The Effect of Teams Games Tournament (TGT) learning model with PQ4R strategy towards the mathematical reasoning based on metacognitive awareness

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Abstract. The purposes of this study are to describe (1) the effect of TGT learning model with PQ4R strategy towards mathematical reasoning, (2) the effect of metacognitive awareness towards mathematical reasoning, (3) the interaction between the learning model and metacognitive awareness towards mathematical reasoning. The research is quantitative research with a quasi-experimental design. The population is the eighth-grade students in Sragen Regency. The sampling technique is cluster random sampling. The data collection techniques are test and questionnaire. The data analysis technique is two ways analysis of variance unequal cell. The research results are (1) The TGT learning model with the PQ4R strategy has a better learning than direct learning towards mathematical reasoning. (2) Students with high metacognitive awareness have a better than students with low metacognitive awareness towards mathematical reasoning. (3) There is no interaction between learning model and metacognitive awareness towards mathematical reasoning. In each learning model, students with high metacognitive awareness is better than students with low metacognitive awareness. In each level of metacognitive awareness, TGT learning model with PQ4R strategy is better than direct learning.

1. Introduction

Education is a means to develop the potential of human resources in order to be able to face the challenges of life in the future in accordance with the notion of education that is conscious and planned efforts to create an atmosphere of learning and learning process so that students actively develop their potential to have religious-spiritual strength, self-control, personality, intelligence, noble character, and skills needed by himself, society, nation, and state [1]. The development of this era is quite rapid, it needs more effort to prepare human resources who can develop their potential and become a quality person.

Mathematics is one of the subjects in the spotlight in the world of education. Mathematics is considered as a subject that can improve the quality of human resources themselves. The important role of mathematics in education is that it can help students to think critically, directed, structured and analytically. Mathematics is not only counting and memorizing existing formulas, but mathematics guides students to be able to understand the process, analyze it, communicate it and evaluate it.

According to PAMER UN 2018/2019 data, the percentage of students’ mastery of mathematics UN question material is less than 50%. In detail, the material numbers are 44.47%, algebra is 42.89%,...
geometry and measurement are 42.80%, and statistics and opportunities are 42.16%. This is caused by several factors, one of which is the low ability of students' mathematical reasoning. This is supported by the statement that the low learning outcomes due to lack of encouragement for students to use reasoning [2]. Students' reasoning ability is an important factor in learning mathematics. The ability of reasoning helps students understand deeply, so students can conclude. Reasoning is a thought process that seeks to relate existing facts to produce a conclusion [3].

Sumarmo stated that mathematical reasoning was classified into two namely inductive and deductive reasoning. Inductive reasoning includes two things, namely drawing conclusions based on limited data observation and drawing conclusions based on several possibilities that arise. Deductive reasoning is drawing conclusions based on agreed rules and drawing conclusions whose conclusions are derived absolutely according to premises and not influenced by other factors. Referring to the technical guidelines of the Director-General of the Ministry of Education's Directorate General of Primary and Secondary Education [4], an outline of the mathematical reasoning ability indicators in this study is (a) submitting an assumption, (b) checking the validity of an argument, (c) drawing conclusions or making generalizations, and (d) doing mathematical manipulation.

Many learning models and strategies help improve students' reasoning abilities in learning mathematics. For example, discussion, problem solving and discovery. But in practice, the learning process in the classroom is less than optimal, the teacher still often gives lectures to students and then gives practice questions to students. This makes students less trained to find out what they are learning, students listen more often and record the material the teacher conveys. Though students need to find out their knowledge, they can convey or communicate the results of their learning to the teacher and his friends to improve students' thinking and reasoning power.

TGT is one of the learning models that can help improve students' understanding of mathematical material. According to Saco in TGT students play games with other team members to get a score [5]. TGT is a group learning model that is packaged in the form of games. Students play games to get scores. The group that gets high scores will get an award. The game in this model is that students compete with students in other groups by answering several questions designed by the teacher to test students' knowledge and reasoning.

Besides, there are strategies Preview, Question, Read, Reflect, Recite, Review (PQ4R). PQ4R is one part of the elaboration strategy that can help the teaching and learning process in the classroom. Elaboration strategy is the process of adding details so that new information will become more meaningful. This strategy helps move information from short-term memory to long-term memory. The PQ4R strategy helps students to remember what they read and they learned [6].

The collaboration of the TGT model and the PQ4R strategy is an optimal and effective combination to improve students' reasoning abilities. The TGT model with the PQ4R strategy helps students improve their understanding and reasoning abilities and make learning mathematics more meaningful. This collaboration not only enhances understanding of the material but can also affect the awareness of students' metacognition.

Metacognition is a level of thought process. Metacognition can be used by someone to monitor their cognitive abilities, how far they understand a problem. With metacognition, students can find out how to learn, know their abilities and learning modalities and know the best learning strategies for effective learning [7]. Flavell explains metacognition refers to active monitoring, appropriate control, and regulation of information processing activities in cognitive processes with a continuous human or non-human environment [8]. According to Schraw metacognition is defined as awareness and monitoring of one's thoughts and performance on a task or in other words, metacognitive is thinking about one's thinking [9].

Metacognitive awareness is the awareness of students in planning and controlling student learning by using student ways/strategies to improve student learning performance. Metacognition Awareness trains students to think about what they need to do, what they need and how they can accomplish it.
Metacognitive awareness has two important components, namely Knowledge of Cognition and Regulation of Convention. Knowledge of cognition refers to what individuals know about their cognition or cognition in general, while regulation of cognition refers to a series of activities that help students control their learning [10]. Knowledge of cognition consists of declarative knowledge, procedural knowledge, and conditional knowledge. Regulation of cognition consists of Planning, Information management Strategies, Comprehension Monitoring, Debugging Strategies, and Evaluation.

2. Methodology
The research is quantitative research with a quasi-experimental design. The population is the eighth-grade student in Sragen Regency. The sampling technique is cluster random sampling. The research sample is VIII grade SMP Negeri 1 Miri. This study uses two classes, namely the experimental class, and the control class. The experimental class was treated by the TGT learning model with the PQ4R strategy, while the control class was treated by the direct learning model. Both classes are tested using a t-test, to find out that both classes have the same initial ability.

Data collection methods include test methods and questionnaire methods. The test method is used to measure students' mathematical reasoning abilities and the questionnaire method is used to measure students' metacognitive awareness.

The data analysis technique is two ways analysis of variance unequal cell. Before the analysis test is carried out, the sample must be subjected to a prerequisite test, namely the normality test using the Lilliefors method and the homogeneity test using the alpha method with a significance of 5%. Data normality test aims to determine whether the data obtained from the results of research are normally distributed or not. The homogeneity test aims to determine whether the variances of several populations are the same or not.

3. Result and Discussion
The results of this study will explain their relevance to several previous studies. The analysis was carried out by two ways analysis of variance unequal cell with a significance level of 5%. two ways analysis of variance unequal cell calculation is presented in table 1 below.

| Source                   | JK     | Dk | RK     | $F_{\text{obs}}$ | $F_{\alpha}$ |
|--------------------------|--------|----|--------|------------------|---------------|
| Learning models (A)      | 1618,412 | 1  | 1618,412 | 6,358            | 4,08          |
| Metacognitive awareness (B) | 2107,239 | 2  | 1053,620 | 4,139            | 3,23          |
| Interaction (AB)         | 786,320 | 2  | 393,160 | 1,545            | 3,23          |
| Error (G)                | 10436,434 | 41 | 254,547 |                  |               |
| Total                    | 14948,405 | 46 |         |                  |               |

Based on table 1 it can be concluded that.

Based on the two ways analysis of variance unequal cell obtained $F_{\alpha}= 6,358 > F_{\alpha}= 4,08$ then $H_{0A}$ is rejected, meaning that there is a difference in the effect of the TGT learning model with the PQ4R strategy on students' mathematical reasoning abilities. The results of the calculation of the marginal mean show that the marginal mean of the TGT learning model with the PQ4R strategy is higher than the direct learning model. The mean marginal TGT with strategy PQ4R of 64.72 while for the model immediately had a mean marginally by 51.64. Thus, it can be concluded that the model of learning TGT with strategy PQ4R much better than the models of learning directly to the ability of reasoning students.

This is supported by the situation in the field that in the learning process using the TGT model with the PQ4R strategy, students in groups understand the matter, reason, discuss the results, and practice the results of the discussion directly. The teacher becomes a facilitator and motivator, especially
during the competition. That way, students are more active and work together to solve the problems given by the teacher.

In the learning process with a direct learning model, some students are embarrassed to ask questions and students lack in expressing ideas or ideas. As a result, teachers talk more in front of the class. Some students also look less active to do the discussion group and solve the problems that awarded teachers.

Based on the two ways analysis of variance unequal cell obtained $F_B = 4.139 > F_α = 3.23$ then $H_0B$ is rejected, meaning that there is a difference in the effect of students’ metacognitive awareness on mathematical reasoning abilities. To find out the difference in mean mathematical reasoning abilities for high, medium, or low metacognitive awareness, the researchers conducted a multiple comparison test.

Multiple comparison tests using Scheffe obtained results $F_{1-2} = 2.350 < 2f_{obs} = 6.46$ then $H_0$ accepted, which means there is no difference in the effect of the reasoning mathematical ability between students who have high metacognitive awareness with students who have medium metacognitive awareness. $F_{1-3} = 7.906 > 2f_{obs} = 6.46$ then $H_0$ is rejected, which means that there are differences in the effect of the reasoning mathematical ability between students who have high metacognitive awareness with students who have low metacognitive awareness. The average marginal level of high metacognitive awareness is 67.17 while the level of low metacognitive awareness has a marginal average of 48.89. It was concluded that students with high metacognitive awareness were better than students with low metacognitive awareness. Lastly, $F_{1-3} = 2.871 < 2f_{obs} = 6.46$ then $H_0$ accepted, which means there is no difference in the effect of the reasoning mathematical ability between students who have the medium metacognitive awareness with students who have low metacognitive awareness.

This is supported by the situation in the field that students with high metacognitive awareness can filter and understand the material better than students with low metacognitive awareness. Students with higher learning outcomes appear to be more serious, thorough and systematic in learning. Because students control their learning. In contrast to students with low metacognitive awareness, they tend to surrender and are less active. Students need the assistance and direction of teachers to resolve the problem of mathematics in the classroom.

Based on the two ways analysis of variance unequal cell obtained $F_{AB} = 1.545 < F_α = 3.23$ maka $H_{0AB}$ is accepted, meaning that there is no interaction of learning models and students' metacognitive awareness of mathematical reasoning abilities.

Students who were given the TGT learning model with the PQ4R strategy gave mathematical reasoning abilities better than direct learning model, both those with high, medium, or low metacognitive awareness. Similarly, students with high metacognitive awareness showed better mathematical reasoning abilities than students with low metacognitive awareness, both were treated using the TGT learning model with the PQ4R strategy and direct learning models.

4. Conclusion

Based on data analysis with a significance level of 5% and the discussion that has been explained before, then some conclusions are obtained. First, there is a difference in the effect between the TGT learning model with the PQ4R strategy on students' mathematical reasoning abilities. The results of comparative calculations show that the marginal mean of the TGT learning model with the PQ4R strategy is higher than the direct learning model. Therefore, it was concluded that the TGT learning model with the PQ4R strategy was better than the direct learning model of students' mathematical reasoning abilities.

Second, there is a difference in the effect between metacognitive awareness of students' mathematical reasoning abilities. The comparison test results that students with high metacognitive awareness have higher mathematical reasoning abilities than students with low metacognitive awareness, while
students who have medium metacognitive awareness have the same mathematical reasoning abilities as students who have high metacognitive awareness and low metacognitive awareness.

Third, there is no interaction between learning models and metacognitive awareness of students' mathematical reasoning abilities. Means that students’ who are given the TGT learning model with the PQ4R strategy have better mathematical reasoning abilities than the direct learning model, both those who have high, medium, or low metacognitive awareness. Similarly, students with high metacognitive awareness have better mathematical reasoning abilities than students with low metacognitive awareness, both are taught using the TGT learning model with the PQ4R strategy and direct learning models.

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