The experimentation of the TTW and the NHT learning models on polyhedron viewed from the problem solving ability

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Abstract. The study aims to obtain empirical data regarding the impact of models of learning models on mathematics outcomes when seen from the problem-solving ability. In this study, an experiment was conducted on the (Think talk write) TTW, (Numbered Heads Together) NHT and direct learning models. This study used a quasi-experimental study consisting of 2 experimental groups and 1 control group. In the experimental class, TTW and NHT were applied, while in the control class, direct learning was applied. The number of samples is 298 people, with details of 100 people from experimental class I, 99 people from experiment class II 99, and 99 people from the control class. The instruments in this study were tests and documentation and had met Validity and reliability. The research data were analyzed using two-way anava with different cells, and had met the prerequisite tests for normality and homogeneity. Research shows that (1) TTW are better than NHT and direct learning, and NHT are better than direct learning. (2) High student problem-solving ability provide better mathematics learning outcomes than medium or low student problem solving ability, moderate student problem solving ability are better than low student problem solving abilities, (3) there is an association between the learning model used and the student problem solving ability on student mathematics learning achievement.

1. Introduction
To increase the learning quality, it requires continuous attention from state authorities, especially education leaders and people involved in the world of education [1]. Indonesia's world of education, mathematics is one of the subjects which is a compulsory subject. This is because mathematics has an important position in solving problems connected to everyday human life. Students are trained to solve small problems in their lives by learning mathematics, students will be more structured in thinking. Learning mathematics can also make students try to improve their thinking skills. This capacity can be achieved if learning is carried out in accordance with the expectations of the learning quality, when students are interested actively in as the primary focus, the mechanism to meet necessities of learning [2]. Realizing the importance of mathematics, various efforts should be made to improve the learning quality. However, the learning outcomes obtained by students have not shown results that match expectations.

Many factors influence the students' low mathematics scores, both internal and external factors. The internal factor one that impacts learning for learners outcomes is the ability to solve problems in learning subject matter delivered by the teacher, while one of the external factors is the way the teacher teaches,
or the way the teacher delivers material in classroom learning. One requirement for mathematical education is the ability to solve problems. Mathematics really requires students' problem solving skills to solve the problems in it. Given the importance of problem-solving skills in studying mathematics, efforts should be made to review the extent to which the ability to solve these problems depends on student responses to material related to shapes or geometry. The efforts made will help teachers in encouraging students to be able to solve math problems faced by students. Currently, students' mathematical problem solving abilities are still lacking. Students have difficulty solving problems that require their ability to solve problems. Teachers need to know how to solve math problems as problem solvers and help students become better problem solvers [3]. To encourage creative action, individual problem-solving styles are very important [4]. Students can develop their ability to think, apply procedures and deepen logical understanding through problem solving abilities [5].

Innovative learning can be used, in order to improve problem-solving abilities, in order to obtain better learning outcomes, including by implementing TTW (Think Talk Write) and NHT (Numbered Heads Together). TTW is a cooperative learning program designed to improve students' mathematical understanding and communication skills [6]. Looking at the mathematics learning outcomes of students in Magelang Regency is still relatively low when compared to the mathematics learning outcomes of students in Magelang City, even the average national examination scores for junior high school students in mathematics for the 2018/2019 school year decreased from the previous academic year. The National Junior School Mathematics Average exams score in Magelang Regency in 2017/2018 was 6.26, while for Magelang City it was 7.57, and the average mathematics score in 2018/2019 in Magelang Regency was 5.85, while in Magelang City it was 6.98. Therefore, mathematics is often referred to as a difficult subject.

2. Methods

There are two variables in this study, namely the independent variable and the variable dependent. The learning model and problem-solving abilities are independent variables, and students' mathematics learning outcomes are the dependent variable. This research was included in experimental research with a 3 x 3 factorial design. All students of class VIII semester 2 of State Junior High School in Magelang Regency 2018/2019 academic year were taken as the population in this study. The randomized strata class technique was used to take the sample, because the students in each school were not the same ability. From the existing schools, three schools were taken with the high, medium and low categories, and each school was taken three classes, to be used as experimental class I by applying TTW, experimental class II by applying NHT and control class by applying direct learning.

Tests and documentation were used as instruments in this study. The test of flat-sided shapes is used to measure student learning outcomes, and the mathematics test is generally used to measure students' problem-solving abilities. documentation in the form of the average national exam scores for the City and District of Magelang to determine the school category, namely in the high, medium or low classification. The test instrument has met the requirements as a valid and reliable instrument before being used to retrieve data.

The learning outcome data obtained are in the form of student scores which will then be analyzed using two-way anava different cells, which must meet the normality of data and data homogeneity where the analysis is carried out using the Lilliefors method and the Bartlet method. As well as data on mathematical problem solving abilities in the form of scores and transformed to categorize problem solving abilities into high, medium and low categories.

3. Results and discussion

Data in this study include: instrument test result data, initial math ability data, problem-solving ability data, and student mathematics learning achievement data on Polyhedron subject matter. Following are the results and discussion related to this research.

The results of the content validity test were validated by 4 validators, which indicated that the test instruments for problem solving abilities and mathematics learning outcomes were said to be valid. The
results of the test instrument test of students' problem-solving abilities showed that of the 6 items tested, 3 items were valid. The results of the mathematics learning achievement test trial showed that of the 35 items obtained 30 valid items. The results of the population normality test, the population variance homogeneity test, and the student's initial ability data balance test showed that the sample originated from a population normally distributed, the population being compared had the same or homogeneous variants, and had the same mean. Initial abilities are in balance. Then the test results data for students' problem-solving abilities were categorized into high, medium, and low problem-solving abilities.

Prior to hypothesis checking, the prerequisite test of the hypothesis test is conducted in the shape of a population test of normality and a population variance test of homogeneity. Because the prerequisite test results for hypothesis testing are met, hypothesis testing can be done using two-way analysis of variance with different cells. Before the multiple comparison test between rows was carried out, first the marginal mean of each row and the mean of each cell was calculated. Presented in Table 1.

**Table 1. Marginal Mean and Individual Cells**

| Learning Model | Problem solving ability | Marginal Mean |
|----------------|-------------------------|---------------|
|                | High | Medium | Low |               |
| TTW            | 76.43 | 64.60 | 63.65 | 68.11         |
| NHT            | 89.11 | 61.15 | 58.27 | 60.93         |
| Konventional   | 67.68 | 58.13 | 46.83 | 55.70         |
| Marginal Maen  | 69.17 | 61.12 | 55.71 |               |

Furthermore, the outcomes of many lines are provided for a description in Table 2.

**Table 2. Double Comparison Summary**

| H<sub>0</sub> | F<sub>obs</sub> | 2F<sub>α</sub> | Result of test decisions |
|---------------|----------------|-------------|--------------------------|
| μ<sub>1</sub> = μ<sub>2</sub> | 12.57 | (2) (3.00) = 6.00 | H<sub>0</sub> rejected |
| μ<sub>2</sub> = μ<sub>3</sub> | 34.43 | (2) (3.00) = 6.00 | H<sub>0</sub> rejected |
| μ<sub>1</sub> = μ<sub>3</sub> | 5.87  | (2) (3.00) = 6.00 | H<sub>0</sub> rejected |

From the calculation results F<sub>obs</sub> for, H<sub>0A</sub>, H<sub>0B</sub> and H<sub>0AB</sub> the results obtained the test decision that, H<sub>0A</sub>, H<sub>0B</sub> and H<sub>0AB</sub> rejected. Based on the test decision, That can be inferred: (1) learning outcomes are influenced by learning models, (2) learning outcomes are influenced by problem solving ability, (3) there are an interaction between the models of learning and problem solving abilities on mathematics learning outcomes. Since, and rejected, it is necessary to carry out further post-anova tests with themethod Scheffe '. Furthermore, the multi-column comparison overview is provided in Table 3.

**Table 3. Summary of Multiple Comparisons**

| H<sub>0</sub> | F<sub>obs</sub> | 2F<sub>α</sub> | Result of test decisions |
|---------------|----------------|-------------|--------------------------|
| μ<sub>1</sub> = μ<sub>2</sub> | 13.78 | (2) (3.00) = 6.00 | H<sub>0</sub> rejected |
| μ<sub>2</sub> = μ<sub>3</sub> | 38.83 | (2) (3.00) = 6.00 | H<sub>0</sub> rejected |
| μ<sub>1</sub> = μ<sub>3</sub> | 6.79  | (2) (3.00) = 6.00 | H<sub>0</sub> rejected |

By comparing F<sub>obs</sub> with the critical area, it can be seen that there are significant differences between μ<sub>1</sub> with μ<sub>2</sub>, μ<sub>1</sub> with μ<sub>3</sub>, and μ<sub>2</sub> with μ<sub>3</sub>. The TTW is better than the NHT and direct learning, because the mean TTW is greater than the NHT and the mean of direct learning, and the NHT is higher than the paradigm of direct learning, because the mean NHT is greater than the mean of direct learning.

By comparing F<sub>obs</sub> with the critical area, it appears that there are significant differences between μ<sub>1</sub> with μ<sub>2</sub>, μ<sub>1</sub> with μ<sub>3</sub>, and μ<sub>2</sub> with μ<sub>3</sub>. High student problem solving abilities have better learning achievement of mathematics than middle and low student problem solving abilities, and moderate student problem solving abilities have better learning achievement of mathematics than low student problem solving abilities.
The findings of this analysis are in line with the results of the first hypothesis, namely the model TTW learning provides better learning outcomes than the NHT learning model and the conventional learning model, and the model NHT learning provides better learning outcomes than the conventional learning model, also according to students who apply TTW better mathematical representation skills than students who apply expository [7]. The metacognitive abilities of students with TTW were better than the metacognitive abilities of students with GI [8]. Student motivation can be improved through NHT compared to direct learning [9-12].

Problem solving ability can be improved by striving for quality learning materials [13], it requires appropriate teaching methods to teach problem solving skills [14]. While the results of other studies are in accordance with the third hypothesis which states that there is an interaction between the model of learning and students' problem solving ability on student learning outcomes, but not all of them are in accordance with the third hypothesis, and in accordance with the results of previous studies [15]. Based on the results of this study, that the learning model and problem solving abilities have an effect on student learning outcomes, this is because the learning model used can invite students to be more active in learning in class, TTW is a learning model that invites students to think about solving problems, then conveying what is the solution plan, and rewrite what is the solution to the problem. Likewise for NHT learning, namely Numbered Heads Together, namely a learning model that divides students into small groups, where each group consists of 4-5 people with heterogeneous abilities. Each group member is given a number and the teacher randomly calls a number, the member whose number is called is asked to come forward to explain to the friends from other groups about the results of the discussion from his group in solving a problem given by the teacher. so that the TTW and NHT models provide better learning outcomes than conventional models, whereas the TTW model provides better learning outcomes than the NHT model, because in the TTW model, in addition to students being asked to convey orally or talk about problem solving, students are also asked to write back, so that information or learning material will be more easily absorbed by students.

Student problem-solving abilities affect student learning outcomes, this is because the more difficult the problems faced by students, the more motivated students will be to solve these problems, and the more difficult the problems they face, the more problem-solving abilities they are faced with, so that their learning outcomes will also be increasingly good.

4. Conclusions

It can be concluded on the basis of the results of the research and discussion: (1) student learning outcomes with TTW are better than NHT and direct, and NHT is better than direct learning, (2) high student problem-solving abilities have better mathematical results of medium and low student problem solving abilities, and moderate student problem solving abilities are better than low student problem solving abilities, (3) The three learning models provide the same mathematics learning outcomes both in high and medium student problem solving abilities, and TTW provides mathematics learning outcomes that are as good as NHT on low student problem solving abilities, but provides better mathematics learning outcomes than direct learning, while NHT offers better learning results than learning directly, (4) students' problem solving abilities high, medium and low have the same good mathematics learning outcomes. High student problem solving abilities have the same good mathematics learning outcomes in direct learning with moderate student problem solving abilities, but have better mathematics learning outcomes than low student problem solving abilities. The problem solving ability of students is having the same good mathematics learning outcomes with low student problem solving ability.

Based on the analysis results, the researcher provides suggestions to various parties involved in the implementation of learning to always pay attention to and evaluate the learning process that is taking place and is expected to be able to develop innovative learning approaches including TTW and NHT learning models that have proven good in providing mathematics achievement, which is better by still paying attention to the characteristics of students, one of which is the ability to solve student problems.
References

[1] Kusuma A P, Rahmawati N K, Putra F G, & Widyawati S 2020 *J. Phys.: Conf. Ser.* **1467** 012065
[2] Anggo M & Arapu L 2018 *J. Phys.: Conf. Ser.* **1028** 012143
[3] Chapman O 2015 *LUMAT: Int. J. on Math. Sci. Technol. Educ.* **3** 1 19
[4] Kim J Y, Choi D S, Shung C S, & Park J Y 2018 *J. Open Innov.: Technol. Mark. Complex.* **4** 1 4
[5] Siagian M V, Saragih S & Sinaga B 2019 *Int. Electron. J. Math. Educ.* **14** 2 331
[6] Yamin M dan Ansari B I 2009. *Taktik Mengembangkan Kemampuan Individual Siswa.* Jakarta: Gaung Persada Press
[7] Supandi S, Waluya S B, Rochmad R, Suyitno H & Dewi K 2018 *Int. J. Instr.* **11** 3 77
[8] Listiana L, Susilo H, Suwono H & Suarsini E 2016 *J. Balt. Sci. Educ.* **15** 3 391
[9] Mustami M K and Safitri D 2018 *Int. J. Instr.* **11** 3 123
[10] Hunter W C, Maheady L, Jasper A D, Williamson R L, Murley R C & Stratton E 2015 *Educ. Treat. Child.* **38** 3 345.
[11] Hunter W C, Dieker L A, & Whitney T 2016 *Jharkhand Educ. Proj. Counc.* **26** 2 186.
[12] Haydon T, Schmidt C, Buncher A & Carnahan C 2019. *Educ. Treat. Child.* **42** 2 245.
[13] Simamora R E, Saragih S & Hasratuddin 2019 *Int. Electron. J. Math. Educ.* **14** 1 61.
[14] Daniel E 2016 *J. Educ. Pract.* **7** 15 91.
[15] Surya E, Putri F A & Mukhtar 2017. *J. Math.* **8** 1 85.