

The effect of flipped classrooms based on team games tournaments on mathematics problem-solving ability

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Abstract: The study aimed to determine the effect of flipped classroom modified Teams Games Tournament (TGT) on mathematics problem-solving skills in terms of self-regulated learning in students. This research is a type of quantitative research with the quasi-experimental method. The population in this study came from Krunjo State Elementary School, Tangerang Regency. The research sample came from two classes, namely class III A (experimental class) and class III B (control class), totaling 46 students. The sampling technique was cluster sampling. Data analysis is quantitative statistical analysis with the Two Way ANOVA test with the help of the JAMOVI application. The results of this study showed: 1) there is an effect of flipped classroom learning modified Team Games Tournament (TGT) on students' math problem-solving can be seen from the results of Two Way Anova p-value $< \alpha$, namely the value of $0.006 < 0.05$; 2) There is a significant interaction between students who learn with flipped classroom modified Team Games Tournament (TGT) on students' mathematical problem-solving ability can be seen from the p-value $< \alpha$, namely the value of $0.045 < 0.05$. 3) There is a difference between students who learn with flipped classroom modified Team Games Tournament (TGT) in terms of high self-regulated learning, which can be seen from the value of p- tukey $> \alpha$ or $0.023 < 0.05$.

Keywords: Flipped Classroom, Team Game Tournament, Pemecahan Masalah, Self Regulated Learning

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INTRODUCTION

Mathematical problem-solving ability is a type of ability that students have to solve a problem in teaching and learning activities in mathematics (Azrai et al., 2022; Chimmalee & Anupan, 2022; Sukontawaree et al., 2022; Yonwilad et al., 2022; Zulkifli et al., 2022). Mathematical problem-solving skills are very important for students in solving problems related to mathematical materials (Hobri et al., 2020; Putri et al., 2019; Zhou et al., 2019). Students with mathematical problem-solving skills will find it easier to understand difficult subjects (Kumar, 2020; Nahdi et al., 2021; Prasher et al., 2019). In addition, mathematical problem-solving is one of the higher-level skills that students must have (Amam, 2017; Hulaikah et al., 2020; Ridwan et al., 2021; Trzebiński et al., 2021; Wahono et al., 2020). Students problem-solving mathematical problem-solving can apply learning problems to real life (Al Ayyubi et al., 2018; Zulkarnain et al., 2021).

Students' mathematical problem-solving skills in Indonesia are still low (Apriyani et al., 2019; Fradila et al., 2021; Hasyim & Eldiana, 2020; Nur et al., 2020; Surur et al., 2020; Utami et al., 2022). It can be seen from the 2018 PISA results that the mathematical literacy of Indonesian students obtained a score of 398, ranked 62 out of 78 member countries (Batlolona et al., 2019; Supriyadi et al., 2023; Zulyusri et al., 2023). The results of the Trends in International Mathematics and Science Study (TIMSS) 2012 study of Indonesian students' mathematic problem-solving are still low in solving problems that lead to problem-solving (Maolidah et al., 2017). The mathematics learning process makes it difficult for students to solve problems that lead to problem-solving (Noviyani et al., 2022; Nursyahidah et al., 2018). The learning model used by the teacher is still passive (S. Tan & Maker, 2020; Yapatang & Polyiem, 2022), so students are less active in learning (Zareen, 2020). The learning process is still teacher-centered or teacher-centered (Erfan et al., 2020; Ichsan, Sofianora, et al., 2023; Karim et al., 2023; Oktarina et al., 2021), so students feel less interested in learning math (Khatimah & Sugiman, 2019; Sappaile & Djam, 2020). Furthermore, teachers in the mathematics learning process have not trained and guided students to solve problems (Setiawan et al., 2022; Sugianto et al., 2022). Therefore, we need a learning model that encourages students' mathematical solution skills (Suriawati & Mundilarto, 2019).

The flipped classroom is a learning strategy that can be done online and offline (Saira et al., 2021; Sengul & Bostanci, 2021; Susanti & Pitra, 2019). The Flipped Classroom model is learning that reverses the learning model in traditional education (Nurkhasanah, 2021). Flipped classroom learning can improve students' problem-solving and critical-thinking skills (Nguyen & Lam, 2021; Indiasari, 2022). In addition, flipped classroom learning encourages students to improve conceptual understanding and learning outcomes. According to Dewi and Harahap (2019), flipped classroom learning can encourage students' mathematical reasoning skills in learning (Zhang et al., 2021; Ario & Putri, 2018). Flipped classroom learning helps students to be more active and motivated in learning. Furthermore, flipped classroom learning is modified with the Team Game Tournament (TGT) model.

The Team Game Tournament (TGT) learning model is a simple cooperative learning model that provides tournaments and quizzes for students to compete to answer (Putri et al., 2019; Solihah, 2016). The team Game Tournament (TGT) learning model can improve students' learning outcomes and mathematical motivation (Amni et al., 2021; Cahyaningsih, 2017; Kristiana et al., 2017; Safarina, 2018). In addition, the (Şimşek & Baydar, 2019) Team Game Tournament (TGT) model encourages students to be more active and creative in learning. Also, the model helps students increase their understanding and communication in the learning process (Velloo et al., 2016) so that it can develop their thinking process (Firdaus et al., 2020).

Previous research by Hava (2021) The flipped model positively affects concept understanding and student learning outcomes. Research by Rusdi et al. (2018) The flipped classroom model effectively improves cognitive learning outcomes in science learning. But in reality, the application of flipped classroom learning in schools has not run optimally, so students lack mathematical problem-solving. Flipped classroom learning modified Team Game Tournament (TGT) is a solution to improving students' mathematical problem-solving skills (Khoirotunnisa' & Irhadanto, 2020). Team Game Tournament (TGT) modified flipped classroom learning can encourage students' creative thinking skills in learning mathematics. Research (Saputra & Mujib, 2018) flipped classroom learning effectively fosters students' understanding of concepts in learning (Ramadhani et al., 2022). A Flipped classroom influences students' feedback in learning mathematics.

Based on the above problems, this study aims to determine the effect of flipped classroom modified Teams Games Tournament (TGT) on students' mathematics problem-solving skills in terms of self-regulated learning.

METHODS

This research is quantitative research with the quasi-experiment method. This study used a nonequivalent control group design (Table 1). In this study, the samples came from two classes, namely the control and experimental classes. The control class used conventional learning, while the experimental class was treated with the application of Team Game Tournament (TGT) modified flipped classroom learning. The population came from students of SD Blukbuk 1, even semester of the 2021/2022 school year, Kronjo District, Tangerang Regency. The sample of this study came from class III A students as the experimental class and class IIIB students as the control class, totaling 46 people. The sampling technique was random cluster sampling.

The instruments used in the study were essay tests and questionnaires. The test was used to measure students' mathematical problem-solving ability, while the questionnaire was used to measure students' self-regulated learning. Before the test was given, students were tested to see the validity, reliability, difficulty index, and distinguishing power. Indicators used to measure mathematical ability are (1) students' ability to choose and apply mathematical problem-solving strategies and (2) students' ability to solve problems in everyday life. Data analysis in this research is descriptive statistical analysis with the Two Way Anova test with the help of the JAMOV application.

Table 1. Nonequivalent Control Group Design (Lufri & Ardi, 2017; Sugiyono in Hasanah et al., (2021)

Class	Pretest	Treatment	Posttest
Experiment	O1	X	O2
Control	O3	-	O4

O1: Pretest for the Exsperimen Class

O2: Posttest for the control class

X: Experiment class treatment (Flipped classroom based TGT)

-: Control class treatment (conventional learning)

O3: Pretest for the control class

O4: Posttest for the control class

RESULTS AND DISCUSSION

Based on the results of research that have been conducted at SD Blukbuk 1 in the even semester of 2021/2022 Kronjo District on students' mathematical problem-solving using flipped classroom learning modified by Team Game Tournament (TGT) on problem-solving skills in terms of self-regulated learning can be seen in Table.2.

Table 2. Students' Mathematical Problem-solving Score in View of Self-Regulated Learning

	Self Regulated Learning	Class	Model	M	SD	Qualification
Problem-solving	Hight	Ekspesimen	Flipped Classroom	80.4	10.45	Hight
		Kontrol	Konvensional	57.9	8.09	Low
	Low	Ekspesimen	Flipped Classroom	61.1	13.53	Simply
		Kontrol	Konvensional	57.1	13.42	Low

Table 2 shows that the average value of students' mathematical problem-solving using flipped classroom learning modified Team Game Tournament (TGT) in terms of high self-regu-

lated learning is 80.4 with a high category, while the average value of students' problem-solving using conventional learning is 57.9 with a low category. Furthermore, the average value of students' mathematical problem-solving using flipped classroom learning modified Team Game Tournament (TGT) in terms of low self-regulated learning is 61.1 with sufficient category, while the average value of students' problem-solving using conventional learning is 57.1. It can be concluded that flipped classroom learning modified Team Game Tournament (TGT) is better than conventional learning.

Furthermore, see the normality test, which aims to determine whether the two classes are normally distributed or not. The normality test in this study used the Shapiro-Wilk test with consideration of samples of less than 50 students. The results of the normality test can be seen in Table 3.

Table 3. Results of Normality Test with Shapiro-Wilk

Class	Statistics	P	Description
Experiment	0.961	0.361	Normal
Control			

Based on Table 3. Both classes are normally distributed if the p value > 0.05 or 0.361 > 0.05. To conduct hypothesis testing, all classes must be normally distributed and homogeneous. The next step is to test the homogeneity of the data using the Levene test with a significance level of 0.05. At the homogeneity test stage, you must pay attention to the criteria of the sig value. > 0.05, then the two sample classes are homogeneously distributed or if the sig value is. <0.05, then the sample class is not homogeneous. The results of the homogeneity test can be seen in Table 4.

Table 4. Homogeneity Test Results Based on Levene's Test

Class	N	Levene's statistic (F)	Sig.	Keterangan
Control	23	1.03	0.397	Homogeneity
Experiment	23			

Based on Table 4 shows Levene's test value of 1.03 with a significance of 0.397 > 0.05, meaning that the two sample classes in this study are homogeneous. So, the two sample classes in the study were normally distributed and homogeneous, so they met the requirements of the one-way ANOVA test. One-way ANOVA test determines the interaction of flipped classroom learning modified Team Game Tournament (TGT) on students' mathematical problem-solving. The results of the one-way ANOVA test can be seen in Table 5.

Table 5. One-way ANOVA Test Results

	ANOVA – Problem-solving				
	Sum of Squares	df	Mean Square	F	p
Overall model	2526	3	842	6.26	0.003
Self Regulated Learning	700	1	700	5.21	0.032
Kelas	1222	1	1222	9.09	0.006
Kelas * Self Regulated Learning	604	1	604	4.49	0.045
Residuals	3227	24	134		

Table 5 shows that the p-value <0.05 or 0.006 <0.05 means that there is a difference in flipped classroom learning modified Team Game Tournament (TGT) on student mathematical problem-solving. Furthermore, if the p-value <0.05 or 0.045 <0.05, then there is an interaction of flipped classroom learning modified Team Game Tournament (TGT). To see more clearly the

interaction of flipped classroom learning modified Team Game Tournament (TGT) mathematical problem-solving with students' self-regulated learning can be seen in Figure 1.

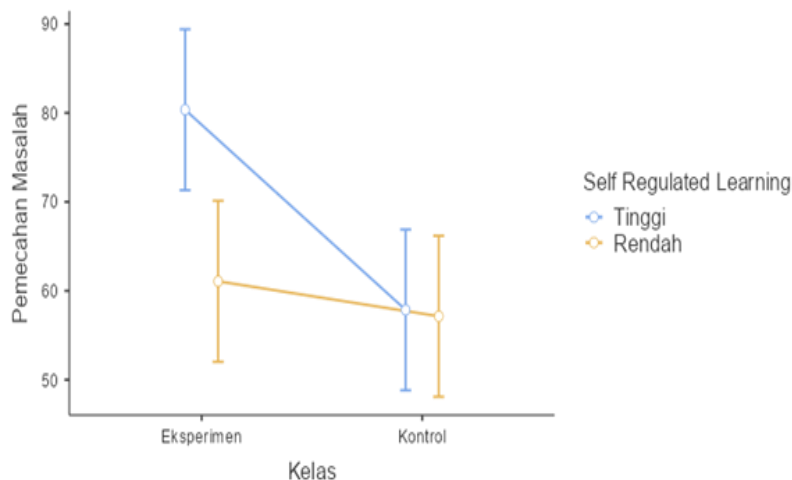


Figure 1. Interaction of problem-solving with self-regulated learning

Figure 1 shows that students' mathematical problem-solving learning significantly interacts with self-regulated learning. In the highly self-regulated learning student group, the students' problem-solving ability is higher. Furthermore, the students' mathematical problem-solving ability is low in the low self-regulated learning student group. Therefore, to find out the interaction of the flipped classroom model on mathematical problem-solving in terms of self-regulated learning, it is necessary to continue with the Two Way ANOVA test by looking at the results of the Tukey and Pos Hoc tests. The results of the two-way ANOVA test can be seen in Table 6.

Table 6. Two-way ANOVA Test Results Based on Tukey and Post Hoc Tests

Post Hoc Comparisons - Class * Self-Regulated Learning									
Comparison									
Class	Self Regulated Learning	Class	Self Regulated Learning	Mean Difference	SE	df	t	p _{Tukey}	
Eksperimen	Hight	-	Experiment	Low	19.286	6.20	24.0	3.112	0.023
		-	Control	Hight	22.500	6.20	24.0	3.630	0.007
	-	Control	Low	23.214	6.20	24.0	3.746	0.005	
	Low	-	Control	Hight	3.214	6.20	24.0	0.519	0.954
		-	Control	Low	3.929	6.20	24.0	0.634	0.920
Kontrol	Hight	-	Control	Low	0.714	6.20	24.0	0.115	0.999

Note. Comparisons are based on estimated marginal means.

Table 6 shows the Tukey test value <0.05 or $0.023 <0.05$. This means a significant difference exists between students' mathematics problem-solving and self-regulated solid learning in the experimental class. Furthermore, the Tukey test results in the control class < 0.05 or $0.099 < 0.05$, so there is no difference in students' mathematical problem-solving with self-regulated learning. So, flipped classroom learning modified by Team Game Tournaments (TGT) has an effect on students' mathematical problem-solving in terms of self-regulated learning.

Discussion

Implementing flipped classroom learning modified Team Game Tournament (TGT) positively affects students' mathematical problem-solving skills. This can be seen from the average

value of mathematical problem-solving of experimental class students of ($M = 80.4$), higher than that of students in the control class of ($M = 57.9$). This is in line with research by Faridah et al. (2021). The flipped classroom model can improve students' problem-solving skills and learning motivation. Flipped classroom learning modified by Team Game Tournaments (TGT) can improve students' problem-solving skills (Alias et al., 2020; Rahayu et al., 2022; C. Tan et al., 2017). Not only that, flipped classroom learning is able to develop students' 21st-century literacy skills of critical thinking and problem-solving and student learning outcomes (Kang & Kim, 2021; Paristiowati et al., 2019). The use of flipped classroom modified Team Game Tournament (TGT) encourages students to be more active and creative in learning (Novita et al., 2022).

The flipped classroom learning model modified by Team Game Tournament (TGT) makes it easier for students to solve difficult math problems (Durak, 2020). According to Koo et al. (2016), Flipped classroom learning helps students to be more active in developing their potential thoughts. Furthermore, the flipped classroom learning model modified by Team Game Tournament (TGT) affects students' mathematics problem-solving skills regarding self-regulated learning. This can be seen from the results of the two-way ANOVA test ($p < 0.05$ or $0.023 < 0.05$). Therefore, it is concluded that flipped classroom learning modified by Team Game Tournaments (TGT) significantly affects students' mathematical problem-solving skills in self-regulated learning. This aligns with research by Dong et al. (2021). The flipped classroom model modified by Team Game Tournament (TGT) significantly affects students' collaborative and problem-solving skills. In addition, research by Hussain et al. (2020) showed that The flipped classroom model affects students' concept understanding ability and thinking process.

Flipped classroom learning modified Team Game Tournament (TGT) is very effective to be applied in learning mathematics at school. Flipped classroom learning modified Team Game Tournament (TGT) positively interacts with students' mathematical problem-solving skills in terms of high self-regulated learning. It can be seen from the value ($p_{tukey} < 0.05$ or $0.045 < 0.05$). This aligns with research (Yurniwati & Utomo, 2020) on applying flipped classroom learning modified by Team Game Tournaments (TGT) to students' higher-order thinking skills. Self-regulated learning helps students to think critically in problem-solving (Ichsan, Suharyat, et al., 2023; Rakovi et al., 2022; Supriyadi et al., 2023). In addition, self-regulated learning helps students to be more active in learning (Hensley et al., 2022). Teachers must be required to be able to direct the Student's mathematics learning process to problem-solving skills (Ahmed & Abdulla, 2019; Zulyusri et al., 2022, 2023). The flipped classroom model is an effective learning model for students and teachers to advance education in the future.

CONCLUSION

Based on this research, it can be concluded below: (1) there is an effect of flipped classroom learning modified Team Games Tournament (TGT) on students' math problem-solving can be seen from the results of Two Way Anova p -value $< \alpha$, namely the value of $0.006 < 0.05$; (2) There is a significant interaction between students who learn with flipped classroom modified Team Games Tournament (TGT) on students' mathematical problem-solving ability can be seen from the p -value $< \alpha$, namely the value of $0.045 < 0.05$; (3) there is a difference between students who learn with flipped classroom modified Team Games Tournament (TGT) in terms of high self-regulated learning, which can be seen from the value of p -Tukey $> \alpha$ or $0.023 < 0.05$. These findings explain that flipped classroom learning modified by Team Games Tournament (TGT) positively impacts students' problem-solving skills. In addition, flipped classroom learning is effectively implemented with online and offline students, so this learning can be without a time limit. Furthermore, the flipped learning model modified by the Team Games

Tournament (TGT) encourages students to improve their 4C skills (Critical thinking and problem-solving, Creative, Communicative, and Collaborative).

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