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Comparing STAD And TPS Assisted By Quizizz Paper Mode On Junior High School Students' Mathematics Learning Outcomes

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Abstract

Choosing an appropriate learning model is key to improving junior high school students' mathematics learning outcomes, since many classrooms remain teacher-centered. This study compared the improvement in mathematics learning outcomes between students taught with the Student Teams Achievement Division (STAD) and Think Pair Share (TPS) cooperative learning models. Both models were assisted by Quizizz Paper Mode and applied to the topic of Flat Side Space (cube, cuboid, prism, and pyramid) over six meetings. The study used a quasi-experimental nonequivalent pretest-posttest comparison-group design with two experimental groups. The sample comprised 52 grade VIII students of SMPN 9 Makassar selected by cluster random sampling: class VIII.G (STAD) and class VIII.I (TPS), with 26 students each. Learning outcomes were measured with a Two-Tier Multiple Choice test that was validated by three experts and showed high reliability (Cronbach's α = 0.78). Data were analyzed using descriptive statistics, an independent-samples t-test, and a Z-proportion test. The STAD class achieved a mean posttest score of 83.58, an N-Gain of 0.76 (high), and 85% classical completeness. The TPS class achieved 79.88, an N-Gain of 0.69 (medium), and 77% completeness. Improvement in the STAD class was significantly greater than in the TPS class, t(50) = 2.96, p = .005, 95% CI [0.02, 0.12], with a large effect size (Cohen's d = 0.82). Both classes exceeded the 75% classical completeness criterion (p < .001). In this context, STAD was more effective than TPS in improving students' mathematics learning outcomes on Flat Side Space. Quizizz Paper Mode served as a formative-assessment medium that gave immediate feedback and equal participation regardless of students' access to personal devices.

Keywords: STAD; TPS; Quizizz Paper Mode; Mathematics Learning Outcomes.

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INTRODUCTION

The success of learning in schools is inseparable from the selection of appropriate learning models and media, since learning objectives can only be achieved through carefully planned instruction (Hamalik, 2014). Mathematics learning in particular requires serious attention because many students have difficulty understanding abstract concepts that require complex mental visualization.

Based on initial observations and interviews with mathematics teachers at SMPN 9 Makassar in June 2024, it was found that the mathematics learning outcomes of grade VIII students were still low, with the majority of final-semester grades below the completeness criteria. Learning was still teacher-centered, so students were less active; Hasanah & Prayogo (2023) explain that teacher-centered learning negatively affects student engagement and understanding, and this is reinforced by Tampubolon & Sitompul (2022), who found that the use of teaching models and materials unsuited to classroom conditions is a main cause of low learning outcomes. Specifically, the learning media used were less interactive and the evaluation system had not been varied enough to explore students' different abilities.

One effort to improve student learning outcomes is the application of a cooperative learning model. Herlawan & Roma (2017) state that active learning is intended to optimize the use of all students' potential in order to achieve satisfactory learning outcomes. The STAD (Student Teams Achievement Division) model is one of the simplest and most effective models for beginners (Slavin, 2005) and focuses on students' activeness and interaction to motivate one another toward optimal achievement (Isjoni, 2012), while the TPS (Think Pair Share) model gives students the opportunity to think independently, discuss in pairs, and share results with the whole class (Istarani, 2024). In this study, both models were implemented on the Flat Side Space topic (cube, cuboid, prism, and pyramid) for grade VIII students across six meetings — a topic that is conceptually abstract and commonly associated with low learning outcomes at the junior high school level.

The novelty of this research lies in the integration of Quizizz Paper Mode into both cooperative models. Quizizz Paper Mode is an offline interactive quiz that uses a paper sheet with a QR code automatically scanned by the teacher (Rini & Zuhdi, 2023). Within the STAD and TPS learning cycles, Quizizz Paper Mode was positioned specifically as a formative-assessment tool administered at the evaluation stage of every meeting: it provides immediate, individualized feedback that helps students and teachers identify gaps in understanding right after group work

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(Black & Wiliam, 2009), reinforces the material just discussed, and — because it uses printed cards rather than personal devices — ensures equal participation regardless of students' access to gadgets or the internet (Purba, 2019). This function is consistent with recent evidence that Quizizz Paper Mode increases the immediacy and inclusiveness of feedback in classroom formative assessment (Moreira & Lara Freire, 2024; Putra, 2023), and with broader evidence that technology-based interactive media can increase motivation and learning outcomes (Audie, 2019; Zhao, 2019).

Several relevant studies support this research. Husain et al. (2024) show that STAD can significantly improve mathematics learning outcomes, Ziziumiza et al. (2022) confirm STAD's effectiveness in improving mathematics skills through a pre-post comparison design, and Tampubolon & Sitompul (2022) report similar findings for mathematical problem-solving ability. Frateissia & Jamaan (2024) show that TPS is effective in improving mathematics learning outcomes. Murdani et al. (2024) found that STAD assisted by Quizizz had a strong influence on cognitive learning outcomes, Khairunnisa et al. (2024) and Firdaus et al. (2022) confirmed the superiority of STAD assisted by Quizizz, and Utami et al. (2024) proved that Quizizz Paper Mode improves student learning outcomes. More broadly, Nasrullah (2026) found that the choice of learning model significantly affects both learning outcomes and student interest, and Nasrullah & Saleh (2026) showed that adapting a learning model to students' needs improves mathematical literacy and motivation — underscoring that the specific pairing of a cooperative model with a given medium, not the medium alone, determines learning effectiveness. However, no published study has directly compared STAD and TPS while both are assisted by the same medium, Quizizz Paper Mode. This comparison matters theoretically because STAD and TPS differ fundamentally in group size and reward structure — individual/group-reward accountability in STAD versus dyadic, ungraded discussion in TPS — so holding the assessment medium constant isolates which cooperative structure, rather than which technology, drives the improvement. This is directly useful for teachers deciding which cooperative model to pair with a low-cost, device-free formative-assessment tool such as Quizizz Paper Mode. This study fills that gap by comparing the two models' effects on the mathematics learning outcomes of grade VIII students of SMPN 9 Makassar.

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METHOD

Type of Research/Design

This research is a quasi-experiment with a quantitative approach. Hastjarjo (2019) explains that quasi-experiments assign intact units (classes), not individuals, to groups. Because the study involved two experimental classes receiving different treatments without an untreated control class, the design is more accurately described as a nonequivalent pretest-posttest comparison-group design (Dantes, 2023) rather than a Nonequivalent Control Group Design: experimental group-1 received the STAD treatment and experimental group-2 received the TPS treatment, both measured with a pretest and a posttest.

Subjects/Population and Sample

The research population was all grade VIII students of SMPN 9 Makassar in the 2025/2026 academic year, consisting of 7 classes. Before sampling, a homogeneity test of variance between classes was conducted using the Levene test (NIST/SEMATECH, 2012), yielding a significance value of 0.110 > 0.05, so the population was declared homogeneous. Of the 7 classes, 2 were randomly selected: class VIII.G (26 students) as the STAD group and class VIII.I (26 students) as the TPS group, ensuring that both groups had relatively balanced characteristics.

Sampling used the cluster random sampling technique, i.e., selection based on naturally formed group units (Sugilar & Juandi, 2015). Through random draw, class VIII.G was selected as experimental class-1 (STAD model) and VIII.I as experimental class-2 (TPS model), each consisting of 26 students.

Instrument

The research instrument was a mathematics learning outcome test on the Flat Side Space material (pretest and posttest) in the form of Two-Tier Multiple Choice (TTMC) items [jumlah butir soal — to be completed by the author with the actual figure], where the first tier assesses the answer to the mathematics problem and the second tier assesses the reasoning underlying that answer; a response was scored as fully correct only when both tiers were answered correctly. Learning outcomes were assessed in the cognitive domain referring to Bloom's taxonomy (Anderson et al., 2001). The instrument was validated by three mathematics education experts. Content validity was further supported by an expert-agreement index (Aiken's V) of [nilai V — to be completed by the author] (criterion: V ≥ 0.75 indicates high content validity), consistent with

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practice in other instrument-development studies in mathematics education (Nasrullah & Armasari, 2025). Empirical testing on a trial sample produced a Cronbach's Alpha of 0.78 (high reliability), an item difficulty index ranging from [range — to be completed by the author] (medium category), and a discrimination index ranging from [range — to be completed by the author] (acceptable to good), with all distractors functioning effectively.

Procedure/Data Collection

The research procedure included three stages: (1) preparation — preparing learning tools, instruments, and validation; (2) implementation — pretest, treatment (six meetings, each 2 × 40 minutes, covering the surface area and volume of cubes and cuboids, prisms, and pyramids), and posttest; (3) data analysis. Experimental class-1 received the STAD cooperative model assisted by Quizizz Paper Mode, while experimental class-2 received the TPS model assisted by Quizizz Paper Mode. At each meeting, the teacher opened with an apperception, conveyed the learning objectives, implemented the cooperative model according to its characteristic steps, and closed with an evaluation using Quizizz Paper Mode: students answered questions printed on paper cards that the teacher scanned with the Quizizz app, so that Quizizz Paper Mode functioned consistently as a formative assessment integrated into the evaluation stage of every session, rather than as the final posttest, which was administered separately using the TTMC instrument. Figure 1 illustrates this implementation procedure.

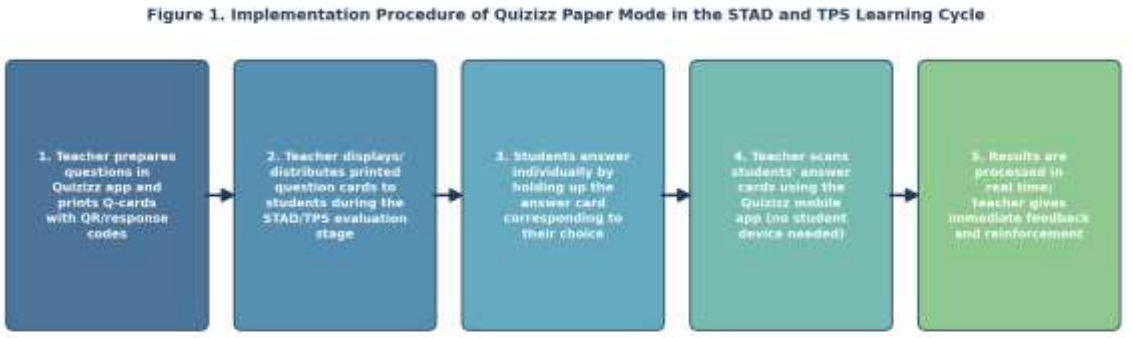


Figure 1. Implementation Procedure of Quizizz Paper Mode in the STAD and TPS Learning Cycle

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Data Analysis

Data were analyzed descriptively and inferentially. Descriptive analysis included the mean, standard deviation, and normalized N-Gain values. N-Gain was calculated using the Hake formula (Hake, 1998): g = (posttest score − pretest score) / (maximum score − pretest score), with categories: high ($g \geq 0.7$), medium ($0.3 \leq g < 0.7$), and low ($g < 0.3$). Inferential analyses included the Kolmogorov–Smirnov normality test, the Levene homogeneity test, the independent-samples t-test to compare the average N-Gain of the two classes, and the Z-proportion test to test classical completeness (> 75%), all computed with SPSS at $\alpha = 0.05$. To complement the significance test, the magnitude of the difference between classes was reported as Cohen's d, interpreted following the conventional guidelines of 0.2 (small), 0.5 (medium), and 0.8 (large) (Cohen, 1988).

RESULT AND DISCUSSION

This section presents the research results, organized according to the phases of data analysis: descriptive statistics, the distribution of the N-Gain category, classical completeness, and the results of the inferential statistical tests. The findings are supported by empirical evidence from the pretest, posttest, and N-Gain data of both experimental classes.

Descriptive Statistics

A summary of the descriptive statistics of the mathematics learning outcomes of the two experimental classes is presented in Table 1.

Table 1. Descriptive Statistics of Mathematics Learning Outcomes for the Two Experimental Classes

Statistics	Pretest E-1	Posttest E-1	Pretest E-2	Posttest E-2	N-Gain E-1/E-2
n	26	26	26	26	26 / 26
Mean	28.58	83.58	32.12	79.88	0.76 / 0.69
Median	25.00	85.00	28.50	80.00	0.78 / 0.70
SD	14.67	5.98	15.91	4.99	0.08 / 0.09
Min	5	69	10	70	0.54 / 0.50
Max	55	96	65	90	0.91 / 0.88

Description: E-1 = Experimental Class-1 (STAD); E-2 = Experimental Class-2 (TPS).

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Based on Table 1, the average pretest scores of experiment-1 (28.58) and experiment-2 (32.12) were both in the very low category, indicating equivalent initial conditions between the two classes. After treatment, the average posttest of the experiment-1 class increased to 83.58 (high category) and the experiment-2 class to 79.88 (high category). The average N-Gain of the experiment-1 class was 0.76 (high category), greater than that of the experiment-2 class at 0.69 (medium category), following the classification of Hake (1998).

Distribution of N-Gain Category

Table 2. Distribution of the N-Gain Category of the Two Experimental Classes

Class	N-Gain Interval	Frequency (%)	Category
Experiment-1 (STAD)	N-Gain ≥ 0.7	23 (88%)	High
	0.3 ≤ N-Gain < 0.7	3 (12%)	Medium
	N-Gain < 0.3	0 (0%)	Low
Experiment-2 (TPS)	N-Gain ≥ 0.7	14 (54%)	High
	0.3 ≤ N-Gain < 0.7	12 (46%)	Medium
	N-Gain < 0.3	0 (0%)	Low

Table 2 shows that the experiment-1 class had a greater proportion of students with a high N-Gain (88%) than the experiment-2 class (54%). No students in either class fell into the low N-Gain category, but the experiment-2 class had more students in the medium category (46% vs. 12%).

Classical Completeness

Based on the Learning Objective Completeness Criteria (KKTP ≥ 78) at SMPN 9 Makassar, the experiment-1 class achieved 85% classical completeness (22 of 26 students completed) and the experiment-2 class reached 77% (20 of 26 students completed). Both percentages exceed the 75% classical completeness threshold, showing that STAD was more consistent than TPS in bringing students to the minimum completeness standard.

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Inferential Statistical Test Results

Table 3. Results of the Prerequisite Test and Hypothesis Test

Test	Data	Statistic	Decision
Normality (K-S)	N-Gain E-1	p = 0.06	Normal
	N-Gain E-2	p = 0.20*	Normal
Homogeneity (Levene)	N-Gain	p = 0.237	Homogeneous
Independent t-test	E-1 vs E-2	t(50) = 2.96, p = .005, 95% CI [0.02, 0.12], Cohen's d = 0.82 (large)	H_o rejected: E-1 > E-2
Z-proportion test	KKTP E-1	p < .001	H_o rejected: π > 75%
Z-proportion test	KKTP E-2	p < .001	H_o rejected: π > 75%

** Lilliefors significance correction.*

Based on Table 3, all N-Gain data met the assumptions of normality and homogeneity. The independent-samples t-test showed t(50) = 2.96, p = .005 (two-tailed), 95% CI for the mean difference [0.02, 0.12], so H_o ($\mu_1 \leq \mu_2$) was rejected: the average N-Gain of experimental class-1 (STAD) was significantly higher than that of experimental class-2 (TPS). The effect size was large (Cohen's d = 0.82), indicating that the difference is not only statistically significant but also practically meaningful. The Z-proportion test for both classes showed p < .001, meaning the classical completeness proportion of both classes statistically exceeded 75%.

DISCUSSION

The results show that both learning models succeeded in significantly improving students' mathematics learning outcomes. The low pretest scores in both classes (averages of 28.58 and 32.12) reflect initial conditions that were less than optimal. Hamzah et al. (2022) state that a lack of variety in teachers' teaching methods is one cause of low learning outcomes, a finding reinforced by Maduratna & Setyawan (2020), who found that less effective learning activities directly affect students' low learning outcomes.

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After treatment, experimental class-1 (STAD) obtained an average posttest of 83.58 with an N-Gain of 0.76 (high), while experimental class-2 (TPS) obtained 79.88 with an N-Gain of 0.69 (medium). These findings are consistent with Murdani et al. (2024), who showed that STAD assisted by Quizizz has a strong influence on cognitive learning outcomes, and with Qodriya et al. (2024), who found that Quizizz Paper Mode positively affects student learning outcomes. The 5.90-point difference in average posttest, together with a large effect size (Cohen's d = 0.82), indicates that STAD's advantage over TPS in this study is both statistically significant and practically substantial. This advantage can be explained from the perspective of group dynamics: STAD's group-reward system creates positive interdependence that encourages students to help and motivate one another, a mechanism that TPS's smaller, ungraded pairs provide to a lesser extent.

The advantage of STAD over TPS can be further explained through group dynamics. In STAD, students study in heterogeneous groups of 4–5 people. Istarani (2024) states that within a learning group, students find and understand difficult concepts more easily. Burden & Byrd (1999) likewise assert that learning in heterogeneous groups allows students to help each other and appreciate one another's contributions. With more members, more ideas can emerge when a student has difficulty, so the material can be understood more thoroughly. The mechanism of calculating individual improvement scores and awarding group recognition in STAD also motivates each student to contribute their best to the group (Slavin, 2005); this group-point system makes individual success contribute directly to group success, increasing students' intrinsic motivation to study seriously and to help peers who are still struggling.

In TPS, by contrast, discussion is carried out in pairs of two. The TPS structure comprises three stages — think, pair, and share (Guenther & Abbott, 2024) — each of which posed a distinct challenge in this study's implementation. During the think stage, some students had limited time to process the Flat Side Space problems independently before pairing, which constrained the depth of ideas they brought into discussion. During the pair stage, several pairs in the experiment-2 class had difficulty resolving disagreements while working on the LKPD, and students tended to rely on their more capable partner rather than reasoning through the problem together, so the exchange of ideas was often asymmetric. During the share stage, limited class time meant not every pair could present their reasoning to the whole class, reducing the cross-group reinforcement that STAD's structured group-scoring process provides. Although Zulkarnain & Djamilah (2015) note that TPS gives students more time for independent and paired thinking, the

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smaller group size (only two members) limits the number of ideas that can emerge when a student struggles, and the absence of an explicit group-reward mechanism like STAD's likely lowers motivation to reach the highest possible result.

The use of Quizizz Paper Mode appeared to have a positive impact in both classes. Rini & Zuhdi (2023) explain that Quizizz Paper Mode using a QR code facilitates efficient, interactive formative quizzes, and its automated scoring feature helped the teacher quickly obtain data on student comprehension to inform subsequent instructional decisions, consistent with the principle that timely feedback is central to effective formative assessment (Black & Wiliam, 2009; Moreira & Lara Freire, 2024). Because it uses printed cards, Quizizz Paper Mode also removed the barrier of unequal access to personal devices, giving all students an equal opportunity to participate in a technology-supported evaluation (Putra, 2023). It is important to note, however, that because both experimental classes used the same Quizizz Paper Mode procedure and no comparison group was taught without it, the specific, independent contribution of Quizizz Paper Mode cannot be separated from the effects of STAD and TPS themselves in this design; its role should be understood as a shared instructional support common to both conditions rather than as a manipulated variable. For the same reason, the observation that students appeared more enthusiastic and engaged during the Quizizz Paper Mode sessions should be read as a qualitative classroom impression rather than a measured finding, since engagement, enthusiasm, and motivation were not assessed with a validated instrument in this study; this is addressed as a limitation and a direction for future research below.

These results align with Rahmi et al. (2022), who found that differences in average student learning outcomes were influenced by differences in the treatment applied. Although TPS did not show as large an improvement as STAD, the 77% classical completeness in the TPS class still met the classical success criterion (> 75%), indicating that TPS assisted by Quizizz Paper Mode remains a feasible alternative for mathematics learning. This is consistent with evidence that the way a learning medium is embedded within a given instructional design — rather than the medium alone — shapes students' opportunity to learn and engagement (Nasrullah et al., 2025). The difference in effectiveness between STAD and TPS in this study confirms that group size and reward mechanism are key factors influencing learning outcomes within a cooperative model.

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CONCLUSION

This research yields three main findings. First, the STAD-type cooperative learning model assisted by Quizizz Paper Mode improved the mathematics learning outcomes of grade VIII students of SMPN 9 Makassar on the Flat Side Space topic, reaching a high average posttest and N-Gain with 85% classical completeness. Second, the TPS model assisted by Quizizz Paper Mode also improved learning outcomes, reaching a high average posttest with a medium N-Gain and 77% classical completeness. Third, students taught with STAD achieved significantly greater improvement than those taught with TPS ($p = 0.005$), with a large effect size (Cohen's $d = 0.82$), indicating that STAD's advantage in this context is both statistically and practically meaningful.

Because this study involved only 52 students from two classes in a single school and a single mathematics topic, and did not include an untreated control group or a class taught without Quizizz Paper Mode, these findings should not be generalized as a blanket recommendation for STAD over TPS in all contexts. Rather, they suggest that STAD assisted by Quizizz Paper Mode may be considered one effective alternative for junior high school mathematics teachers working with content requiring in-depth conceptual understanding, such as Flat Side Space, particularly where STAD's group-reward structure can be implemented well. Other limitations include the absence of a validated instrument to measure student engagement, enthusiasm, or motivation, and reliance on a single learning topic and duration.

Future research is recommended to include an untreated control group and a comparison group taught without Quizizz Paper Mode to isolate the medium's independent contribution, to use a larger sample across multiple schools and mathematics topics, to measure student engagement and motivation with validated instruments, and to report effect sizes alongside significance tests as standard practice.

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