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# The analysis of students' mathematical connection ability and responsibility in two stay two stray learning with problem cards

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Abstract

This research aimed to discover mathematics learning on Two Stay Two Stray (TSTS) learning assisted by effective problem cards on students' mathematical connection abilities and to describe students' mathematical connection skills based on responsibility for TSTS learning and students' responsibilities in TSTS learning. The method used in this research was a mixed method. The population in this research was students of class VII A - VII B on one of junior high schools in Semarang, based on random sampling technique. Then it was selected that class VII A as the experimental class and class VII B as the control class. The results of the research showed that (1) students' mathematical connection ability by using the TSTS model reached the Minimum Mastery Learning Criteria or called as *KKM* and classical completeness, (2) the mathematical connection ability of students by using TSTS learning was better than those with expository learning, (3) the subjects with high responsibility were able to achieve three indicators of mathematical connection ability well, subjects with moderate responsibility had differences in achieving mathematical connection indicators, while subjects with low responsibility were able to achieve one of mathematical connection indicator.



## 1. Introduction

Mathematics is a basic science that is very important for the development of modern technology. One of the objectives of mathematics learning is to help the students to be able to understand mathematical concepts, explain the interrelationship between concepts or logarithms in a flexible, accurate, efficient, and appropriate in solving problems. (Ministry of National Education, 2006).

In the Organization for Economic Co-operation and Development (2016: 5), the results of the Programme for International Student Assessment (PISA) survey in 2015 in the field of mathematics, Indonesia was ranked 63rd out of 70 countries. Indonesia is still low based on the international average score in the field of mathematics. Indonesia obtain a score of 386, while the international average score was 490. According to Provasnik et al. (2016: 5), math scores written by Trends in International Mathematics and Science Study 2015 (TIMSS), Indonesia ranked 51st out of 55 countries. Indonesian math scores are still low based on the international average math score, which is 397 out of 539.

The results of research conducted by Baki et al. (2009) show that the low benefit in teaching mathematics related to real life is 14.7%. Based on the research of Jaijan & Loipha (2012: 91) in Thailand, it shows that students' mathematical connection ability increases with active student learning, so that learning is not teacher-centered. The Mhlolo et al (2012: 1) study in South Africa shows that teachers must be able to streamline the learning process, so that students can develop their mathematical connection skills.

According to Hendriana et al. (2014: 1), the purpose of mathematics learning is to understand mathematical concepts and their applications and connect variables accurately, efficiently, and correctly and to apply mathematics in real life. According to Karakoc & Alacaci (2015),

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connections in real life can increase learning motivation of students and improve student performance and achievements in mathematics learning. Saminanto and Kartono (2015) explaine that the low mathematical connection ability of students because there is no application of the principles of learning.

According to National Council of Teachers of Mathematics (NCTM) (2000), if students can connect mathematical ideas, their understanding will be deeper and more lasting. The teacher must remind students about their previous experiences and require students to be responsible for what they have to learn and use that knowledge to understand and understand new ideas. So NCTM (2000) indicates that mathematical connections are divided into 3 aspects of connection groups which will be indicators of students' mathematical connection abilities, namely: 1) connecting among mathematical topics, 2) connecting mathematics with other sciences or other fields of study, and 3) connecting mathematics with real life.

The researcher has conducted a preliminary test of mathematical connection ability in the comparison material. The test was given to students of class VII A as many as 20 people. The results of the preliminary tests show that there are only 5 students who scored above the minimum criteria of mastery learning or called as *KKM*. It shows that the ability of mathematical connections in real life is still low. From these results, it can be concluded that students' mathematical connection ability in one of Junior High School in Semarang before the research was conducted was still low.

The character of responsibility is the prepared attitude of students to carry out their obligations in learning mathematics to solve mathematical problems. The indicators used in this research refer to the character indicators of responsibility in accordance with Aisha, et al. (2014: 45), namely: (1) discipline; (2) sportsmanship; (3) obedience to discipline; and (4) commitment in learning.

One of the learning models that can explore students' mathematical connection skills is the Two Stay Two Stray (TSTS) learning model. This TSTS learning model can make students actively involve in learning activities. It is in accordance with the opinion of Lie in Wardhani et al. (2012: 4) which reveal that the TSTS learning model is one of the cooperative learning models that provides opportunities for groups to share results and information with other groups. The researcher also used problem cards as the learning media. Thus, the TSTS model assisted by problem cards can create a learning that stimulates students to explore, discover and gain experience, and make mathematical connections.

Hamiddin's research in Miftachuddin et al. (2015: 3) shows that the use of TSTS models in mathematics learning can improve students academic achievement. TSTS requires students to be active in learning process. The group activities that enable the transfer of knowledge among students so that students become more active in seeking knowledge, complementing each other's material, and exchanging information, so that learning becomes more meaningful and encourages students to associate the various information to construct their own knowledge.

Based on the background of the problems described above, there several research problems, as follows (1) Is the application of the Two Stay Two Stray model assisted by problem cards effective against students' mathematical connection abilities? (2) How is the description of mathematical connection abilities based on groups of student responsibilities in the Two Stay Two Stray learning model assisted by problem cards? (3) How is the description of student responsibility in the Two Stay Two Stray learning model assisted by the problem card?

Based on the research problems, the purpose of this research is to find out (1) the effectiveness of students' mathematical connection abilities through the Two Stay Two Stray learning model assisted by problem cards, (2) the description of mathematical connection abilities based on student responsibility in the Two Stay Two Stray learning model assisted by problem cards, and (3) the description of student responsibility in the Two Stay Two Stray learning model assisted by problem cards.

Further, the hypothesis proposed in this research are (1) mathematical connection ability of students through Two Stay Two Stray learning assisted by problem cards achieve the classical mastery learning, and (2) mathematical connection ability of students through Two Stay Two Stray learning assisted by problem cards is better than ability students' mathematical connections through expository learning models.

## 2. Research Methods

This research used a mix method. According to Creswell (2014: 18), mixed method research is a research approach that combines or associates qualitative forms and quantitative forms. This

research uses a sequential/ gradual mixed method strategy. The population in this study were students of one of the junior high schools in Semarang in class VII of the academic year 2017/2018 in even semester. From the population, samples were taken by cluster random sampling technique, namely the experimental class selected was class VII A which was subjected to the learning model of Two Stay Two Stray assisted by problem cards and the selected control class was class VII B subject to expository learning. While class VII C was as a trial class of the instrument tests of the mathematical connection ability. To analyse the mathematical connection ability in terms of the character of the students' responsibility, the research subjects were taken by purposive sampling technique. Purposive sampling is a technique of determining samples with certain considerations (Sugiyono, 2016: 124). It was grouping students' responsibilities by using standard deviations according to Azwar (2015: 149) then selecting each of the students from high, moderate, and low responsibilities.

The design used in this research was posttest-only control design (Sugiyono, 2012: 112), whereas there were two groups with one group obtaining treatment called the experimental group and one group does not get the treatment called the control group. The quantitative research design which was used in this study is presented on the following table.

**Table 1.** Table of Research Design of Posttest-Only Control Design

| Class Classification | Implementation | Posttest |
|---|---|---|
| Experimental Class | $X$ | $O_1$ |
| Control Class | - | $O_2$ |

Information:
X: Two Stay Two Stray Learning
K: Expository Learning
$O_1$: post-test in the experimental class
$O_2$: post-test in the control class

The learning was conducted four times in the experimental class by using the TSTS model and the control class by using the expository model. The material used were a quadrilateral, namely the circumference and area of a rectangle, square, parallelogram, and rhombus. The variables used were independent variables and dependent variables in which the independent variable was the TSTS learning model and the dependent variable was mathematical connection ability.

The data collection techniques used in this research were (1) documentation which was used to obtain the data which were related to the research, (2) written tests which were in the form of posttest, (3) character questionnaire responsibility in mathematics learning, and (4) interviews which were conducted to obtain students' answer data on the test of mathematical connection ability.

The quantitative data analysis techniques used were (1) the analysis of prerequisite test data in the form of normality, homogeneity and average safety test, (2) the final data analysis in the form of prerequisite test which includes normality test to find out parametric or nonparametric statistics used, homogeneity test to find out what statistical tests were used, the hypothesis I test used the *t* test to test the achievement of the classical completeness limit on average and the *z* test to test the achievement of completeness limits in proportion, and the hypothesis test II using the *t* test and *z* test to test differences and expository .

The analysis of qualitative data used was the data from interviews and questionnaires. The analysis of interviews in this research was done by reducing data, presenting data and drawing conclusions. The validity of the data was done by triangulating the technique that was comparing the data from the results of the mathematical problem solving ability test through the interview data.

## *3.* Results & Discussion

### *3.1. Quantitative Research Analysis*

Based on the posttest results of mathematical connection skills, the result can be seen in the following table.

**Table 2.** Results of Student Mathematical Connection Ability

| Class Classification | Data | Result |
|---|---|---|
| Two Stay Two Stray Learning | Average | 77,40 |
| | Variance | 81,305 |
| | The highest score | 95 |
| | The low score | 62 |
| | The number of students who succeed | 17 |

| | | |
|---|---|---|
| Expository Learning | Average | 70,50 |
| | Variance | 88,368 |
| | The highest score | 90 |
| | The low score | 55 |
| | The number of students who succeed | 11 |

From Table 2, it can be seen that the experimental class' average value is higher than the control class'. So that the overall the data obtained can be seen that the experimental class is better than the control class.

*3.1.1. Normality Test*

Based on SPSS 21.0, it obtained sig = 0.200. Because sig = 0.200 then $H_0$ is accepted. So, both come from populations that are normally distributed.

*3.1.2. Homogeneity Test*

Based on SPSS 21.0, it obtained sig = 0.813> 0.05 then $H_0$ is accepted. So, both groups have the same variance.

*3.1.3. Test of Hypothesis 1*

Hypothesis 1 test was used to show that the mathematical connection ability of students through Two Stay Two Stray learning assisted by problem cards on average reaches the minimum criteria of mastery learning or *KKM* and classical completeness. Based on SPSS 21.0, the value of sig = 0.02 <0.05, then $H_0$ is rejected. So, the mathematical connection ability of students with TSTS learning assisted by problem cards has reached a minimum criteria of mastery learning of 77.50.

Based on the test of the proportions of one left, the value of $z_{count}$ = 1.03> $z_{tabel}$ = -1.64 which means the mathematical connection ability of students with TSTS learning is assisted by the problem card to achieve classical completeness.

*3.1.4. Hypothesis 2 Test*

Hypothesis 2 test was used to find out that the mathematical connection ability of students with TSTS learning is better than expository. Based on SPSS 21.0, the value of sig = 0.023 <0.05, then $H_0$ is rejected. So, students' mathematical connection ability with TSTS learning is better than expository.

Based on NCTM, students' mathematical connections have three aspects, namely connecting among mathematical topics, connecting mathematics with other sciences or other fields of study, and connecting mathematics with real life. In the aspect of connecting between mathematical topics, students are expected to be able to solve problems that have to do with other material in mathematics. The material should have been studied before the subject matter being taught. In the aspect of connecting mathematics with other sciences or other fields of study, students are expected to be able to solve problems that have to do with other fields of study, such as science, economics, and so on. In the aspect of connecting mathematics with real life, students are expected to be able to solve problems that have to do with real life or everyday problems.

In the TSTS learning model, students were given the opportunity to convey the results of the discussion to other groups, so that information was exchanged. The host provided information to guests who came, guests get information from other groups which will later be submitted to members of the original group. So, all students must understand the information obtained, then students would understand better because students must explain the results of group discussions and information obtained from other groups.

When each group resolved the problems they get on the problem card, the teacher monitored the course of the discussion while examining the answers they had done. When a group had an inappropriate answer, the teacher told them that it was not right and gave a few questions to lure students to complete and get the right answers. After the teacher ensured that each group succeeds in answering correctly and each group member understood the problem that had been resolved, the teacher invited students to carry out their role as host or guest by visiting other groups and exchanging information.

The results of the research are in line with Vygotsky's theory of social interaction with others that spurs the development of new ideas and enhances learners' intellectual development, as the TSTS model that applies group discussion activities in learning to understand the material and solve problems. It is in accordance with Vygotsky's theory (Trianto, 2011), namely after carrying out group discussions, the teacher gives an opportunity to the group representatives to present the results of the group discussion to be presented in front of the class. It aims to evaluate what students have discussed in group discussions.

### *3.2. Analysis of Qualitative Methods*

The qualitative data which were obtained from this research are the result of posttest mathematical connection ability of the subject and the results of interviews conducted by the researchers with the subject. This section will show the achievement of high, moderate, and low responsibility groups. The selected subjects were based on considerations namely subject E-08 and E-10 from high responsibility groups, subject E-02 and E-07 from moderate responsibility groups, and subjects E-15 and E-19 from low responsibility groups.

#### *3.2.1. Mathematical Connection Ability with High Responsibility*

The research subjects interviewed for mathematical connection skills with high responsibility were E-10 and E-08. Based on the results of the test of the mathematical connection ability, the E-10 and E-08 subjects can achieve mathematical connections well. This is evident because both subjects can achieve three indicators of mathematical connections, namely connecting among mathematical topics, connecting mathematics with other sciences or other fields of study, connecting mathematics with real life.

On indicators of connecting among mathematical topics, students could work on the questions correctly, completely, and coherently. It means that students really understand mathematics, both the material being studied, and the one that was previously studied, so that it could connect among one material and another. It is in line with Ausubel's theory as quoted by Maulana (2011) that meaningful learning is learning to understand what has been obtained, then be connected and developed to other conditions.

On indicators of connecting mathematics with other sciences or other fields of study, students could work on the questions correctly, completely, and coherently, even though they complained that the calculations are too difficult. It means, not only mathematics subjects that students master, but also other subjects, such as science. Students also knew that there was a relationship between mathematics and science subjects.

On indicators connecting mathematics with real life, students could work on the questions correctly, completely, and coherently. Students also knew that this problem was related to real life because the problems can be found in real life. It means that students are able to connect between mathematics and real life.

#### *3.2.2. Mathematical Connection Abilities with Moderate Responsibilities*

The interview subjects for mathematical connection skills with moderate responsibility are E-02 and E-07. Based on the results of the analysis, it can be concluded that students with moderate responsibility can master the two indicators of mathematical connections.

On indicators of connecting mathematical topics, students could work on the questions correctly, completely, and coherently. It means that students really understand mathematics, both the material being studied, and the one that was previously studied, so that it could connect between one material and another. This is in line with Ausubel's theory as quoted by Maulana (2011) that meaningful learning is learning to understand what has been obtained, then be connected and developed to other conditions.

On indicators of connecting mathematics with other sciences or other fields of study, students could not work on the questions correctly. They experienced mistake in the calculation and substitution of numbers. It means they did not understand the meaning of the symbols that exist in science lessons or maybe they forgot. But when they were interviewed, they learned that there was a relationship between mathematics and science subjects.

On indicators connecting mathematics with real life, students could work on the questions correctly, completely, and coherently. It means that students are able to connect between mathematics and real life.

#### *3.2.3. Mathematical Connection Capabilities with Low Responsibilities*

The interview subjects for mathematical connection skills with low responsibility were E-15 and E-19. Based on the results of the analysis, it can be concluded that students with low responsibility can master a mathematical connection indicator.

On indicators of connecting among topics of mathematics, there were students who could work correctly, some were not. There were students who did not master the material related to questions other than quadrilateral material. It means that students did not really understand mathematics, because with a slight modification of the problem, i.e. questions that fulfill the indicators of connecting among mathematical topics, students experienced mistake in progress.

On indicators of connecting mathematics with other sciences or other fields of study, students could not work on the questions correctly. The effort of students in working on this problem was very minimal, and some even did not do it. It means that they did not know where to start and did not understand the meaning of the symbols in the science lesson or they may forget. But when interviewed, students learned that there was a relationship between mathematics and science subjects.

On indicators of connecting mathematics to real life, there were students who could work on the questions correctly, some students did not. It means that not all of students were able to connect between mathematics and real life.

*3.2.4. Student Responsibilities*

Based on the information obtained by the researcher, the responsibility of students in class VII of junior high school was not optimal. So, to increase student responsibility learning activities were needed that can involve all students with various characters. TSTS learning model is one of the learning models that can make students being responsible, because in learning process, students do activities that make them become accustomed to behaving that reflects responsibility in learning. Two Stay Two Stray model is one of the cooperative learning models that can provide opportunities for groups that discuss to share results and information to other groups (Lie, 2010: 61)

On disciplinary indicators, students are required to come to school before the bell rings and collect assignments on time. It is expected that students can be disciplined in accordance with the appointed time. In the indicator of sportsmanship, students are required to be honest. Honesty is seen from how students work on assignments or tests. Students work on their own or copy the answers of friends. On indicators of obedience to discipline, students are required to pay attention when the teacher teaches and does not make noise in the classroom. On the indicator of commitment to learning, students are required to listen and appreciate the opinions of friends when discussing, want to express opinions with group friends, take time to study, be careful in working on questions, and dare to convey the results of group discussions in front of the class.

During the TSTS learning process assisted by the problem cards, it was seen that the E-10 subject fulfilled several indicators of responsibility, one of which was discipline, namely collecting assignments on time as determined by the teacher. At the teacher presentation, E-10 subjects paid attention when the teacher gave an explanation, although they rarely answered the joint questions, but when the teacher gave questions individually the E-10 subject was able to answer correctly. At the stage of group activities, the subject of E-10 respected and expressed opinions, wanted to explain to a group of friends who did not understand in solving problems on the problem card, and were responsible for their role as host/ guest. At the stage of formalization, the subject of E-10 dared to convey the results of the group discussion in front of the class.

During the TSTS learning process assisted by the problem cards, it was seen that the subject of E-08 fulfilled several indicators of responsibility, one of which was discipline, namely coming to class and collecting assignments on time. At the teacher presentation, the E-08 subject paid attention to the teacher when giving an explanation by answering questions from the teacher even though his voice was slow. At the group activity, the subject of E-08 respected and expressed opinions, even tended to play more roles in group discussions, wanted to explain to group friends who did not understand in solving problems on the problem card, and were responsible for their role as host / guest. Subject E-08 was able to make conclusions together, but during the implementation of the research, when the formalization phase of the subject E-08 did not convey the results of group discussions.

During the TSTS learning process assisted by the problem cards, it was seen that the subject of E-02 fulfilled several indicators of responsibility, one of which was discipline, which often collected tasks on time. At the teacher presentation, subject E-02 paid attention to the teacher when giving an explanation by answering questions from the teacher aloud even though sometimes doubts whether the answer was correct or not, but sometimes subject E-02 talked with his group friends when not yet invited to discuss making the classroom atmosphere noisy. At the group activity, the subject of E-02 would appreciate and express opinions, dared to ask the teacher when experiencing difficulties in working on the problem and was responsible for his role as host/ guest. At the stage of formalization, the subject of E-02 dared to convey the results of the discussion in front of the class.

During the TSTS learning process assisted by the problem cards, it was seen that at the teacher presentation, the E-07 subject paid attention to the teacher when giving an explanation by answering questions from the teacher in a low voice and sometimes hesitating. At the group activity, the subject of E-07 would appreciate and express opinions, dared to ask the teacher when experiencing difficulties, and be responsible for his role as host/ guest.

During the TSTS learning process assisted by the problem cards, it was seen that the E-15 subjects were less disciplined in collecting assignments because several times they did not collect the assignments on time as requested by the teacher. At the teacher presentation, E-15 subjects paid attention to the teacher during learning but rarely answered the questions given by the teacher or answered in a low voice and doubt. At the group activity, the E-15 subject listened and respected to the opinions of others, but rarely believed, because they did not master the material too much, dared to ask the teacher when experiencing difficulties, and were less responsible for their role as host/ guest.

During the TSTS learning process assisted by the problem cards, it was seen that the E-19 subjects were less disciplined in collecting assignments because they did not collect assignments on time. At the teacher presentation, E-19 subjects sometimes paid attention to the teacher during learning but gave inappropriate answers to make the class noisy. At the group activity, E-19 subjects wanted to listen and appreciate the opinions of others but rarely argued, dared to ask the teacher when experiencing difficulties, and were less responsible for their role as host / guest. At the stage of formalization, the subject of E-19 dared to convey the results of group discussions in front of the class.

In addition, researcher looked at students' responsibilities based on the results of the questionnaire. The researcher also calculated the percentage of achievement of each indicator of responsibility to find out what indicators were not optimal. It can be a consideration or attention of the teacher to develop student responsibility in the next learning.

Based on the teacher's observations during the learning process and the value of the test of mathematical connection skills, students who have high responsibility also have scores on high test results. It is in line with the research of Aisyah et al., (2014) that the learning process requires responsibility as indicated by significant changes in student learning behavior to obtain optimal learning outcomes. So that the higher responsibility of students, it will make the students will get optimal learning outcomes.

## 4. Conclusion

Based on the results of the research and discussion on the ability of mathematical connections in Two Stay Two Stray learning based on responsibility, the conclusions are as follows.

Mathematical learning uses an effective TSTS model for students' mathematical connection skills because (1) the mathematical connection ability of students with TSTS learning can achieve minimum criteria of mastery learning and classical completeness criteria, (2) students' mathematical connection ability with TSTS learning is better than students with expository learning.

The description of students' mathematical connection skills based on the responsibility of using TSTS learning as follows. (a) Subjects with high responsibility have fulfilled three indicators of students' mathematical connection skills well, namely they were being able to connect among mathematical topics, connecting mathematics with other sciences or other fields of study, connecting mathematics with real life, although there was still a little inaccuracy calculate. (b) Subjects with moderate responsibility have different achievement indicators. One of the subjects fulfilled all three indicators, the other subject fulfilled only two indicators, namely connecting among mathematical topics and connecting mathematics with real life. (c) Subjects with low responsibility fulfilled one mathematical connection indicator. One of the subjects fulfilled the indicators of connecting among mathematical topics, the other subjects fulfilled the indicators of connecting mathematics with real life. The description of the responsibilities of students who use TSTS learning in each group as follows. (a) subjects with high responsibility fulfilled four indicators of responsibility, namely discipline, sportsmanship, obedience to discipline, and commitment in learning, (b) subjects with moderate responsibilities fulfilled three indicators of responsibility, namely discipline, sportsmanship, obedience to order, (c) subjects with low responsibility fulfilled one indicator of responsibility, namely discipline.

Based on the conclusions above, the researcher suggests several suggestion, as follows (1) teacher can make the TSTS model assisted by problem

cards as one of the innovative learning alternatives in order to improve students' mathematical abilities. (2) teacher should prepare a long duration if he wants to use the TSTS model, because this learning takes a long time in exchanging information.

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