

The Effect of Quizlet-Assisted STAD on Mathematical Problem-Solving Skills of Eighth-Grade MTs Students

Bulan Naysabilla*¹, Asrul²,

^{1,2} Universitas Islam Negeri Sumatera Utara

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ABSTRACT

This study aims to determine the effect and size of the effect of the Quizlet-assisted Student Teams Achievement Division (STAD) learning model on eighth-grade MTs students' mathematical problem-solving skills in the Pythagorean theorem material. The research was driven by students' low mathematical problem-solving abilities, particularly in devising strategies and evaluating solutions. Grounded in a quantitative quasi-experimental framework, the research implemented a Non-equivalent Control Group Design to evaluate intervention outcomes. The research population comprised all 62 eighth-grade students at MTs Zia Salsabila, all of whom were selected as the sample using a saturated sampling technique. The sample was divided into an experimental class (32 students) receiving the STAD model integrated with Quizlet and a control class (30 students) taught via conventional methods. Data were collected using a mathematical problem-solving test structured around Polya's indicators, followed by analysis using an Independent Samples t-Test and Cohen's d effect size. The findings revealed a significance value (Sig. 2-tailed) of 0.001 ($p < 0.05$), indicating a significant impact of the Quizlet-assisted STAD model on students' mathematical problem-solving skills. Furthermore, the Cohen's d value of 0.879 indicates a large effect size, suggesting that the STAD learning model assisted by Quizlet had a substantial effect on improving students' mathematical problem-solving ability.

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Corresponding Author:

Bulan Naysabilla

Departement of Mathematics Education,

Universitas Islam Negeri Sumatera Utara, Indonesia

Email: bulan0305222050@uinsu.ac.id

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1. INTRODUCTION

Education plays a pivotal role in national development by systematically and continuously enhancing human resource quality (Bp et al., 2022). Worldwide, the quality of mathematics instruction—particularly regarding literacy and numeracy competencies—remains a critical priority. Outcomes from the 2022 Programme for International Student Assessment (PISA) underscore a post-pandemic contraction in mathematical literacy across numerous countries, including Indonesia. As a result, students consistently struggle with tasks requiring high-level reasoning, interpretation, and contextualized problem-solving. These challenges align with recent empirical evidence indicating that higher-order thinking (HOT) skills among secondary students remain sub-optimal, highlighting the imperative for pedagogical innovations that stimulate deeper cognitive processing (Yulianto et al., 2024).

Mathematics serves as a foundational science centered on logical reasoning, laying the groundwork for mastering science and technology (Harahap, 2021). As a universal language underpinning virtually all real word context and scientific knowledge (Zulmaulida & Saputra, 2024), mathematics instruction should ideally equip students with problem-solving capabilities rather than mechanical procedural calculations. In practice, however, mathematics instruction at the middle school level (SMP/MTs) remains heavily dominated by conventional lectures and routine drills. As a result, many students still perceive the subject as difficult, daunting, and tedious (Ayyasy & Asrul, 2024).

Mathematical problem-solving skills are essential for navigating the demands of modern life (Siswanto et al., 2025) and are closely linked to students' metacognitive abilities in monitoring and evaluating their cognitive processes (Ramadanti et al., 2022). Recent empirical studies reveal that the majority of junior high school students (SMP/MTs) in Indonesia still face significant challenges during the strategy planning phase and the final answer evaluation stage. A consistent pattern emerged during preliminary observations at MTs Zia Salsabila Class VIII, where pre-research test results involving 32 students demonstrated that only 32% could successfully solve problems following Polya's framework. Conversely, the remaining 68% tended to record final answers directly without demonstrating clear planning procedures.

A viable alternative to address these issues is the Student Teams Achievement Division (STAD) cooperative learning model. This model emphasizes peer interaction to foster mutual motivation and subject mastery (Wulandari, 2022) within heterogeneous groups consisting of 4–5 students (Budiman, 2020). By combining group discussions with individual quiz accountability, STAD encourages students to actively articulate ideas, consider peer perspectives, and collaboratively formulate problem-solving strategies (Rahmadhani & Indrapangastuti, 2025), while simultaneously training them to think critically and independently identify problems in mathematics learning. Prior research confirms that implementing STAD yields a significant improvement in mathematical problem-solving skills compared to conventional instructional approaches (Rahmawati et al., 2025).

Theoretical perspectives suggest that the success of cooperative learning models such as STAD is deeply rooted in the social constructivist theory developed by Lev S. Vygotsky. This theory posits that knowledge is not passively received; rather, it is constructed through social interactions between individuals and their environment. Central to this theoretical framework is the Zone of Proximal Development (ZPD), defined as the spectrum of tasks a student can perform with scaffolding from a more knowledgeable peer relative to their unassisted capability. Consequently, the learning process becomes more effective when students are afforded opportunities to discuss, exchange ideas, and

collaborate in problem-solving (Nurjamilah et al., 2025). Within the context of STAD learning, group members with higher comprehension levels can assist struggling peers through peer discussion and temporary support (scaffolding), thereby enabling students to develop competencies they could not previously achieve on their own.

Previous empirical studies have confirmed the effectiveness of integrating the STAD model with various digital learning media. Research by (Ntjalama et al., 2020) demonstrated that the STAD model assisted by Kahoot media exerted a significant effect on senior high school students' understanding of mathematical concepts. Similarly, (Udayani et al., 2024) revealed that the STAD model integrated with Dakota media significantly enhanced students' ability to solve mathematical word problems, while also boosting student participation and learning motivation. In line with these findings, (Wagiarni et al., 2024) applied a Game-Based Learning model supported by the Quizlet application, reporting a significant positive impact on eighth-grade students' learning outcomes and self-directed learning. Their findings confirm that incorporating Quizlet into game-based instruction effectively improves cognitive achievements and student autonomy compared to conventional instruction.

Prior empirical studies confirm the efficacy of the STAD framework in enhancing students' mathematical problem-solving skills. (Setiawan et al., 2025) reported a notable increase in problem-solving averages from Cycle I (60.8) to Cycle II (77.5) following STAD implementation. Further supporting these findings, (Hadimiati & Asrul, 2025) integrated PowToon media with STAD, yielding a substantially higher N-Gain score in the experimental class (0.65) than in the control class (0.38). Furthermore, a systematic review across 35 indexed studies (Anggraini et al., 2025) reinforced that STAD substantially enhances learning outcomes, classroom participation, and motivation over conventional approaches, offering critical scaffolding for lower-performing students.

The selection of the STAD model in this study is further justified by its distinct pedagogical advantages, including offering students opportunities to utilize questioning skills, analyze problems, foster leadership capabilities, develop discussion skills, and cultivate mutual respect for diverse group perspectives. Nevertheless, the implementation of STAD presents certain limitations, such as instructional time constraints and teacher managerial hurdles in maintaining a conducive collaborative learning environment (Sudarsana, 2021). Consequently, integrating supportive learning media becomes necessary to optimize the model's effectiveness—one such medium being the Quizlet application, which serves as a platform for practice and conceptual reinforcement both individually and collaboratively.

Concurrently, advancements in educational technology have driven the integration of digital media to enhance instructional delivery (Khasanah et al., 2024). Among these tools, the Quizlet application leverages flashcards and interactive quizzes to support retrieval practice and adaptive repetition strategies. Incorporating Quizlet into mathematics instruction has been shown to boost student engagement and conceptual understanding (Hidayati et al., 2026), however, most existing studies focus primarily on general learning outcomes or conceptual comprehension rather than specifically targeting mathematical problem-solving skills. Although both the STAD model and the Quizlet application have been individually investigated, research integrating the STAD model with Quizlet to enhance mathematical problem-solving skills based on Polya's indicators—specifically within the Pythagorean theorem topic at the middle school level (SMP/MTs)—remains scarce.

Bridging this gap in the literature, this study evaluates the impact and magnitude of integrating Quizlet with the STAD model to enhance mathematical problem-solving performance among eighth-grade MTs students learning the Pythagorean theorem.

2. METHOD

A quantitative quasi-experimental design featuring a non-equivalent control group was implemented to evaluate changes in students' mathematical problem-solving performance. The intervention involved two non-randomly assigned cohorts: an experimental group exposed to the Quizlet-assisted STAD cooperative framework and a control group receiving traditional instruction. Pre- and post-intervention assessments were conducted across both groups to measure initial mathematical abilities and post-treatment progress, allowing for a rigorous comparison of instructional efficacy. The conceptual diagram of this research design is structured as follows:

Table 1. Pretest-Posttest Non-Equivalent Control Group Design

Class	Pre-test	Treatment	Post-test
Experiment	O_1	X	O_2
Control	O_1	-	O_2

Where:

O_1 : Pre-test

O_2 : Post-test

X : Treatment (Quizlet-Assisted STAD Learning Model)

The target population comprised all eighth-grade students enrolled at MTs Zia Salsabila during the 2025/2026 academic year ($N = 62$), distributed across Class VIII A ($n = 32$) and Class VIII B ($n = 30$). Utilizing a saturated sampling (total sampling) strategy, the complete population was incorporated into the study. Class VIII A was assigned as the experimental cohort receiving Quizlet-assisted STAD instruction, whereas Class VIII B served as the control group under conventional teaching. Class VIII A was assigned as the experimental group, while Class VIII B served as the control group because this study employed a Nonequivalent Control Group Design using intact classes without individual random assignment. The two classes had relatively equivalent initial abilities based on the pretest results.

Data collection was executed through a mathematical problem-solving instrument centered on the Pythagorean theorem, administered prior to and following the intervention. Designed in direct alignment with the instructional objectives, the instrument was operationalized using Polya's four-stage problem-solving framework: (1) understanding the problem, (2) devising a plan, (3) executing the plan, and (4) reviewing the solution.

The measurement instrument comprised essay-based assessments consisting of five items for the pre-test and five items for the post-test. Prior to empirical deployment, the instrument underwent rigorous validation by expert judges to verify content validity, construct validity, and linguistic appropriateness. Reliability analysis using Cronbach's alpha yielded a coefficient of 0.869, demonstrating high internal consistency and confirming the instrument's suitability for data collection.

Consequently, there is an urgent imperative to examine the efficacy of the Quizlet-assisted STAD model on students' mathematical problem-solving skills. The findings of this study are anticipated to advance pedagogical strategies in mathematics education

Data collection was carried out in three main stages. First, a pre-test was conducted to determine baseline mathematical problem-solving skills. Second, the Quizlet-assisted

STAD learning model was implemented over two instructional sessions covering the Pythagorean theorem. Third, a post-test was administered to both classes to compare the mathematical problem-solving skills of Grade VIII A, which received the Quizlet-assisted STAD learning model, and Grade VIII B, which did not receive the treatment.

Analytical procedures comprised descriptive and inferential statistics. Descriptive techniques were used to compute key data parameters, including mean scores, score ranges (minimum and maximum), and standard deviations. To assess individual learning progress prior to hypothesis testing, gain scores were computed by subtracting pre-test scores from post-test scores.

Subsequently, the normality of the gain score distribution was assessed using the Shapiro-Wilk test, as a primary assumption of parametric t-tests is that the score differences approximate a normal distribution (Pallant, 2010). A significance value exceeding 0.05 indicates that the data satisfy the normality assumption. After that, item homogeneity was checked using Levene's Test on the pre-test and post-test score differences. If the p-value exceeds 0.05, the data meets the homogeneity assumption, and an independent samples t-test is used for analysis.

To evaluate differences in problem-solving performance between the experimental and control groups, hypothesis testing was conducted using an Independent Samples t-Test at a significance level of ($\alpha = 0.05$). The null hypothesis (H_0) is rejected if the two-tailed significance value is less than 0.05 (2-tailed) < 0.05 , demonstrating that the Quizlet-assisted STAD model exerts a statistically significant effect on students' mathematical problem-solving skills.

To complement inferential hypothesis testing, the practical magnitude of the intervention was quantified using Cohen's d for independent samples, assessing the strength of the Quizlet-assisted STAD model on students' mathematical problem-solving skills (Lakens, 2013). The effect size was calculated as follows:

$$d = \frac{\bar{X}_1 - \bar{X}_2}{S_p}$$

Where:

d = Cohen's d

$\bar{X}_1$ = Experimental group mean

$\bar{X}_2$ = Control group mean

S_p = Pooled standard deviation

The pooled standard deviation (S_p) is calculated using the following formula:

$$S_p = \sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}}$$

s_1^2 = sample variance of the experimental class

s_2^2 = sample variance of the control class

n_1 = number of participants in the experimental class

n_2 = number of participants in the control class

Table 2. Interpretation Criteria for Effect Size

Range	Category
$0 \leq d \leq 0.19$	Very small
$0.20 \leq d \leq 0.49$	Small
$0.50 \leq d \leq 0.79$	Moderate
$d \geq 0.8$	Large

All statistical analyses were performed using SPSS.

Bridging this empirical gap, the present study evaluates the extent to which integrating Quizlet within the STAD cooperative framework enhances mathematical problem-solving competencies among eighth-grade MTs students in the context of the Pythagorean theorem.

3. RESULTS AND DISCUSSION

3.1 Result

Based on the descriptive statistical analysis, the mean pre-test scores for the experimental and control groups were 55.04 and 55.21, respectively, with a minimum score of 42.50 and 43.75, a maximum score of 68.75 for both groups, and standard deviations of 7.49 and 7.63. Following the instructional intervention, the mean post-test scores for the experimental and control groups increased to 80.43 and 76.75, respectively. The minimum score for both groups was 68.75, while the maximum scores were 88.75 for the experimental group and 83.75 for the control group, with standard deviations of 5.76 and 4.71, respectively. A summary of the descriptive statistics is presented in Table 3.

Table3. Descriptive Statistical Summary of Pre-test and Post-test Performance

Statistic	Pre-test Experimen	Pre-test Control	Post-test Experiment	Post-test Control
Measure	32	30	32	30
Mean	55,04	55,21	80,43	76,75
Minimum	42,50	43,75	68,75	68,75
Maximum	68,75	68,75	88,75	83,75
Std. Deviation	7,49	7,63	5,76	4,71

The observed difference in mean gains provides an initial indication that the intervention implemented in the experimental group is associated with the enhancement of students' mathematical problem-solving skills. However, descriptive mean differences alone are insufficient to draw definitive conclusions regarding statistical significance. Therefore, further evaluation through prerequisite tests and inferential hypothesis testing is necessary to determine whether the difference in mathematical problem-solving skills between the two groups is statistically significant.

Normality Test Results

Prior to parametric statistical analysis, a Shapiro-Wilk test was performed on the pre-test and post-test scores of both experimental and control groups to verify the assumption of normality. The corresponding normality test results are summarized in Table 4.

Table 4. Normality Test Results

	Shapiro-Wilk		
	Statistic	df	Sig.
Eksperiment Class	,973	30	,615
Control Class	,969	30	,516

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on Table 4, the results of the Shapiro-Wilk normality test show that the normality values for both the experimental and control classes are greater than 0.05 ($0,615 > 0,05$) and ($0,516 > 0,05$). Since the significance values for both classes exceed 0.05, the data for the experimental and control classes are declared normally distributed. Thus, the assumption of normality is met to proceed with parametric statistical analysis.

Homogeneity Test Results

Following the normality test, a homogeneity of variance test was conducted as an essential prerequisite prior to performing the Independent Samples t-Test. This test was executed to determine whether the variances of the two research samples were equal (homogeneous).

Tabel 5. Homogeneity Results

Test of Homogeneity of Variance

	Levene Statistic	df1	df2	Sig.
Based on Mean	3,905	1	60	,053
Based on Median	3,539	1	60	,065
Based on Median and with adjusted df	3,539	1	55,243	,065
Based on trimmed mean	3,932	1	60	,052

Based on Table 5, the homogeneity test using the Levene Statistic for the experimental and control classes yielded a significance value of 0.053 on the "Based on Mean" row. This significance value is greater than the significance level used, which is 0.05. This indicates that the variance of the data between the experimental and control classes does not show a significant difference.

Based on the homogeneity test results above, it can be concluded that the research data meets the assumption of homogeneity because the significance value is greater than 0.05. Meeting the assumption of homogeneity, along with the previous assumption of normality, confirms that the research data is eligible for further analysis using parametric statistics, specifically the Independent Samples t-Test.

Hypothesis Testing Results

Hypothesis testing was conducted to investigate whether there is a statistically significant difference in students' mathematical problem-solving skills between the experimental group, which was taught using the Quizlet-assisted STAD learning model, and the control group, which received conventional instruction. The results of the analysis are presented in Table 6.

Table 6. Inferential Analysis: Independent Samples t-Test

Independent Samples 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	
NILAI	Equal variances assumed	3,905	,053	3,459	60	,001	3,84896	1,11277	1,62309	6,07483
	Equal variances not assumed			3,495	56,263	,001	3,84896	1,10115	1,64332	6,05459

Based on table 6, the results of the Independent Samples t-Test show that the significance value for Levene's Test for Equality of Variances is 0.053 ($p > 0.05$). Thus, it can be concluded that the variance between the experimental and control classes is homogeneous. Consequently, the interpretation of the Independent Samples t-Test results is based on the "Equal variances assumed" row.

On the "Equal variances assumed" row, a t-value of [t-value] was obtained with degrees of freedom (df) of 60 and a significance value (p-value) of [p-value]. This significance value is smaller than the significance level of 0.05 ($0,001 < 0.05$). Based on the decision-making criteria, if the significance value is less than 0.05, H_0 is rejected and H_a is accepted. This study demonstrates that there is a significant difference in the average mathematical problem-solving ability between students in the experimental class and the control class.

Effect Size Results

To determine the practical significance of the treatment, the effect size was quantified using Cohen's d. Table 7 presents the resulting effect size metrics.

Table 7. Effect Size Results

Independent Samples Effect Sizes					
		Standardizer ^a Point Estimate		95% Confidence Interval	
				Lower	Upper
selisih nilai	Cohen's d	4.37869	.879	.353	1.398
	Hedges' correction	4.43439	.868	.349	1.380
	Glass's delta	3.59123	1.072	.496	1.633

a. The denominator used in estimating the effect sizes.

Cohen's d uses the pooled standard deviation.

Hedges' correction uses the pooled standard deviation, plus a correction factor.

The analysis yielded a Cohen's d value of 0.879, indicating that the Quizlet-assisted STAD learning model exerts a large effect on students' mathematical problem-solving skills.

Further evidence regarding the efficacy of the Quizlet-assisted STAD learning model on students' mathematical problem-solving skills is illustrated through the analysis of students' written responses evaluated against Polya's problem-solving indicators.

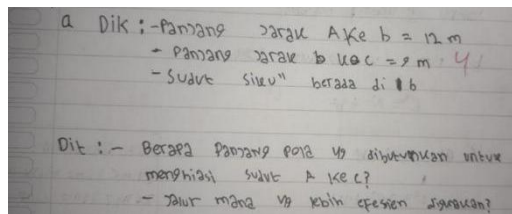


Figure 1. Understanding the Problem

Based on the analysis of student answer sheets, students demonstrated the ability to comprehend the problem by articulating the given information and the explicit requirements using their own words. As shown in the student work, they explicitly identified the given parameters: the distance from point A to B as 12 meters, the distance from point B to C as 9 meters, and the right angle of the triangle located at point B. Additionally, they correctly formulated the problem's objective: determining the pattern length required to bridge points A and C, as well as identifying the more efficient route to take.

This indicates that students were not only capable of recognizing essential information within the word problem, but also of transforming that raw data into a foundational representation to formulate a solution strategy. Consequently, the criteria for the "Understanding the Problem" indicator were successfully fulfilled.

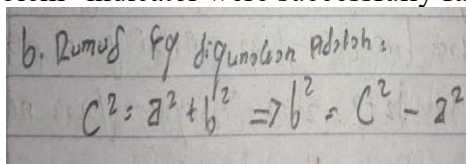


Figure 2. Divising a Plan

Based on the analysis of student answer sheets, students fulfilled the "Devising a Plan" indicator by accurately selecting and applying the Pythagorean theorem formula. Students effectively connected the identified given parameters with the problem's explicit objective, establishing a systematic sequence of solution steps. Nevertheless, minor omissions in mathematical notation were observed on the answer sheets, indicating areas where formal mathematical representation can be further refined.

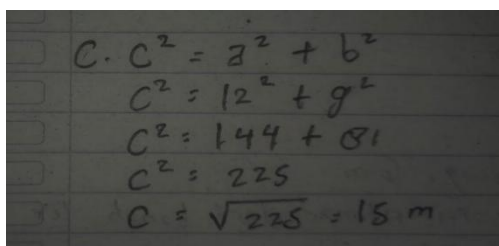


Figure 3. Carrying Out the Plan

The analysis of student answer sheets demonstrates that students successfully fulfilled the "Carrying Out the Plan" indicator, as evidenced by their accurate formula selection and precise computational execution.

The integration of the STAD model alongside the Quizlet application effectively fostered active collaboration and facilitated conceptual understanding. Peer discussions within cooperative learning groups helped minimize computational errors before students independently completed the problem-solving steps in a structured and sequential manner.

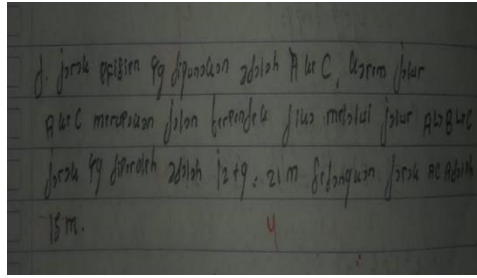


Figure 4. Looking Back

Based on the analysis of student answer sheets, students satisfied the "Looking Back" indicator by critically evaluating their final solutions through a comparison of alternative distance options. Students successfully validated the correctness of their answers, ensured that their mathematical steps aligned with the problem's contextual constraints, and drew accurate conclusions.

Overall, the analysis of student answer sheets demonstrates that the Quizlet-assisted STAD learning model exerts a positive effect on students' mathematical problem-solving skills across all four Polya indicators. The entire problem-solving sequence—ranging from understanding the problem, devising and carrying out a strategy, to re-evaluating the solution—proved to be interconnected as a holistic cognitive process. The combination of group interactions, conceptual practice via Quizlet, and individual accountability within this model effectively supports students in developing their mathematical problem-solving skills optimally.

3.2 Discussion

This study confirms that integrating the STAD cooperative learning model with the interactive media Quizlet facilitates the enhancement of students' mathematical problem-solving skills more effectively than conventional instruction. Within the STAD framework, students are provided opportunities to collaborate in heterogeneous groups, articulate perspectives, compare solution strategies, and support one another when encountering learning difficulties, while individual quizzes promote personal accountability for their learning outcomes. Concurrently, the Quizlet application serves as a mechanism for conceptual reinforcement through its *flashcards*, *learn*, *match*, and *test* features, which facilitate retrieval practice and spaced repetition, thereby enabling students to recall and apply the Pythagorean theorem more readily when solving problems.

The analysis of students' written work in the experimental group demonstrated strong achievement across all four of Polya's problem-solving indicators. On the understanding the problem indicator, students successfully articulated the given information and explicit problem objectives using their own words. Regarding the devising a plan indicator, students effectively connected the identified information with the appropriate Pythagorean theorem formula, although minor refinements in formal mathematical notation remain necessary for a subset of students. For the carrying out the plan indicator, students executed precise value substitutions and calculations, supported by group discussions that helped minimize procedural errors. On the looking back indicator, students exhibited critical evaluation skills, such as comparing alternative solution pathways to ensure the most efficient result.

Inferential statistical analysis reinforces these qualitative findings, as evidenced by an Independent Samples t-Test significance value of $p = 0.001 (< 0,05)$. This result confirms that the superior post-test mean score of the experimental group (80,43) compared to the control group (76,75) is statistically significant. Furthermore, an effect

size of $d = 0.697$ (large category) indicates that the Quizlet-assisted STAD intervention exerts a meaningful and substantial impact on the quality of student achievement.

These results are consistent with previous studies by (Rasid et al., 2025) which demonstrated that the STAD model incorporated with a problem-posing approach is more effective in enhancing mathematical problem-solving skills than direct instruction. Similarly, (Ntjalama et al., 2020) established that combining STAD with digital media effectively fosters an active and meaningful learning environment. The primary theoretical and empirical contribution of this study stems from the novel synthesis of digital flashcard technology (Quizlet) with the STAD cooperative learning framework within secondary mathematics education, as well as its focus on measuring mathematical problem-solving skills grounded in Polya's indicators within the context of the Pythagorean theorem. Consequently, this study extends the empirical literature regarding the synergy between cooperative learning models and digital technology in mathematics education.

4. CONCLUSION

Drawing upon the empirical findings and subsequent discussion, this study concludes that: (1) integrating the Quizlet platform into the STAD cooperative learning framework significantly enhances the mathematical problem-solving capabilities of eighth-grade MTs students, as evidenced by an Independent Samples t-Test significance value of 0.001 ($p < 0.05$); and (2) the magnitude of this effect falls into the large effectt, with a Cohen's d effect size of 0.879. These results indicate that the Quizlet-assisted STAD model can be considered a viable alternative strategy for mathematics instruction—particularly for topics requiring problem-solving skills—as it enhances active student engagement, group collaboration, and conceptual understanding through technology-based interactive practice. Future reserch is recommended to examne the implementation of this model across different mathematical topics, educational levells, or larger sample sizes to achieve broader generalization of the findings.

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