the third phase that is helping the investigation, students are assisted by the teacher to get the right information, carry out experiments, search for explanation and solution to interact with group members, so that they can discuss the problems and ways how to determine the solution. Through the discussion, they can connect themselves to study, improve reflective thinking, and expand their knowledge. This is in accordance with one of the principles of learning theory of Piaget that is learning through social interaction, because the shared learning will help students' cognitive development. (2) Using realistic-scientific approach in linking mathematics to daily life. A knowledge will be meaningful for students if the learning process uses realistic problems (Wijaya, 2012). The scientific approach is intended to provide insight to the student in recognizing, understanding the various materials using scientific activities, so that information can come from anywhere and anytime does not depend on the information in teacher's direction. Therefore, the learning conditions are expected to encourage students to find out from various sources of observation, and not only being informed (Daryanto, 2014). (3) The use Edmodo media as a learning media. Edmodo which is assisted learning makes students become more interested in, and not only allows students to interact with teachers, it also had a positive impact on student learning outcomes.

In the implementation of PBL-PRS-E model, students were actively interacted and discuss the issues. They worked together if there were students who did not understand the other would have explained or asked for teacher's help. They also actively asked in which it encouraged them to be able to solve the problem correctly. Thus, they could solve problems and understand correctly, in consequence, their ability in solving mathematical literacy is increased.

Implementation of PBL-PS model in the experimental group 2 is similar to the implementation of experimental group 1, yet the difference is in the used media; Edmodo. In the experimental group 2, the teacher focused on the completion of material with a few lessons. In PBL-PS learning, students actively improved their knowledge. The improvement of the information they got from observing the issues which weregoing to be studied. Followed up by asking the information to find the concept itself with the problems of daily life which then try and make sense in group discussions using LDS, communicate the results of the discussion to obtain a conclusion which was same for all students. Afterwards, the learning was closed with the presentation by the teacher to the student by giving a quiz to find out how much students' understanding during the learning process. As for the development of information after learning depends on each student's self.

While the implementation of learning the scientific approach in the control group, students were still less than the maximum in solving the problem. Students had not been able to identify and resolve the issue appropriately. It was caused by not using Edmodo as the supporting media to their learning process.

Based on two-way ANOVA test result, there is no difference in mathematical literacy skills based on V-A-C learning style. This is due not to award a special learning on students who had different learning styles. They were given a different treatment for each group of experiments. They are also able to adapt to the learning environment. Students who have a visual learning style, auditory, and kinesthetic maximize their learning by observing what happens, understanding and solving problems that occur in their own way and communicate what they have earned. This is in accordance with the steps to the scientific approach (Nasution, 2013). Although each student's learning style is different, they know the learning objectives which have to be achieved. Therefore, they are able to optimize their ability to achieve these goals.

Based on two-way ANOVA test, there is no difference between students' mathematical literacy skills based on learning model which was applied and based on different learning styles. Hence, the learning model with no interaction of learning styles are independent or not influencing each other. It was probably caused by students who have different learning styles to adapt to the learning environment.

To find an increase in the experimental group 1, group 2 experimental and control groups can be seen in the following discussion.

In the experimental group 1, the ability on mathematical literacy of students is better than initial ability before being given a PBL-learning model PRS-E. Through the implementation of mathematical model, their literacy skills have increased. As Anni (2011) argues that in the implementation of learning, students were active in solving the problem by using the information which has already obtained to find the concept itself. Followed by processing the information to find the concept itself through the problems of daily life which are then manipulated in discussion groups using a sheet student discussion, props. Then to deepen the materials, teachers gave assignments through Edmodo media.

In the experimental group 2, students' mathematical literacy ability is better than the initial capability before being given with PBL-PS models. Through the implementation of mathematical model, their literacy skills have increased. That is because, in the implementation of student learning, they were also active in solving the problem by using the information which had been already obtained to find the concept itself. Followed by processing the information to find the concept through the daily life problems which were then manipulated in discussion groups by using a sheet student discussion, props.

Meanwhile, in the ability on mathematical literacy of students is better than initial ability the initial ability before being given a scientific approach to learning. With the implementation of the model of mathematical literacy skills of students has increased. That is because, in the implementation of student learning, they were also active in solving the problem by using the information which had been already obtained to find the concept itself through daily life problems.

4. Conclusion

Based on the results of research and discussion, the conclusions which can be drawn are as follows (1) the mathematical literacy ability of 9 grade students with the model PBL-PRS-E is better than by using model PBL-PS and PS, (2) there is no difference in the mathematical literacy ability of 9 grade students based on visual, auditory, and kinesthetic learning style, (3) there is no interaction between students' mathematical literacy ability based learning model to those who based on learning styles, and (4) the increase of mathematical literacy ability of 9 grade students with model PBL-PRS-E is higher than those with PS, but not higher those with PBL-PS model.

Regarding to above conclusion, the researchers suggest that the model PBL-PRS-E can be used as an alternative by the 9 grade mathematics teacher of SMPN 1 Majenang, Cilacap to improve the students mathematical literacy ability and VAK learning style of each student need to be identified so that teachers of SMP Negeri 1 Majenang can optimize the use of media and learning activity in the classroom, as well as optimizing the use of instructional media such as Edmodo to improve students' spirit and interest in learning mathematics. In addition, it helps the students in the communication between teachers and students anytime and anywhere.

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Misconception as a critical and creative thinking inhibitor for mathematics education students

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Abstract

The accurate understanding of critical thinking and mathematical creativity in solving the current problem is still difficult to standardize. These two thinking skills are indispensable to anyone who is studying mathematics, especially for Undergraduate Mathematics students who are studying Linear Algebra. However, the difficulties in critical thinking discourage students to think creatively and mathematically. In linear algebraic subject matter, many problems require critical reasoning. It goes without saying that the difficulties in various reasoning aspects critically cause other difficulties in developing creative thinking aspects. Further, mathematical critical thinking skills in solving problems require a background in understanding the concepts related to the problem faced. In addition, the failure to understand and connect between concepts in solving linear algebra problems makes it worst and difficult to critically and creatively think.

1. Introduction

In solving mathematics problems, students are required to understand the concepts which are related to the problems encountered. Students who lack of understanding the concepts will be hampered in developing their critical thinking skills in solving the problem. While students who are stuck in critical thinking will be hampered in developing their creative thinking skills. Mathematics education experts attempt to define concepts from different points of view. The concept is a tool used to organize knowledge and experience into various categories constructed by making connections between new information and conceptual networks or existing mental structures (Arends, 2008; Woolfolk & Margetts, 2013; Carpenter et al., 1988; Zahid & Sujadi, 2017). Gagne, as quoted by Nasution (2000) suggests that if one can deal with objects or events as a group, class, class or category, then he has learned the concept. Concrete concepts can also be obtained through observations in which it can be shown "what is the object". In consequence, it causes in the use of an inductive mindset in constructing concepts which are based on observations on specific cases given. As Slavin (2005) argues that concepts are generalized abstract ideas of specific examples.

A learner at a higher level may construct abstract concepts, for instance concepts in the form of definitions, such as the definition of "solution of an equation system", the definition of "vector space of a non-empty set", and the definition of "linear transformation of a vector space to another vector space". A new concept can be learned and then stored in a person's mind in long term memory. It will be better embedded in a longer time if the concept can be attributed to the concept which possesses and has already existed in his mind (Rochmad, 2010).

Besides, various definitions of critical thinking also have been delivered by many experts. According to Van de Walle (2007), critical thinking is a directional and clear process used in mental activities such as problem solving, decision making, analyzing assumptions, and conducting scientific investigations. By using critical thinking skill, it allows students to systematically study the

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problem, deal with challenges in an organized way, work on problems in various ways, design original solutions, and develop or more detail in their thinking. In other words, in this circumstance, it is highly necessary to think critically.

Regarding to preliminary research, this study discusses the deliberation of critical thinking which becomes the cause of the delay in critical thinking in solving algebra problems in the Linear Elementary 2 course in Bachelor Degree of Mathematics Education study program of Universitas Negeri Semarang.

2. Method

This study is a qualitative research which took 36 participants of Elementary Linear Algebra 2 subject as research subject. In collecting the data, this study used written test, observation, and interview method. Interview was used as clarification of student answers to their written answers, as well as triangulation which focuses to find out the connection between conceptual error and critical thinking.

To obtain data of the relationship between conceptual ability and critical thinking ability, a written test was done with the following questions.

1. a. Write the complete sub-space theorem.
   b. Investigate whether $W = \left\{\begin{pmatrix} a & b \\ c & d \end{pmatrix} \middle| ad - bc = 0\right\}$ is a subspace of M_{2x2} (R).
2. Given that set S = {v_1, v_2, v_3, v_4} with v_1 = (1,0,1,1), v_2 = (-3,3,7,1), v_3 = (-1,3,9,3), and v_4 = (-5,3,5, -1). Find the subset of S which forms the basis for space spanned by S. What is the dimension?
3. Review B base = {p_1, p_2} and base B' = {q_1, q_2} with p_1 = 6 + 3x, p_2 = 10 + 2x, q_1 = 2, and q_2 = 3 + 2x.
   a. Find the transition matrix from B to B'.
   b. Calculate the coordinate matrix $[p]_{B'}$ with p = -4 + x.
4. a. Write the complete definition of linear transformation.
   b. Investigate whether F: P_2 → which is defined as $F(a_0 + a_1x + a_2x^2) = a_0 + a_1(x+1) + a_2(x+1)^2$ is a linear transformation.
   c. Let's say T is the multiplication by the matrix $\begin{pmatrix} 1 & 3 & 4 \\ 3 & 4 & 7 \\ -2 & 2 & 0 \end{pmatrix}$, look for T nullity..
5. a. Write the definition of a matrix diagonalizable.
   b. Investigate whether the matrix A = $\begin{pmatrix} 3 & -2 & 0 \\ -2 & 3 & 0 \\ 0 & 0 & 5 \end{pmatrix}$ can be diagonalized. If yes, then find the matrix P and determine P^{-1} AP.

The analysis is based on misconception indicators as follows: (1) inaccurate concepts definition, (2) improper or false the use concepts, (3) classifying incorrect examples of concepts, (4) misinterpretation of concepts with the meaning of the concept, (5) confusion because does not master the supporting concept yet; and (6) improperly linking the concept. In addition, critical thinking aspects which are observed include the ability: (1) to think in understanding and clarification; (2) to think in conducting assessment problem; and (3) to make inferences in problem solving. According to Perkins & Murphy (2006), critical thinking skills are often cited as aims or outcomes of education. So that the learning process in the school should be planned to help learners improve their critical thinking skills. Above all, in this study, critical thinking indicators refer to those which are proposed by Perkins and Murphy (2006) namely clarification, assessment, inference, and strategies.

3. Results & Discussion

Firstly, the analysis was done toward the result of 36 students' works on Linear Elementary Algebra 2. Based on the analysis results, it was found that the achievement index (IP) of 22 students can be categorized thoroughly in the course. From the obtained data, there are 4 students who get the value of 86 above with the IP acquisition of A, 2 students who get the value from 81 to 85 with IP acquisition of AB, 7 students with the value from 71 to 80 with IP acquisition of B, 4 students who get the value of 66 up to 70 with the IP acquisition of BC, and 4 students who get the value from 61 to 65 with the IP acquisition of C.

While 16 other students include in the category who have not been completed. From the obtained data, there are 5 students with value from 56 up to 60 with IP acquisition of CD, 4 students with value from 51 until 55 with IP acquisition of D, and 6 others get IP acquisition of E with value less than 51. Overall, the average value of students' works result in linear elementary algebra 2 is 61,33. If the value is converted into IP scoring system then obtained IP of C, so that it can be categorized completely.

Furthermore, a related-qualitative analysis of conceptual difficulties and critical and creative thinking skills was conducted. In solving students' algebra problems, it is involved the understanding and mastery of algebraic concepts which was going to be used. However, the difficulties in understanding concepts or connecting between concepts hampers in critical and creative thinking. Nevertheless, the main conceptual difficulties directly impact on the difficulty in critical thinking. The following information relates to some misconceptions of students in solving problems and their relation to critical thinking.

Based on the analysis of the written test results of the students in defining the subspace of a vector space; defining a linear transformation; and defining the diagonalizable matrix results in the following causes of misconceptions as follows.

3.1. Do not know the concept in question

When the students were asked to write the definition of linear transformation; they did not answer at all. For example for question 4a: "Write down the definition", yet not write anything; it indicates that the student does not know the concept. From this ignorance, the student probably forgets how the concept of linear transformation is. Also, they did not answer when they were asked to write the definition of a matrix which is can be diagonalized (question 5a): "Write the definition of a matrix which can be diagonalized"

3.2. The concept was incorrectly answered.

3.2.1. Confusion: answering the concepts that he feels to know or memorize, yet the answer is out of expectation.

Based on the data in Figure 1, from question 1a, student has to answer the question relates to a rule which can be used to indicate a subspace of a vector space; in fact, he answers the definition of vector space, indeed the answer is wrong. This student's confusion is also predicted caused that he lacks of mastery of other concepts such as indicated by writing $\{v_1, v_2, v_3, ..., v_n)$ which contains R^n. The vector space concept error that students think if it is linear based. Thus, they suffer from misconceptions due to confusion: about the concept which is being asked, about the concepts that are supposed to support it; in relating one concept and others. As a result of this misconception, his confusion continues. He cannot work correctly with question 1b, which does not use the concept which he wrote at 1a.

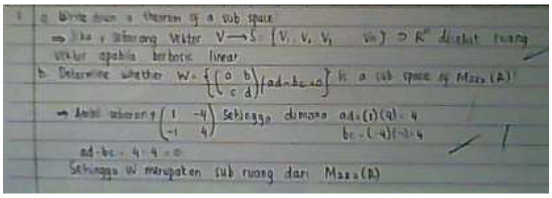

Figure 1. Student's confusion in answering

3.2.2. The existence of overlapping knowledge and unable to sort it out.

Firstly, students have to understand what is being asked, write down what will be defined that is vector subspaces (usually called subspaces only), yet they remember about other concepts that encompass it namely 10 vector space axioms, consequently, he is carried toward the concept of vector space axioms. The Figure 2 is as an illustration of student misconceptions.

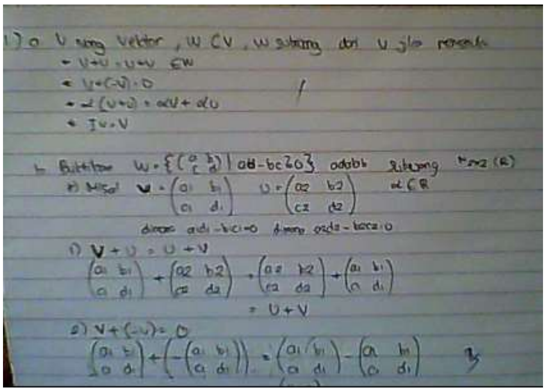

Figure 2. Overlapping Misconceptions

The student's mindset is first when entering the subspace sphere of vector space V; they have already focused their thinking on added "+" and the multiplication results scalar α with vectors; but they enter the realm of vector space axioms; cannot sort it out so it does not return to the subspace sphere. It is also illustrated in figure 3.

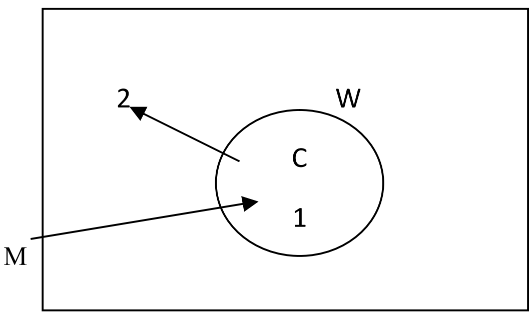

Figure 3. Students have difficulty connecting between concepts

In answering this question, at first student's thought was M is outside V (also outside W). After he understood the problem he made the mathematical symbols of the vector space and its subspace represented by W. He made V as vector space and W as the subset of non-empty V. He had known that he had to find the rules (definitions or concepts) that can be used to show that W is a subspace of vector of V. The position of M is at 1that is in the set of W. He wanted to answer the question: how the theorem which can be used to determine that W is a subspace of V. Then he remembered that the vector space must have two operations: addition and multiplication operation with scalar. Above all, misconception occurs when student was reminded of 10 vector space axioms; it means that his thought is in position 2 out of W into V and tried to find a match for the definition.

Basically the third line written by the student, $\alpha(a+b), \forall a, b \in V;\ \alpha \in R$, is a rule (definition) to show that W is a subspace of V. The overlap concepts affect the student being unable to sort them out of 10 vector space axioms (that only 1 and 6 axioms and if it is filled, it indicates that W is a subspace vector of V), as the result misconception occurs. The rules obtained were used to solve the question number 1b, in which it went without saying resulted in a wrong solution.

According to Smolleck & Hershberger (2011), the term of misconception is used to describe situations in which student's ideas about concepts are different from scientists. The difference between theoretical concepts and the imprecise notions of the scholarship leads to misconceptions. Meanwhile, according to Luz, et al (2008), misconceptions are understood as ideas that differ from those which are received by experts, yet constantly held by students as a result of repeated experiences with their daily phenomena. The use of wrong concepts stored in their minds which affects the occurrence of mathematical misconception.

Moreover, concepts in mathematics are abstract ideas that can be used, enable and facilitate people in grouping an object or event into the sample or not. In mathematics learning, including linear algebra, students should understand the concept first; and sometimes the concept is hierarchically arranged. However, difficulties in understanding concepts (misconceptions) will hamper their critical and creative thinking. According to Urban (2005), to test the traditional creative thinking ability, all this time they are only given a quantitative information about creativity which is obviously less precise. Indeed, qualitative aspects need to be put forward in testing students' critical and creative thinking skills. Further, the analysis of creative thinking is based on indicators of creative thinking, as follows: (1) clearly; (2) flexibility; (3) originality; and (4) elaboration. While concepts are the building blocks of thinking, the basis of the higher mental processes id to formulate principles and generalizations. To solve a problem, a student has to know the relevant rules which are based on critical and creative thinking aspects.

Regarding to above explanation, this study is concerned with the effect of creative activities on high thinking skill level. Students who are taught and given creative activity (instruction with creative activity) have a higher thinking skill better than those who are taught without creative activity (instruction with no creative activity). However, the final test results of both groups are not significantly different there was no significant difference between pre-test and post test of the two groups (Ramirez & Ganaden, 2008).

Regarding to explanation above, the participation of the undergraduate students of Mathematics Education is very important in the formation of creative young generation, capable of producing something for themselves, others, and their environment. Creative is also intended for prospective mathematics teachers to do learning to solve various problems which fulfill various aspects of creative thinking. According to Storm (Sharwa, 2014), the end of creative thinking is a major concern in the world. The role of learning in developing students' thinking skills, such as creative thinking, is an important aspect that contributes to the success of mathematics education. According to Sharma (2014), in education, creativity should include a variety cognitive and skills-based knowledge, as well as the development of students' interests, values and beliefs in creative activities.

To cultivate critical mathematical thinking skills, math learning is needed which involves students' thinking in every learning process. As Duron et al. (2006) argue that it would be difficult to cultivate critical thinking skills when only using teacher-centered learning. A suitable lesson to develop students' critical thinking is learning that uses a student-centered approach.

Another opinion from Jacob and Sam (2008) in the same issue that is the process of critical thinking of students is the stages experienced by students to solve open problems. This study refers to Jacob & Sam (2008) who define 4 stages of critical thinking process, as follows: (1) clarification which is a phase stage in which student formulate problem correctly and clearly; (2) assessment which is the stage in which students find the important questions in the problem; (3) inference which is the stage in which students make inferences based on information that has been obtained; (4) strategy which is the stage in which students think openly in solving the problem. According to Fascione (2011), someone who has critical thinking ability can be indicated through ability of (1) interpretation, (2) analysis, (3) evaluation, (4) inference, (5) explanation, and (6) self-regulation.

According to research conducted by Recio & Godino (2001), it can be assumed that there are still many college students in the first semester who think as concrete as in operation phase with inductive reasoning and less able to learn mathematics by using deductive mindset. As Recio and Godino explain that the ability of critical and creative thinking of undergraduate students of Mathematics Education is low. Based on the results of preliminary studies, it is pointed out that the students' lack of criticism is caused by the inaccuracy in changing from written language into the language of mathematics.

Though Winn (2004) argues that teachers should teach critical thinking. The disposition of critical thinking and problem-solving skills become essential to daily life. Winn states that few teachers use and discuss strategies which lead to building students' creative thinking. To understand a topic, students must be able to think freely and apply the skills obtained from learning skills (Saurino, 2008). For example, class writing activity is one way to understand the concepts and structure of mathematics (Consiglio, 2003).

Again, Facione (2011) argues that critical thinking as a skill with the self-realization of self-regulation in giving reasoning considerations to the evidence, context, standards, methods, conceptual structures by which a decision made about what is believed and distrusted. A broader understanding of critical thinking encompasses the characteristics of critical thinking which involves inductive and deductive reasoning, reflective thinking, dialectical thinking, and problem solving (Chan, Dixon, Sullivan, Tang, & Tiwari, 1999).

4. Conclusion

Based on the description of analysis, it can be concluded that generally, the undergraduate students of Mathematics Education in following the Linear Elementary Algebra 2 course have to get mastery in learning. Some students have difficulty in critical thinking. This difficulty makes them difficult to think creatively. These difficulties are caused by lack of understanding about the underlying concept of the problem, or difficulty in connecting between mathematical concepts.

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The effect of scaffolding techniques on the ability of student's reasoning ability and mathematics anxiety reviewed from gender

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Abstract

The research conducted in Madrasah Aliyah Negeri (MAN) Insan Cendekia Serpong with quasi-experimental design aims to find out the effect of scaffolding technique on students' ability of mathematical reasoning (KPM) and mathematical anxiety (KM) viewed from gender. The research sample is class X of science students (MIPA) which consist of 87 students; 41 male and 46 female obtained by cluster random sampling technique. The research data was obtained from the KPM test result and KM questionnaire filling and processed with two-track anava and t-test to answer the research hypothesis. The findings of this research are: (1) students' KPM who were taught with scaffolding technique is higher than the conventional; (2) there is no interaction between learning techniques and gender to KPM; (3) KPM of male students who were taught with scaffolding technique is higher than the conventional; (4) there is no difference of KPM between group of female students who were taught with scaffolding and conventional technique; (5) there is no difference of KM between group of students who were taught with scaffolding and conventional technique; (6) there is no interaction between learning techniques and gender to student's KM; (7) there is no difference of KM between male students who were taught with scaffolding and conventional technique; (8) there was no difference of KM between female students who were taught with scaffolding and conventional technique.

1. Introduction

Problems encountered in mathematics learning are the assumption of mathematics is difficult, the habit of memorization, and the inability to convey arguments over answers obtained from a mathematics problem. It is experienced by many students in Indonesia. As a result, generally their level of mathematics achievement is low. This fact is supported by data from TIMSS (Trends in International Mathematics and Science Study) which notes that Indonesia's position is far below Malaysia, especially compared to Singapore. Overall, the cognitive achievement of 8th grade Indonesian students is ranked 38th out of 45 participating countries of TIMMS in 2011.

According to NCTM (2000), the achievement of the ability to construct mathematical conjectures, develop and evaluate mathematical arguments, select and use representations are the standard things needed in the mathematical reasoning. Further, to assist students fulfilling these standards, NCTM emphasizes on the importance of classroom math discussion. Students do not only discuss reasoning with teachers and friends, but they can also explain the basis of their mathematical reasoning, both in writing and oral through discussion.

With regard to that symptom, the effective teachers will support students to make connections of knowledge by allowing them to engage in challenging tasks and giving chance that they can explain their solution and think the strategies, as well as listen to others' thoughts (Anghileri, 2006). In addition, they will help students to create, refine, and explore allegations on the basis

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evidence and use various arguments and verification techniques to confirm or disprove the allegations. As a result, students will be more flexible in their role as problem solver. For more, they will appreciate math more and be actively involved in mathematics learning. However, the students' positive attitudes and behaviors unlikely arise if they experience mathematics anxiety in learning process.

Mathematicz anxiety is a real problem faced by students and teachers. One of the contributing factors of students' mathematicz anxiety is the type of learning method used in the classroom (May, 2009). In line with that opinion, Steele & Arth (1998) state that the main source of mathematics anxiety is the "explanatory-practice-memorization" approach into teaching. Though, Clute (1984) explores how two methods of learning, discovery and expository, interact with students' mathematics anxiety in the core classes of undergraduate mathematics curriculum. He found that students with high levels of mathematics anxiety achieved high marks on achievement tests if they were taught using expository methods, and vice versa. Students who have low levels of mathematics anxiety got better value if taught by the discovery method. In addition, the postulate of Greenwood (1984) states that the main cause of mathematics anxiety can be found in teaching methods and mathematics classes in which it does not encourage the aspects of reasoning and understanding. Therefore, it is necessary to consider the methods or solutive learning techniques to solve the problems in mathematics learning, especially mathematics anxiety.

Scaffolding technique is a technique that gives a new skill by asking students to complete the tasks which are too difficult to solve by their own and teachers can provide full and continuous learning assistance. The students' mathematical reasoning abilities can be developed by providing meaningful guidance and support from the teacher. Such guidance and support become one of the characteristics of a learning strategy of scaffolding technique. In this case, it helps them to build an understanding of new knowledge and processes. Once the students get a sufficient and correct understanding, then by the time it can be reduced and even eliminated.

Moreover, scaffolding supports students to receive a good response. It does not only give a positive impact in the learning process, but also in building social relationships with students, both men and women. Therefore, scaffolding technique that applied in this study, was chosen to determine the effect on mathematical reasoning ability as well as students' mathematics anxiety in terms of gender aspect.

Then, a review of gender conducted in this study is based on the circumstance that gender development in boarding schools with religious nuances may differ from public schools. Male and female students who have different characters become interesting things to examine related to how mathematical reasoning ability and mathematics anxiety in scaffolding learning technique, considering the technique has already proved gives positive effect to the students' success in math class though, as revealed in the research conducted by Stragalinou (2012) and Frederick et al. (2014).

Based on the description of the background above, there are several research problems that can be drawn, as follows: (1) is there any difference in the ability of mathematical reasoning between students who are taught by scaffolding to conventional technique? (2) Is there an interaction between learning technique and gender to students' mathematical reasoning abilities? (3) Is there any difference in mathematical reasoning ability of male students who are taught by scaffolding to conventional technique? (4) Is there any difference in mathematical reasoning ability of female students who are taught by scaffolding to conventional technique? (5) Is there a difference in mathematics anxiety between students who are taught with scaffolding to conventional technique? (6) Is there an interaction between learning technique and gender to students' mathematics anxiety? (7) Is there a difference in mathematics anxiety of male students who are taught by scaffolding to conventional technique? (8) Is there any difference in mathematics anxiety of female students who are taught by scaffolding to conventional technique? Shortly, the research problems are summarized into a research objective that is to find out the effect of scaffolding technique on students' mathematical reasoning and mathematics anxiety in terms of gender.

1.1. Mathematical reasoning abilities

Reasoning is a special kind of problem solving (Dominowski, 2002). In other words, reasoning is a particular part of the problem-solving work that is part of doing mathematics. Completing a math task is the completion of the series of sub tasks with different characters and grain sizes. If the sub-tasks are not routine, then the following four steps can be used as a way of illustrating reasoning (Lithner, 2000), they are as follows: (1) problem situation is understandable, the difficulty is unclear how to proceed; (2) strategy selection, one possibility is to try to choose (in the broad sense: pick, remember, build, find, etc.) the used strategy to overcome difficulties. This choice is supported by the predictive arguments: will this strategy overcome difficulties? Otherwise, the students choose another strategy; (3) strategy implementation, it can be supported by verification argumentation: is the strategy overcoming difficulties? Otherwise, students repeat step (2) or (3), depending on if one thinks the problem is on the selection of strategy or in the implementation of the strategy; (4) conclusion, a solution has been obtained. As well mathematical reasoning ability which is based on the opinion of Kilpatrick et al. (2001), Brodie (2009), Lithner (2000), and Sidenvall et al. (2015) is the ability to create a line of thought or a chain of arguments in writing that is generated to convince oneself and / or others about the truth of a statement or doing math which involves the process of thinking skills, from understanding the problem, choosing and applying the strategy, until drawing deductive conclusions as well inductive.

1.2. Mathematics Anxiety

Mathematics anxiety is described as panic, powerlessness, paralysis, and mental disorganization that arise between individuals when solving a mathematical problem (Tobias & Weissbrod, 1980). It is characterized with the anxiety when he or she is asked to do mathematical work, he or she avoids math classes until the last time, physical pain, fainting, fear, or panic, the inability to do the test, little success is obtained from the utilization of tutoring sessions (Smith, 1997). With regard to explanation above, mathematics anxiety can be seen from three symptoms; physical, psychological, and behavioral symptom. First, physical symptoms of mathematical anxiety are the increased heart rate, sweaty hands, abdominal pain, and lightheadedness. Second, psychological symptoms include an inability to concentrate and feelings of helplessness, worry, and disgrace. Third, behavioral symptoms include avoiding math classes, delaying math homework until the D time, and not learning regularly (Woodard, 2004).

The mathematical anxiety used in this research is cognitive, somatic, learning strategy, and attitude. These four aspects were adapted from two instruments, the mathematics anxiety instrument developed by Ko & Yi (2011) and Cooke et al. (2011). The indicators developed from these 4 aspects are created to measure the level of mathematical anxiety based on the students' experience in school situations.

1.3. Scaffolding

Scaffolding instructions that support the development of reasoning and evidentiary capabilities are further investigated in a study by Meyer & Turner (2002). Teachers need to create a classroom environment so that students can be directed to create conjectures, generalizations, justifications, opening minds, listening, and reflecting on their peer contributions. Through questioning, teachers can build the environment as described by Martino & Maher (1999) which describe three types of question strategies. Questions that investigate justifications such as, "are you absolutely sure of that answer?", Questions that offer an opportunity for generalizations, such as "does that apply to all cases too?", Questions that trigger students to make a relationship, such as "what is the relation between the two things?". The definition of scaffolding is a learning technique applied to students in which there is selective intervention of teachers in providing assistance to students to some extents to develop their ability in completing tasks that previously seemed impossible to complete. Meanwhile, the scaffolding practices applied in this study were adapted from Anghileri (2006).

1.4. Gender

The definition of gender which refers to the opinion of Blakemore, Berenbaum, and Liben (2009), Egan & Perry (2001) cited by Santrock (2011), also opinion Puspitawati (2013) is characteristic of a person as male or female through different functions, status and responsibilities to male and female as the result of socio-cultural constructions which are embedded through the process of socialization from one generation to the next and may change in its development, depending on the factors that influence it. Furthermore, the gender in this study is about male or female.

2. Method

Quasi-experimental designs were used because random allocations were practically difficult to do.

The experimental group is determined by an existing arrangement, such as the class chosen to be part of the treatment, while for the control group is a class which is similar to the experimental group. Meanwhile, this study did not make a new group, but used the existing groups of classes that have been naturally formed. The normality test, homogeneity, and average equality of four classes (two experimental classes and two control classes) use final exam of first semester (UAS- 1). For more, the number of female students in the experimental and control classes is same; 23, while the number of male students is respectively 21 and 20. The number of students in the experimental class is 44, whereas in the control class 43. Further, the form of the research design is as follows:

Table 1. Research Design

Group determination	Treatment	Testing
R	X	O
R	–	O

The data of this research were obtained through the students' filling on two types of instruments, namely the cognitive test of the ability of mathematical reasoning and non-test instrument to measure the affective aspect through the mathematical anxiety questionnaire. Both instruments are tested for validity and reliability. To determine the validity of mathematical reasoning instruments, content validation ratio was performed by five experts (three mathematics lecturers and two math teachers) and empirical validity (pilot test). Further, mathematics anxiety instrument is a non-test instrument in the form of rating scale with five choices of answers, they are never, rarely, often enough, often, and always. The higher the total student score will be, so will the level of mathematical anxiety. The questionnaire was constructively validated by two psychologists, two lecturers of mathematics, and two Indonesian teachers, while for empirical validity the product moment correlation coefficient formula was used. Above all, the result of the test instrument obtained by Alpha Cronbach coefficient is 0.92.

3. Findings and Discussion

The process of research data is done with the help of statistics software SPSS v23 and Excel. Mathematics anxiety data using Likert scale (ordinal data) is converted first with Method of Successive Interval (MSI) as for ordinal data is actually qualitative data. The interval successive method itself is the process of converting ordinal data into interval data. As for the Pearson correlation procedure, t test, and anova require interval-scale data. The data conversion is done with the help of Excel. The prerequisite test of the research data in the form of normality, homogeneity, and average equality is done before anova test.

3.1. Results of Mathematics Reasoning Ability Data Process

The result of the data of mathematical reasoning ability (KPM) in Table 1 which is obtained from t and anava test with significance level $\alpha = 0{,}05$ shows that the mean score of KPM in the scaffolding technique learning group (A) is 73.98 with standard deviation of 12.83. Meanwhile the mean score of KPM in the conventional learning group (B) is 68.02 with the standard deviation of 11.65. In other words, the mean score of KPM in group A is 5.9 points higher than group B.

Table 2. Results of KPM Data from Two Groups

Group	*N*	$\bar{x}$	*SD*	*t_count*
Scaff (A)	44	73,98	12,83	2,27
Conv (B)	43	68,02	11,65	

Df	*F*	*p*	*ES*	*Power*
85	5,13	0,026	0,057	0,61

Table 1 shows the value of t_count = 2.27, while t_table with $\alpha = 0{,}05$ and degree of freedom of 85 is obtained value 1.66. Because t_count > t_table, then H_0 is rejected, so it can be concluded that the average of KPM test scores of scaffolding technique students group is higher than conventional. It also can be seen from value $p = 0{,}026$ which is less than 0.05 (the rejected H_0 criterion is $p\,value < \alpha$) or a value $F = 5{,}13$ which is greater than F (0.05; 2; 84) = 3.11.

According to Cohen, 2000 (in Cohen et al., 2007), effect size (ES) is a simple way to quantify or measure the differences between two groups, such as experimental and control groups. Thus, it can be concluded that ES is a measure of the effectiveness of a treatment. It can be calculated in several different ways. Glass et al., 1981 (in Cohen et al., 2007) calculated the effect size through the formula:

$$\frac{\bar{x}_{experimental} - \bar{x}_{control}}{SD_{pooled}} \quad \text{with}$$

$$SD_{pooled} = \sqrt{\frac{(N_E - 1)SD_E^2 + (N_C - 1)SD_C^2}{N_E + N_C - 2}}.$$

Based on the criteria proposed (if using Cohen's *d*), the range of ES values is as follows: 0 – 0.20 = weak effect; 0.21 – 0.50 = modest effect; 0.51 – 1.00 = moderate effect; and ES> 1.00 = strong effect. Yet, if it is calculated by the formula, it is obtained that the value of d = 0.49 (category of modest effect, it means that the applied learning technique was not quite enough to affect the KPM).

The effect size is obtained from SPSS output with anava test (see partial eta squared, η^2 partial). Based on Cohen, 1988 (in Cohen et al., 2007), the reference of η^2 partial value is 0.01 = very small effect; 0.06 = moderate effect; and 0.14 = very large effect. Thus, in Table 1, the η^2 partial value = 0.057 includes to moderate effect. In other words, as much as 5.7% of the variance in the KPM variable can be explained through the instructional techniques, either by scaffolding or conventional learning technique.

Then, power is the ability of statistical tests to detect the effect of treatment on relationships or differences. It is also defined as the probability that a study will reject H_0 when it is false (Murphy et al., 2014). The relationship of power value with β (the probability of making a type II error or the probability of failure to reject the incorrect H_0) is as follows: $Power = 1 - \beta$. The acceptable power value is 0.80 or more. In Table 1, the number of power obtained from anava is 0.61, so $\beta = 0{,}39$ is obtained.

The SPSS output of interaction test results between learning techniques and gender to KPM is presented in Table 2. From the table, it can be concluded that there is no interaction between learning techniques and gender to students' mathematical reasoning abilities. In Table 2, the *p* value (0.024, 0.073, and 0.590) indicates that there is one value (on the technique line) which indicates a difference (*p* value is less than 0.05), while the other two (on the gender line and interaction), there is a significant difference (*p* value is greater than 0.05). In addition, there is insufficient evidence to detect engineering effects, gender effects, or the interaction effects (observed power 0.62, 0.434, and 0.083, all is less than 0.80).

Table 3. The Anava Test Results of KPM Data

Dependent Variable: KPM_Score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Observed Power[b]
Corrected Model	1303,763[a]	3	434,588	2,946	,038	,096	,680
Intercept	438558,586	1	438558,586	2973,125	,000	,973	1,000
Teknik	774,418	1	774,418	5,250	,024	,059	,620
Gender	485,747	1	485,747	3,293	,073	,038	,434
teknik * gender	43,246	1	43,246	,293	,590	,004	,083
Error	12243,134	83	147,508				
Total	452540,000	87					
Corrected Total	13546,897	86					

a. R Squared = ,096 (Adjusted R Squared = ,064)

b. Computed using alpha = ,05

Table 3 shows that the t_count of independent t-test for male students in groups A and B of 1.89, while t_table = 1.69 ($\alpha = 0{,}05$ and *df* = 39). Because t_count > t_table, then H_0 is rejected, so it can be concluded that there is difference mean of KPM test scores between male students in group A and B. Then, on female students in group A and B obtained value t_count = 1.31, while t_table = 1.68 ($\alpha = 0{,}05$ and *df* = 44). Since t_count < t_table, then the criterion H_0 is rejected, so it can be concluded that there is no difference in the average KPM test scores among female students in groups A and B. The other component interpretations in Table 3 are analogues such as Table 1. The *p* score on male students and female in groups A and B are more than 0.05. The effect size with male students is 0.084 and female is 0,038

Table 4. The results of KPM Data Process in Terms of Gender

Gender	Kel	N	$\bar{x}$	SD	*t_count*	*F*	*p*	*ES*	Power
Male	A	21	77,19	12,41	1,89	3,58	0,07	0,084	0,455
	B	20	69,80	12,59					
Female	A	23	71,04	12,76	1,31	1,72	0,20	0,038	0,249
	B	23	66,48	10,81					

3.2. Mathematical Anxiety Data Process Results

The result of data of mathematic anxiety (KM) in Table 4 with significance level $\alpha = 0{,}05$ shows that the mean score of KM in scaffolding learning technique group (A) is 68.70 with standard deviation of 12.85. The mean score of KM in the conventional learning group (B) is 67.07 with standard deviation of 11.78. In other words, the mean KM score in group A is 1.6 points higher than that of group B.

Table 5. The Results of KM Data from Two Groups

Group	N	$\bar{x}$	SD	t_count	df	F	p	ES	Power
Scaff (A)	44	68,70	12,85	0,62	85	0,38	0,54	0,004	0,094
Conv (B)	43	67,07	11,78						

Table 4 also shows the value of t_count = 0.62, t_table = 1.66 ($\alpha = 0{,}05$ and *df* = 85). Because t_tabel > t_count, it can be concluded that the KM scores of the students group of scaffolding learning technique are not different from the conventional. It is also seen from value $p = 0{,}54$ is greater than 0.05 or $F = 0{,}38$ which is less than *F* (0.05; 2; 84) = 3.11. Partial value η^2 = 0.004 which includes a very small effect. In other words, only 0.4% of the variance in KM variables which can be explained by learning techniques, either scaffolding or conventional learning techniques. Then, the value of power = 0.094 so $\beta = 0{,}906$. From the explanation above, it can be concluded that the probability of making a type II error is quite large, it is possibly due to sampling error.

The results of the interaction test between learning techniques and gender on KM are presented in Table 5. In Table 5, *p* values (0.573, 0.275, and 0.255) indicate that there is no significant difference for the techniques, gender, or interaction (*p* value is greater than 0, 05). There is also insufficient evidence to detect the effects of techniques, gender, or interaction (observed power 0.087, 0.190 and 0.203, all of them are less than 0.80). Thus, it can be concluded that there is no interaction between learning techniques and gender to students' mathematical anxiety. Moreover, with partial values η^2 = 0.016 then only 1.6% of the variance in KM variables which can be explained by the joint effect of learning techniques and gender.

Table 6. Anava Test Results of Mathematical Anxiety Data

Dependent Variable: Skor_Anxiety

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Observed Power[b]
Corrected Model	440,827[a]	3	146,942	,972	,410	,034	,256
Intercept	398745,572	1	398745,572	2637,281	,000	,969	1,000
Technique	48,461	1	48,461	,321	,573	,004	,087
Gender	179,295	1	179,295	1,186	,279	,014	,190
Technique * gender	198,483	1	198,483	1,313	,255	,016	,205
Error	12549,242	83	151,196				
Total	414055,000	87					
Corrected Total	12990,069	86					

a. R Squared = ,034 (Adjusted R Squared = -,001)

b. Computed using alpha = ,05

Table 6 shows the t_count of independent t-test in male students in group A and B of -0.39, while t_table = 1.69 ($\alpha = 0{,}05$ and *df* = 39), so it can be concluded that there is no difference in average score of KM between male students in groups A and B. Then, in female students in groups A and B the value of t_count = 1.27, whereas t_table = 1.68 ($\alpha = 0{,}05$ and df = 44) or it can be concluded there is no difference in average KM test scores among female students in group A and B. 0.4% of the variance in the male KM variables can be explained by the instructional technique (η^2 partial = 0.004) and by 3.5% of the variance in the KM variables of female students can explained by the learning technique (η^2 partial = 0,035). The probability of making type II error in KM data of male students is 93.3% because power = 0.067, while the probability of making type II error in KM data of female students is 76,2% because power = 0,238.

Table 7. The Result of KM Data Process viewed from Gender

Group	N	$\bar{x}$	SD	*t_count*	*F*	*p*	*ES*	Power
A	21	65,62	11,75	–0,39	0,15	0,7	0,004	0,067
B	20	67,15	13,34					
A	23	71,52	13,42	1,27	1,62	0,21	0,035	0,238
B	23	67,00	110,54					

3.3. Discussion

The findings of this study signify that students' reasoning ability can be developed in mathematics learning that is by scaffolding technique. The findings can be explained as follows, the practice of scaffolding applied to mathematics learning has a positive impact on student involvement in learning. The students' need to develop their mathematical reasoning abilities is reached because of the nature of learning with teacher meaningful assistance. Further, teacher assistance is done intensively and effectively, so they can get many information, such as knowledge that already gained by students, misconception, and learning difficulties experienced by students. In other words, teachers can actively diagnose the needs and understanding of students which is one of the elements of teaching with scaffolding technique (Hogan & Pressley, 1997). Then, the social interactions will be built, either between teachers and students or among students themselves in discussion situations. According to Yelland & Masters (2007), students can support each other through sharing strategies and articulating the reasons behind them. This causes a positive atmosphere in learning situation. For more, male and female students will be active and proactive in the classroom. Another impact of the learning situation developed is that students do not show significant mathematics anxiety. In other words, in scaffolding and conventional learning groups, there is no difference in mathematics anxiety between male and female students.

Based on the results of the data which lead to a reasonable conclusion that this study does not have sufficient evidence or power to detect significant influence even though in fact, such an effect exists. In this case, it may be because the number of sample is small (N = 87) and the error in sampling. All of power values shown in each table are less than 0.8. In addition, the value of effect size is also no more than 0.06. This research does not only refer from the p value in determining the criteria of conclusion, but also the effect size and power. The reason for the low power value is that the sample is too small to provide accurate and reliable results. A what Murphy et al. (2014) argue that a test would have statistical power at a higher level if the number of samples and effect sizes were enlarged, and the criteria for statistical significance were not rigid.

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4. Conclusion

The conclusions of the study which aims to determine the effect of scaffolding techniwue on mathematical reasoning ability (KPM) and mathematics anxiety (KM) of students are: (1) the KPM scores of students who were taught by scaffolding technique (group A) were higher than those were with conventional technique (group B); (2) there was no interaction effect between learning techniques and gender to KPM. It means that the influence of learning technique factors on KPM does not depend on gender factors, while the influence of gender factors on KPM does not depend on the factors of applied learning techniques; (3) KPM score of male students in group A is higher than group B; (4) there is no difference in KPM between female students in group A nad B; (5) there is no KM difference between students in group A and B; (6) there is no interaction effect between learning technique and gender to KM; (7) there is no difference in KM between male students in group A and B; (8) there is no KM difference between female students in group A and B.

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The students' activity profiles and mathematic problem solving ability on the LAPS-heuristic model learning

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Abstract

Problem-solving skills that cover the ability to understand problems, design mathematical model, complete the model and interpret the solution obtained are the abilities which students must possess. With regard to above symptom, this study described student's activity and mathematics problem solving ability based on SOLO Taxonomy on Laps-Heuristic learning model. The procedure of the study was done through providing learning with Laps-Heuristic model with mind mapping, observing student activity during learning, giving mathematics problem solving test, analyzing the result of mathematics problem solving test, classifying the result of mathematics problem solving test based on taxonomy of SOLO, choosing the subjects of study, interviewing selected subjects, and compiling the study results. While the procedures of data analysis of this study included data reduction, data presentation, and conclusion. Based on the result of the study, it showed that the students' activity was excellent due the fact that their scores were above 75% and their problem solving abilities were classified based on the SOLO Taxonomy consisting of 8 relational level students, 25 multi-structural level students, and 1extended abstract student.

1. Introduction

According to the Regulation of the Minister of National Education No. 22 of 2006, mathematics learning aims that students have the ability to solve problems which include the ability to understand problems, design mathematical models, complete the model and interpret the solutions obtained. In addition, in Curriculum and Evaluation Standards for School Mathematics, NCTM (2000) poses problem solving as the main vision of mathematics education in addition reasoning, communication, and connections. Hence, problem solving is one of the main objectives of mathematics learning and an important part of mathematical activity.

One of the characteristics of mathematics is possessing abstract study object, or often also called as mental objects (Soedjadi, 2000). The characteristics of this abstract inherent in the branch of mathematics that causes many students in elementary and secondary education have difficulty in studying and solving mathematics problems. The higher level of education, as well as the greater or more abstract properties exist in mathematics.

Based on the results of PISA under the Organization Economic Cooperation and Development (OECD) in 2015, Indonesia ranked 63 out of 70 countries in the field of mathematics with the score below the OECD average. In the same year, the result of the study shows that among the 49 countries participating in TIMSS (Trends in International Mathematics and Science Study), the achievement of Indonesian students in mathematics was ranked 44th. Based on the data obtained, it shows that the problem solving ability of students is still low. This is due to the lack of student interest in mathematics lessons because of the abstract mathematical characteristics. In addition, the problems faced by students above can be caused by the way the presentation of materials or learning models used by the teachers which have not been able to develop student activeness.

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According to Suyitno (2011), learning model that is often used in the learning of mathematics is an expository model which is essentially same as the lecture method and teacher-centered learning. Whereas teacher-centered learning actually less explores the potential of the students, so that learning becomes less active. For that, we need an innovative learning model that can help students to be more active and able to improve their problem solving skills.

Moreover, according to Risnanosanti (2008), to be an efficient problem solver, students need to know carefully what they really know and use their knowledge effectively. To be successful students, they need to know what they learn and how the best way to learn is. They should also know when to seek help when they encounter obstacles/difficulty in their lessons. Regarding to above explanation, one of innovative learning models that can help students to improve problem solving abilities is Logan Avenue Problem Solving Heuristic (LAPS-Heuristic) learning model. This is supported by Anggrianto et al. (2016) which state that problem solving and problem solution finding are the main characteristic of the LAPS-Heuristic learning model.

Again, according to Shoimin (2014), the learning model of Logan Avenue Problem Solving is a series of guiding questions in solution of the problems. LAPS (Logan Avenue Problem Solving) usually uses the question word what the problem is, is there any alternative, is that useful, what the solution is, and how to do it. While heuristic is a guide in the form of questions needed to solve a problem. Heuristics directs the students' problem solving to find solution from a given problem.

Meanwhile, to give a pleasant impression as well as to sharpen the creativity of students, then this learning model assisted mind mapping. According to Swadarma (2013), mapping is a technique of utilizing the whole brain by using visual images and other graphical infrastructure to form an impression. Meanwhile, according to Buzan (2013), the mind map can encourage problem solving by letting us see new creative breakthroughs.

Students' mathematics problem solving skills can be classified into several levels. Biggs and Collis in Putri & Manoy (2013) explain that each stage of cognitive response is the same and increasing from the simple to the abstract. The Biggs and Collis theory is known as Structure of the Observed Learning Outcome (SOLO) which is the observed learning structure. The SOLO taxonomy is used to measure students' ability to respond a problem which is classified into five and hierarchical levels: pra-structural, unsructural, multi-structural, relational, and extended abstract. In the field of mathematics, the SOLO model is used in assessing results. In the field of mathematics, the SOLO model is used in assessing students' cognitive results in several skills and scope of mathematics including statistics, algebra, probability, geometry, error analysis and problem solving (Ekawati, 2013). Thus, the objective of this study is to obtain an overview of student activity and problem solving skills of mathematics students on the model of mind-based Minded LAPS-heuristic based on SOLO Taxonomy.

2. Methods

The sample of this study is the students of class VIIA SMP Negeri 2 Ungaran which are randomly selected by random sampling technique. While the subject of this study is selected by using purposive sampling technique which is a technique of taking data sources with certain considerations (Sugiyono, 2015). The consideration in the selection the study subjects is based on the answers of written test results that are unique and the subject belongs to active and communicative students. Then, the selected subjects were interviewed and analyzed their problem-solving abilities based on SOLO Taxonomy in LAPS-Heuristic learning assisted by mind mapping.

Since the object of this study id to describe student activity and problem solving ability of student mathematics based on Taxonomy of SOLO, the approach of this study is descriptive qualitative study. It is a study that tries to describe and interpret the existing condition or relationship, growing opinion, ongoing process, current result or developing trend (Sumanto, 1990). While the data of this study are quantitative data which consist of observation of student activity and the result of students' mathematics problem solving ability test, while the qualitative data which were obtained from interview. It was done to know the reason of student's answer.

The steps which were done in this study were providing the learning with Laps-Heuristic model with mind mapping, observing student activity during the learning, giving mathematics problem solving test, analyzing the result of mathematics problem solving test, grouping the result of mathematics problem solving skills based on SOLO Taxonomy, selecting study subjects, conducting interviews on selected subjects, and compiling study results. Furthermore, the methods in collecting study data are mathematics problem solving test, student activity observation, and interviewing mathematical problem solving ability. The result of the mathematical problem solving test was analyzed and then selected by several subjects to be interviewed about mathematical problem solving ability.

Then, the analysis of students' mathematics-solving skills tests was done by using the indicators according to NCTM (2000), namely (1) building new mathematical knowledge through problem solving, (2) solving problems in mathematics-related contexts, (3) applying and adapting various appropriate strategies to solve problems, (4) observing and developing the process of solving mathematical problems. While the analysis of student's mathematical problem solving abilities based on SOLO Taxonomy was conducted by using indicators from Chick (1998), namelyy prastructural, unructural, multistructural, relational, and extended abstract.

The procedures of analysis included data reduction, data presentation, and conclusion. From the data that have been collected, then summarized and reduced to focus on student activity profile and students' mathematics problem solving ability based on SOLO Taxonomy in LAPS-Heuristic learning model assisted by mind mapping.

3. Result & Discussion

3.1. Students' Activity

The observation of student activity in LAPS-Heuristic learning model assisted by mind mapping is by using observation sheet of student activity. The results of the student activity assessment are then analyzed based on the final score obtained. The range of scores used on student activity observation sheets is adjusted to the assessment criteria as shown in Table 1.

Table 1. The Student Activity Observation Sheet Score Score Range

Score Range	Criteria
$1\% \leq x \leq 25\%$	Less
$26\% \leq x \leq 50\%$	Enough
$51\% \leq x \leq 75\%$	Good
$76\% \leq x \leq 100\%$	Excellent

The observations score of students' activity for each successive meeting in four meetings are 76.25; 95; 87.5; and 98.75. It can be seen that the score of the observation result of the students activity during the learning is very good as for they are in the range of score 76% ≤x≤100%.

According to Diedrich (in Hamalik, 1995), students' activities are divided into eight groups: visual, speech, listening, writing, drawing, motor, mental, and emotional activity.

Visual activity has three indicators, they are paying attention to teacher explanation; paying attention, reading, and studying the learning media (LKS); and studying the presentation of friends or other groups. While the average score of visual activity obtained is 3.5; 3.75; and 3.5. The second activity is talking activity which has an indicator that is active in asking questions, and able to express opinions or respond to questions in group discussions. The average score of speech activity is 3 and 3.25.

The third activity is listening activity that has an indicator the students are able to listen to explanations or conversations in the group discussion, and able to listen to explanations of the results of discussion from other groups. In a row, the average score of listening activity was 3.75 and 3.75. Furthermore, the fourth activity is a writing activity that has indicators making important notes or writing teacher explanations and discussion results, and able to make discussion conclusions. The average score of writing activity obtained is 3.75 and 3.75.

For morw, the fifth activity is a drawing activity that has an indicator in order to be able to solve mathematical problems in the LKS and quiz, and to write mathematical sentences according to problem questions. The average score of drawing activity is 3.75 and 3.5. Then, the sixth activity is motor activity that has indicator that student is able to be active in group discussion and ready to accept the next task. The average score of motor activity is 3.75 and 3.

The seventh activity is a mental activity that has indicator that student is able to follow the learning and actively follow the course of discussion or enthusiastic in listening to friend's presentations. The average score obtained for mental activity is 3.5 and 3. As well as the eighth activity is emotional activity that has the indicator that students are able in working on the problem independently, developing confident, discipline, initiative, and responsible character. The average score obtained is respectively 3.5; 3.5; 3; and 3.

Based on the results obtained, 15 of the 20 indicators of student activity are divided into eight activities, including excellent category. The 5 indicators of good student activity are the activity of asking questions (talking activity), ready to accept the next task (motor activity), actively following the discussion or enthusiastic in listening to the friend presentation, developing discipline and initiative character (emotional activity). This increased activity is the result of the application of LAPS-Heuristic learning model assisted by mind mapping.

In addition, the increase is caused by several advantages of LAPS-Heuristic learning model assisted mind mapping, as follows 1) it can cause curiosity and the motivation to build a creative attitude; 2) it generates original, new, distinctive, and varied answers and can add new knowledge; 3) it can improve the application of the knowledge which has been acquired; 4) it invites students to have problem solving procedures ang be able to make analysis and synthesis, and they are required to make an evaluation of the results of the solution; 5) it is an important activity for students who involve themselves (Adiarta et al, 2014). Thus, the student activity in learning with Laps-Heuritudes model assisted mind mapping increased. This is in accordance with Wahyuni et al (2015) study, that the learning model of LAPS-Heuristic as an alternative model of mathematics learning to develop the character of discipline and solving problem ability. In addition, the students also give positive response to the components and learning activities with Laps-Heuristic model (Purba, 2017).

3.2. *Problem Solving Ability*

The average score of the students' mathematical problem-solving skills is 86.4 with the score of 24 students is above the predetermined KKM. This shows that 79.4% of students reach the KKM. Based on these results, students are further grouped into SOLO Taxonomy level. The SOLO taxonomy is used to measure students' ability to respond a problem which is classified into five and hierarchical levels. The results of students' mathematics problem solving skills test have been grouped according to the SOLO Taxonomy as shown in Table 2.

Table 2. Students SOLO Taxonomy Level

SOLO Taxonomy Level	Number of Students	Percentage (%)
Prestructural	0	0
Unistructural	0	0
Multistructural	8	23,5294
Relational	25	73,5294
Extended Abstract	1	2,9412
Total	34	100

Based on Table 2, from 34 students of class VIII A SMP Negeri 2 Ungaran, which included 8 multistructural students with a percentage of 23,5294%, 25 relational students with a percentage of 73.5294%, and 1 abstract extended student with percentage of 2,9412%, it can be seen that the majority of students are at a relational level because students are able to re-examine the results obtained and can make the relevant conclusions. While there is no students who are at the prestructural and unistructural level because all of them already understand the problem and plan the problem solving well.

The result of mathematics problem solving analysis based on SOLO Taxonomy from 8 selected subjects is one student who belongs to the extended abstract level that is A12 subject. Four students belong to the relational level, they are A14, A20, A31, and A29 subject. Three students belong to multistructural level, as follows, A01, A09, and A15 subject.

While A12 subject is classified as extended abstract level. He is able to solve mathematics problems which are given by the researcher. He can understand the concept and determine the volume formula of building blocks of space and prism. From one item given, the A12 subject is able to work on the problem with three solutions with one of the solutions is by using the fractional concept. It shows that the A12 subject is capable in working on many interactions and abstract systems involving the widespread use of the data provided simultaneously. In addition, he is able to explain the relationship between the three solutions that he writes. In brief, he successfully reaches all mathematical problem solving indicators.

The A14, A20, A31, and A29 subject are in relational level. A14 and A20 subject can solve the problem in four ways. While A31 and 29 subject are able to solve the problem in three ways. The four subjects can understand the concept and determine the volume formula of building a flat side space, especially the volume of the beam. A14 and A29 subject are able to explain that the problem can be solved using the prism volume formula, but A14 does not write it on the answer sheet. In addition, all of them are able to explain the relationship of some of completions of the written subject. Hence, they successfully reach all of mathematical problem solving indicators.

Furthermore, A01, A09, and A15 subjects are classified as multistructural levels. They are able to solve the problem in two ways. The three subjects can understand the concept and determine the volume formula of building blocks of space. But they are unable to explain the second completion of the written subject. Nevertheless, when they are given a feed then they can explain well. However, A15 subject gives a less precise explanation of the second completion of the written subject. Shortly, they have not reached all the indicators of problem-solving abilities, particularly on indicators of observing and developing mathematics problem solving processes. This is in line with study by Fatchurrohim et all (2016), that the Laps-Heuristic learning model can improve students' conceptual understanding.

4. Conclusion

With regard to the description of analysis above, it can be concluded that student activity with Laps-Heuristic learning model including criteria is excellent. While the students' mathematical problem solving ability which is classified based on SOLO Taxonomy consists of 8 reational students, 25 multistructural students, and 1 extended abstract student.

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