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How to cite: Candra, T. H., Aziz, A., & Rahayu, E. (2026). Effect of a Teams Games Tournament Using Quizizz on Mathematical Reasoning as Viewed from the Level of Mathematics Anxiety. *Kognitif: Jurnal Riset HOTS Pendidikan Matematika*, 6(2), 869–879. <https://doi.org/10.51574/kognitif.v6i2.4953>

To link to this article: <https://doi.org/10.51574/kognitif.v6i2.4953>



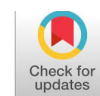
Opened Access Article



Published Online on 22 June 2026



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Effect of a Teams Games Tournament Using Quizizz on Mathematical Reasoning as Viewed from the Level of Mathematics Anxiety

Tantia Hedyanti Candra^{1*}, Abd Aziz² , Eka Rahayu¹

¹Mathematics Education Study Program, Faculty of General Education, Zainul Hasan Genggong Islamic University

²Islamic Education Study Program, Faculty of Tarbiyah, Zainul Hasan Genggong Islamic University

Article Info

Article history:

Received Apr 21, 2026

Accepted Jun 05, 2026

Published Online Jun 22, 2026

Keywords:

Mathematics Anxiety

Mathematical Reasoning

Quizizz

Teams Games Tournament

ABSTRACT

Mathematics instruction in schools still tends to be teacher-centered, so student engagement in developing mathematical reasoning is not yet optimal. This leads to students struggling to provide logical justifications and relying on formulas, as well as being influenced by affective factors such as mathematics anxiety; therefore, innovative instructional models such as the Teams Games Tournament (TGT) supported by Quizizz are needed. This study aims to analyze the effect of the Quizizz-assisted TGT model on students' mathematical reasoning abilities as viewed from their level of mathematics anxiety regarding sequences and series. The study employed a quantitative approach using a quasi-experimental design with a nonequivalent control group pretest-posttest design. The research subjects were 11th-grade students at SMA Istiqlal, consisting of 25 students in the experimental class and 26 students in the control class. The instruments used were a mathematical reasoning essay test and a mathematics anxiety questionnaire using a Likert scale, both of which were validated and reliable. Data analysis was performed using an independent samples t-test, one-way ANOVA, and two-way ANOVA. The results showed that the average posttest score for the experimental class (84.36) was higher than that of the control class (76.73), with a significance level of $0.000 < 0.05$; there was a difference based on mathematics anxiety with a significance level of $0.032 < 0.05$; however, there was no interaction between the two variables with a significance level of $0.549 > 0.05$. Thus, TGT assisted by Quizizz is effective in improving mathematical reasoning and can serve as an interactive learning alternative while reducing students' mathematics anxiety.



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Corresponding Author:

Tantia Hedyanti Candra,
Mathematics Education Study Program,
Faculty of General Education,
Zainul Hasan Genggong Islamic University,
Jl. P. B, Sudirman No. 360, Kraksaan, Probolinggo, Jawa Timur
✉ tantiahedyanti23@gmail.com

Introduction

Mathematics education serves a strategic role in improving logical, critical, and systematic thinking abilities of student (Miagusttin et al., 2025). However, field implementation demonstrates that the learning process is still teacher-centered, limiting students' active engagement in increasing comprehension. Based on preliminary observations made at Istiqlal High School among 11th-grade students on sequences and series topic, the majority (approximating 60%) of the 51 pupils observed struggled to solve problems that needed mathematical reasoning. This was obvious when students were asked to explain the logic behind their solutions, identify patterns, or draw inferences, since they tended to apply formulas without first understanding the topics. This illustrates a gap between mathematics education objectives and classroom practice, emphasizing the importance of developing mathematical reasoning skills. Mathematical reasoning skills are cognitive components which enable students to develop logical arguments based on mathematical concepts and principles (Purwanto & Yusmin, 2023). The current study examines mathematical thinking skills involve generating conjectures, conducting mathematical operations, drawing conclusions, and providing arguments or justifications for the solutions achieved (Wau et al., 2022). This lack of proficiency is often due to teaching methods that emphasize memorization over conceptual understanding (Arma, 2022). As a result, students have difficulty explaining the problem-solving process even though they are able to arrive at the final answer, meaning that their thinking Skills have not yet reached their full potential.

One alternative teaching model that can be used to improve mathematics reasoning skills is the Teams Games Tournament (TGT) (Arma, 2022). This model combines group work, game-based activities, and academic competitions designed to increase student engagement (Harjuna, 2024). Through group discussions, students are encouraged to formulate hypotheses and justify their answers, while tournament-style activities help develop precise thinking and the ability to draw conclusions quickly (Rani, 2022). Thus, activities in the TGT model are directly related to the development of indicators of mathematical reasoning (Royani & Kelana, 2022). In addition to cognitive factors, affective aspects has significant role in mathematics learning; one such factor is mathematics anxiety (Marweli & Meiliasari, 2024). Students with a significant quantity of anxiety tends difficulty understanding concepts, lack self-confidence, and struggle with problems that require reasoning (Shahriza et al., 2026). This condition can disrupt the thinking process and lead to poor mathematical reasoning skills. Therefore, affective factors must be taken into account when designing effective instruction.

Technological advancements in the field of education are opening up opportunities to create more interactive and engaging learning experiences (Muti et al., 2024). One tool that can be used is Quizizz, a game-based learning platform that provides interactive questions and immediate feedback (Maghfirah et al., 2025). Using Quizizz can boost student participation and motivation through a fun learning environment (Handina & Parisu, 2025). In addition, instant feedback helps students understand their mistakes and improve their understanding, thereby supporting the process of mathematical reasoning. The integration of the TGT model and Quizizz is expected to foster more active and collaborative learning and support the development of Thinking mathematically abilities (Dewi et al., 2026). A combination of group discussions, games, academic competitions, and digital feedback enables students to engage cognitively and emotionally in the learning process (Mahbubi, 2025). In addition, the enjoyable learning environment provided by Quizizz has the potential to reduce math anxiety, thereby helping students feel more confident in solving problems that require critical thinking (Indriani et al., 2024).

Although several studies examined TGT model and the use of digital media effectiveness, most still focus on improving learning outcomes in general. Research that specifically links mathematical reasoning ability to levels of mathematics anxiety and integrates cooperative learning models and digital media simultaneously remains limited. Therefore, this study offers a novel approach by examining Quizizz's TGT learning approach affect mathematical reasoning ability while considering levels of mathematics anxiety, this contributes to the development of a more complete mathematical education.

Method

Research Types and Designs

Quantitative approach employed with a quasi-experimental design, notably a nonequivalent control group pretest-posttest (Jelena & Jelena, 2022). The design was adopted since the researcher was unable to completely randomize the subjects, therefore existing classes were employed instead. Both groups took a pretest to assess initial mathematical thinking skills. The experimental group was taught using Teams Games Tournament (TGT) supported by Quizizz, while the control group received conventional instruction (Lam & Wolfe, 2023). Following the treatment through Spost-test to assess changes in mathematical reasoning skills. Table 1 illustrates the general research strategy that will be employed in this study.

Table 1. Research Design

Group	Pre-Test	Treatment	Post-Test
Experimental Class	O_1	X	O_2
Control Class	O_3	-	O_4

Description:

O_1 = Pre-test for mathematical reasoning skills in the experimental class.

O_2 = Posttest on mathematical reasoning skills in the experimental class.

O_3 = Pre-test for mathematical reasoning skills in the control class.

O_4 = Post-test of mathematical reasoning skills in the control class.

X = The intervention included the adoption of the Teams Games Tournament learning model, with the support of Quizizz.

Population and Sample

The study population comprised of all eleventh-grade pupils from Istiqlal High School in Sumber Centeng, Kotaanyar, Probolinggo. Purposive sampling was utilized, using the following criteria: taught by the same teacher, having a relatively balanced number of students, having comparable prior mathematics scores, and having initial abilities that did not differ significantly based on pretest results. Based on these criteria, Class XI A was selected as the control class (26 students), and Class XI B as the experimental class (25 students).

Instruments

The research instruments constituted a mathematical reasoning a test and a questionnaire to assess arithmetic anxiety. Scoring was based on a 1–5 scale for each indicator. The mathematical reasoning test consisted of five open-ended questions designed based on the following indicators:

Table 2. Assessments of Mathematical Reasoning Ability

No	Indicator	Description
1	File a complaint	Students are able to formulate hypotheses or predict answers
2	Performing mathematical operations	Students are able to process information mathematically
3	Drawing conclusions	Students are able to draw logical conclusions
4	Provide reasons/evidence	Students are able to explain the steps to solve the problem

The mathematics anxiety the questionnaire with 20 items on a 5-point Likert scale. covering cognitive, affective, and physiological aspects. Survey results are classified into three levels: low, medium, and high. The research instrument has been tested for content validity by experts and for empirical validity using product-moment correlation and dependability has been Cronbach's Alpha was used during the testing coefficient with a value > 0.60 , thereby establishing its reliability.

Data Collection

Data collection was completed in three stages: planning, implementation, and conclusion. During the preparation phase, the researcher developed the instruments and selected the research sample. During the implementation stage, both classes took a pretest, followed by instruction tailored to their respective treatment groups over four sessions. During the conclusion stage, both classes took a posttest to measure their mathematical reasoning skills, as well as a mathematics anxiety questionnaire to assess their anxiety levels.

Data analysis.

Data analysis was carried out quantitatively utilizing statistical software. The first stage consisted of precursor tests, notably a normality test using the Shapiro-Wilk test and a homogeneity test with Levene's test. An independent samples t-test on posttest results in comparing experimental and control classes' mathematical thinking abilities. One-way ANOVA was used to compare ability differences based on mathematics anxiety level. Meanwhile, the influence of the learning model and learning model and the amount of mathematics anxiety relationship were investigated using two-way ANOVA. Testing used 0.05 significance level.

Research Findings

This study collected various data, including pretest and posttest results as well as students' Mathematics Anxiety questionnaire scores from the control and experimental classes.

Statistical Analysis of the Effect of the Teams Games Tournament (TGT) Learning Model, Assisted by Quizizz, on Mathematical Reasoning Skills

Normality testing was conducted on students' mathematical problem-solving scores to determine the distribution of the data from both pretest and posttest in the experimental and control groups. At a significance level of $\alpha = 0.05$, data are considered normally distributed when Sig. > 0.05 (H_0 accepted), while Sig. < 0.05 indicates non-normal distribution (H_0 rejected). Table 3 presents the normality results for both tests of mathematical reasoning ability.

Table 3. Normality Test Results for the Mathematical Reasoning Ability Test

Class		Kolmogorov-Smirnov ^a			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Results	Control pretest (XIIA)	.168	26	.057	.922	26	.051
	Control posttest (XIIA)	.160	26	.083	.941	26	.139
	Experimental pretest (XIIB)	.170	25	.060	.938	25	.133
	Experimental posttest (XIIB)	.117	25	.200*	.943	25	.176

Table 3 shows that for all data in the control group (which utilized traditional instruction) and the experimental group (which used Teams Games Tournament instruction supplemented by Quizizz), the Shapiro-Wilk test yielded a significance value > 0.05 . The results show that the data is regularly distributed.

After completing a normality test and determining that data normally distributed, the then homogeneity test with SPSS Version 22. The homogeneity test to identify depending on the data groups from the students' mathematical reasoning ability tests are from the same sample or not. The study hypothesis states that if H_0 is accepted and H_1 is rejected, the data have equal variances or are homogenous, but if H_0 is rejected, and H_1 is accepted; the data have uneven variances or are not homogeneous. The testing criteria are as follows: if sig. > 0.05 , H_0 is accepted and H_1 is rejected, the data has equal variances or is homogenous; if Sig. < 0.05 , rejecting H_0 and accepting H_1 , the data has unequal variances or is not homogeneous. The homogeneity test result conducted with SPSS version 22.

Table 4. Results of the homogeneity test for the math reasoning test.

		Levene Statistic	df1	df2	Sig.
result	Based on Mean	1.324	3	98	.271
	Based on Median	.968	3	98	.411
	Based on Median and with adjusted df	.968	3	88.327	.411
	Based on trimmed mean	1.310	3	98	.275

The significance value of 0.217 (> 0.05) that indicate homogeneous variances between the experimental (TGT model) and control classes, so H_0 is accepted. After meeting normality and homogeneity assumptions, an independent samples t-test used to compare post-test results between groups.

Table 5. Results of the Independent Samples T-Test

		Levene's Test for Equality of Variances		t-test for equality of means.						
		F	Sig.	t	df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
result	Equal variances assumed	.030	.862	-6.832	49	.000	-7.629	1.117	-9.873	-5.385
	Equal variances not assumed			-6.838	48.994	.000	-7.629	1.116	-9.871	-5.387

The significance level (two-tailed) is $0.000 < 0.05$. This suggests there is a difference in average mathematical reasoning skills between students in the control and experimentation classes. The experimental class has a greater average mathematical reasoning skill than the control class. Students in experimental class performed better at drawing logical conclusions, making conjectures, performing mathematical manipulations, and providing justifications or proof for their results. This suggests that the education was more effective in strengthening students' mathematical reasoning abilities than the instruction in the control class. The statistical [Table 6](#) provides further information on the posttest means for both classes.

Table 6. Shows The Results of the Independent Samples T-Test.

	Class	N	Mean	Std. Deviation	Std. Error Mean
result	control posttest	26	76.73	4.085	.801
	experimental posttest	25	84.36	3.882	.776

A statistical analysis of students' mathematical reasoning abilities based on their level of mathematics anxiety (high, moderate, and low)

A one-way ANOVA was conducted on N-gain scores to examine differences in students' mathematical reasoning improvement across levels of mathematics anxiety (high, moderate, and low). The decision rule states that a significance value greater than 0.05 indicates no significant difference (H_0 accepted), while a value below 0.05 indicates a significant difference (H_0 rejected). Thus, if H_0 is rejected, it means the mean N-gain differs across anxiety levels; otherwise, the improvement is considered similar among the groups.

Table 7. Shows The Results of The One-Way ANOVA Test

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	42.4859	2	212.4915	4.049	.032
Within Groups	11.5416	22	524.6223		
Total	15.79028	24			

Based on the ANOVA table, the Sig. was $0.032 < 0.05$, rejecting H_0 and accepting H_0 . This indicates a significant difference in mathematical reasoning improvement across the three mathematics anxiety groups.

Table 8. Results of the one-way ANOVA test

95% Confidence Interval for Mean								
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
High	8	56.8750	44.94572	15.67115	53.1840	60.5660	5.12	6.49
Medium	9	57.0000	23.59052	76.19684	40.5650	75.4350	5.00	7.71
Low	8	29.1250	31.35032	11.94213	27.5290	56.7210	5.00	6.67
Total	25	48.8000	25.44622	51.88924	37.6092	59.9908	5.00	7.71

Furthermore, the Descriptives [Table 9](#) that the mean N-Gain scores for each group differ in the level of improvement in mathematical reasoning ability, with the group with lower levels of mathematics anxiety having a higher mean improvement score than the other groups.

Table 9. Shows the results of the One-Way ANOVA test

(I) anxiety group	(J) anxiety group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
High	Medium	-92.12500	11.91528	.996	-28.6394	27.3894
	Low	27.75000	11.41247	.063	-13.1179	56.6179
Medium	High	92.12500	11.91528	.996	-27.3894	28.6394
	Low	286.87500*	11.91528	.046	40.3606	56.3894
Low	High	-27.75000	11.41247	.063	-56.6179	13.1179
	Medium	-28.87500*	11.91528	.046	-56.3894	-40.3606

In addition, the post hoc (Tukey) test findings revealed substantial differences in mathematics anxiety levels across numerous pairings of groups, indicating that not all groups had the same considerable improvement. Thus, it is possible to conclude that the level of mathematics anxiety considerably affect pupils' mathematical reasoning skills' development.

A statistical analysis of the interaction between the Teams Games Tournament (TGT) learning model supplemented by Quizizz and the level of mathematics anxiety on students' mathematical reasoning skills

Learning model and the level of mathematics anxiety on students' mathematical reasoning ability analysis, as well as to examine whether there is an interaction between these two variables, a two-way ANOVA was conducted using posttest scores and mathematics anxiety questionnaire results. The criteria states that if H_0 is rejected and H_1 is accepted, a significant interaction exists among learning model and mathematics anxiety level on mathematical reasoning ability. Conversely, if H_0 is accepted and H_1 is rejected, no significant interaction is found. At $\alpha = 0.05$, Sig. > 0.05 indicates no interaction, while Sig. < 0.05 indicates a significant interaction.

Table 10. Results of the Two-Way ANOVA

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	782.874 ^a	5	156.575	9.549	.000	.515
Intercept	326488.212	1	326488.212	19912.347	.000	.998
model	722.799	1	722.799	44.083	.000	.495
anxiety	22.844	2	11.422	.697	.504	.030
model * anxiety	19.941	2	9.971	.608	.549	.026
Error	737.832	45	16.396			
Total	331772.000	51				
Corrected Total	1520.706	50				

According to the exam results, the significant Value for the interaction between the learning model and the level of mathematics anxiety (Sig.) > 0.05 , hence H_0 was accepted and H_1 was rejected. This suggests there is no substantial learning model and the level of mathematics anxiety connection on students' mathematical reasoning abilities. Thus, we can conclude that the learning model and the level of mathematics anxiety do not interact with each other in influencing students' mathematical reasoning ability. This means that the effects of each variable are independent and do not depend on one another.

Discussion

The findings of the study show that the learning model has a considerable impact on students' mathematical thinking abilities. The experimental class (84.36) had higher posttest mean scores than control class (76.73), with a significant difference (p-value < 0.05), that

indicate Teams Games Tournament (TGT) model assisted by Quizizz is significantly more effective than conventional learning. When examined by mathematical reasoning indicators, the most notable improvement was observed in the indicators of providing reasons or evidence and drawing conclusions (Riswari et al., 2024). This is because, during group discussions and competitions, students are required not only to arrive at the correct answer but also to explain their solution steps and defend their arguments. Meanwhile, the indicators for formulating conjectures and performing mathematical manipulations also showed improvement, though not as significant as the previous two indicators, as there are still students who are accustomed to following procedures without exploring various possible solutions (Nurhasanah et al., 2025).

This effect is intimately associated with the learning mechanisms within the TGT model supported by Quizizz. The group discussion phase provides students with an opportunity to construct knowledge through social interaction, thereby encouraging the development of mathematical conjectures and arguments (Muslim et al., 2026). Furthermore, the game and tournament phases on Quizizz help strengthen students' problem-solving skills and mental agility, as they must answer questions quickly and accurately (Al Wahida, 2023). Quizizz provides real-time feedback that helps students quickly correct mistakes and improve understanding (Rohman & Khaliza, 2024). Each stage of the TGT model supports mathematical reasoning development, making learning more meaningful than outcome-focused (Dewi et al., 2026).

Additionally, to the influence of the learning model, the research results also indicate that mathematics anxiety significantly influence on mathematical reasoning ability, with a p-value of $0.032 < 0.05$. Students with low levels of anxiety demonstrated better reasoning skills compared to those with moderate and high levels of anxiety. This suggests that emotional state plays a role in supporting logical thinking processes, as calmer students tend to be better able to focus, construct arguments, and draw conclusions. Thus, mathematics anxiety has a major impact on the quality of pupils' mathematical reasoning. However, the two-way ANOVA test revealed no interaction among learning model and the amount of mathematics anxiety, using a significance threshold of $0.549 > 0.05$. This suggests that the Quizizz-assisted TGT model's ability to improve mathematical reasoning skills is unaffected by students' levels of anxiety. This learning paradigm still has a good effect on all types of arithmetic anxiety. These findings indicate that an interactive, collaborative, and game-based learning atmosphere can generate a more conducive learning environment, thereby assisting students with varied levels of anxiety to remain actively involved in the learning process. This study has significant limitations, including a sample size of only one institution and a relatively short period. Future research should include a bigger sample size and investigate other characteristics such as learning motivation or self-efficacy. Overall, this work contributes to the integration of cognitive and affective aspects in mathematics education by utilizing an innovative learning model based on collaboration and technology..

Conclusion

The study shows Quizizz-assisted Teams Games Tournament (TGT) model significantly affects students' mathematical reasoning abilities. The independent samples t-test revealed a significant difference among experimental and control groups ($p < 0.001$). The experimental group achieved a higher mean post-test score (84.36) than the control group (76.73), showing that the TGT approach outperformed conventional instruction in improving mathematical reasoning. Mathematics anxiety significantly affects students' mathematical reasoning ability. The one-way ANOVA test revealed significantly difference in mathematical reasoning skills

related to students' levels of anxiety ($p\text{-value} = 0.032 < 0.05$). Students with lower levels of anxiety had superior mathematical reasoning skills than those with moderate to high levels of anxiety. However, the two-way ANOVA found no significant interaction between instructional model and mathematics anxiety ($p = 0.549 > 0.05$). It suggests impacts of the instructional model and the level of mathematics anxiety operate separately; hence, the efficiency of the TGT model coupled with Quizizz in increasing mathematical reasoning skills is unaffected by students' level of mathematics fear. This study has flaws, specifically the use of a quasi-experimental methodology that does not fully randomize the subjects, allowing external influences to impact the study results. Furthermore, the study was carried out at a single school, with a small sample size, and over a relatively short period. Future research should use a more rigorous experimental design, a larger sample size, and take into account other characteristics that may influence students' mathematical reasoning abilities.

Conflict of Interest

The author declares that there are no conflicts of interest in this study whether financial or non-financial that could influence the results or interpretation of the study.

Auhor Contributions

T.H.C. contributed to the conceptualization of the research, the development of the research instruments, data collection, data analysis, and the writing of the initial draft of the article. A.A. contributed to the development of the research methodology, the validation of the research instruments, and the review and refinement of the article's content. E.R. contributed to the analysis of the results, the discussion, and the final revision of the manuscript. All authors have read and approved the final version of this paper. The total percentage of contribution is as follows: D.Q.A.: 40%, A.A.: 30%, and E.R.: 30%.

Data Availability Statement

The author states that data sharing is not possible, as no new data were generated or analyzed in this study.

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Authors Biography

	Tantia Hedyanti Candra is a student in the Mathematics Education Program at the Faculty of General Education, Zainul Hasan Genggong Islamic University. Email: ✉ tantiahedyanti23@gmail.com
	Abd. Aziz is lecturer in Islamic Education Study Program, Faculty of Tarbiyah, Zainul Hasan Genggong Islamic University. Now, he is the Rector of Zainul Hasan Genggong Islamic University ✉ abdazizwahab65@gmail.com
	Eka Rahayu is a lecturer and currently serves as the head of the Mathematics Education Program in the Faculty of General Education at Zainul Hasan Genggong Islamic University. ✉ eka.rahayu0792@gmail.com