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The Effectiveness of STAD with a Deep Learning Approach Assisted by Zep Quiz in Improving Students' Mathematical Problem-Solving Ability

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ABSTRACT Students' mathematical problem-solving ability remains relatively low, particularly when dealing with contextual and non-routine mathematical problems. This condition highlights the need for learning environments that encourage collaborative problem solving, meaningful learning, and active student engagement. Therefore, this study aimed to examine the effectiveness of the Student Teams Achievement Division (STAD) learning model with a deep learning approach assisted by Zep Quiz on students' mathematical problem-solving ability. This study employed a quantitative approach using a quasi-experimental method with a nonequivalent control group design. The research was conducted at Junior High School 1 Paron involving eighth-grade students from an experimental class and a control class selected through cluster random sampling. Data were collected using essay-based pretest and posttest instruments developed based on Polya's problem-solving indicators. The data were analyzed using normality and homogeneity tests, an independent-samples t-test, and N-Gain analysis. The independent-samples t-test yielded $t(58) = 1.589$ and $p = 0.117$, indicating no statistically significant difference between the experimental and control classes. Descriptively, the experimental class showed greater improvement than the control class, as indicated by the higher N-Gain score (0.48 compared with 0.32), although both were categorized as moderate improvement. The effectiveness ratio was 1.52, indicating a descriptive advantage of the experimental class over the control class. This study addresses a gap in previous research by operationally integrating STAD, a deep learning approach emphasizing mindful, meaningful, and joyful learning, and Zep Quiz as an interactive gamification-based medium within a collaborative mathematical problem-solving sequence. This integration connects peer collaboration, meaningful engagement, and interactive digital practice in supporting students' engagement with contextual and non-routine mathematical problems. Although the difference between the experimental and control classes was not statistically significant, the descriptive findings indicate a positive tendency associated with the implementation of STAD with a deep learning approach assisted by Zep Quiz.

Keywords: deep learning, mathematical problem-solving ability, STAD learning model, Zep Quiz

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INTRODUCTION

Education plays an important role in developing students' critical thinking skills, character, and problem-solving abilities as preparation for facing challenges in modern society. According to the Indonesian National Education System Law Number 20 of 2003, education aims to develop students' potential to become knowledgeable, creative, independent, and responsible citizens. One of the subjects that contributes significantly to the improvement of educational quality is mathematics. Mathematics learning focuses not only on mastering concepts but also on developing logical thinking, reasoning, and mathematical problem-solving skills (Arsyad et al., 2024). Therefore, mathematics learning should be designed effectively to support the development of higher-order thinking skills.

Mathematical problem-solving ability is considered one of the most essential competencies in mathematics education. According to Pólya (2014), problem solving involves four stages: understanding the problem, planning the solution, carrying out the plan, and reviewing the result. This ability is not naturally acquired but must be developed through meaningful and systematic learning processes (Nasution & Hsb, 2022). In line with this, Novitasari and Mashuri (2024) emphasized that problem-solving ability is a key competency that students need in order to face real-world and professional challenges effectively. Therefore, mathematics learning should provide opportunities for students to think critically, collaborate, and actively construct their own understanding through meaningful learning experiences. Meaningful mathematics learning occurs when students are actively involved in solving problems, allowing them to construct knowledge through experience and interaction (Prayitno et al., 2022). In addition, problem-solving activities also contribute to students' cognitive, affective, and psychomotor development because students are encouraged to think critically, collaborate, and communicate mathematical ideas (Santos-Trigo, 2024).

However, Indonesian students' mathematical problem-solving abilities remain a concern. According to the Programme for International Student Assessment (PISA) 2022 conducted by the Organisation for Economic Co-operation and Development (OECD, 2023), Indonesian students achieved an average mathematics score of 366 points, substantially below the OECD average of 472 points. Furthermore, only 18% of Indonesian students attained Level 2 or higher in mathematics, compared with an OECD average of 69%. At this proficiency level, students are expected to be able to interpret and recognize how a simple situation can be represented mathematically without direct instructions. The OECD also reported that students at higher proficiency levels are able to model complex situations mathematically and select, compare, and evaluate appropriate problem-solving strategies. These findings indicate that Indonesian students continue to face challenges in mathematical reasoning and problem solving, particularly when dealing with more complex mathematical situations. Siswanto and

Meiliasari (2024) stated that these conditions indicate that students still experience difficulties in solving non-routine mathematical problems that require reasoning and higher-order thinking skills. Based on observations conducted at Junior High School 1 Paron, more than 50% of students had not achieved the minimum learning mastery criteria in mathematics. Most students were able to identify the known and required information but were unable to complete the problem-solving procedures systematically. This condition indicates that students' mathematical problem-solving abilities still need to be improved.

One factor contributing to low mathematical problem-solving ability is the limited use of innovative learning models and interactive learning media that actively engage students in the learning process. Learning activities are still dominated by teacher-centered approaches, causing students to become passive and less accustomed to solving problems systematically. Himmawan and Kusumah (2024) explained that students often struggle to connect mathematical concepts with real-life situations. Therefore, teachers need to implement learning models that encourage collaboration, interaction, and active participation. One of the cooperative learning models considered effective is the Student Teams Achievement Division (STAD) model. According to Slavin (1982), STAD encourages students to work collaboratively in heterogeneous groups where each member helps one another understand the learning material. Previous studies have shown that the STAD model can improve students' mathematical problem-solving abilities and learning participation (Gultom et al., 2023).

Although the STAD learning model has several advantages, some limitations remain in its implementation, such as ineffective time management and unequal student participation during group discussions (Aminah, 2025). To address these limitations, a learning approach that strengthens students' cognitive engagement is needed. In this study, the deep learning approach is operationally defined as a pedagogical approach that promotes conceptual understanding through critical, reflective, and applicative learning processes. Biggs and Tang (2011) explained that deep learning encourages students to connect ideas, construct meaning, and apply concepts in relevant contexts. The approach is characterized by three principles: mindful, meaningful, and joyful learning, which are implemented through students' awareness of learning objectives and problem-solving processes, connections between mathematical concepts and prior knowledge or real-life contexts, active participation and collaboration, application of solution strategies, and reflection. These principles are integrated into STAD activities through problem identification, group discussion, explanation of solution strategies, contextual application, and reflection, with Zep Quiz serving as interactive technological support. Research conducted by Siregar et al. (2025) also revealed that deep learning positively affects students' mathematics learning outcomes through active learning experiences supported by interactive digital media.

In addition to applying appropriate learning models and approaches, integrating digital learning media is also important for improving the effectiveness of mathematics learning. One interactive digital medium that can be utilized is Zep Quiz, a gamification-based quiz platform designed to create engaging and enjoyable learning experiences. Zep Quiz provides immediate feedback, increases students' motivation, and encourages active participation during learning activities (Sari et al., 2025). In addition, integrating gamified digital media can strengthen students' learning motivation and retention of mathematical concepts (Siregar et al., 2025). Several studies have shown that both STAD learning models and Zep Quiz media positively impact students' mathematics learning outcomes. However, studies integrating the STAD learning model, deep learning approach, and Zep Quiz media simultaneously to improve mathematical problem-solving abilities are still limited.

Based on the explanation above, the research gap of this study lies in the limited integration of the STAD cooperative learning model with a deep learning approach assisted by Zep Quiz in mathematics learning, particularly in developing students' mathematical problem-solving abilities. Therefore, this study aims to examine whether there is a significant difference in students' mathematical problem-solving abilities between those taught using STAD with a deep learning approach assisted by Zep Quiz and those taught using conventional STAD assisted by Zep Quiz. Thus, the study specifically focuses on comparing the two treatments to determine whether their implementation results in a significant difference in students' mathematical problem-solving abilities.

RESEARCH METHOD

Research Setting and Time

This research was conducted in the eighth grade at Junior High School 1 Paron during the second semester of the 2025/2026 academic year, specifically in April 2026. The study employed a quasi-experimental design (Sugiyono, 2022) and compared students' mathematical problem-solving abilities between those taught using the STAD learning model with a deep learning approach assisted by Zep Quiz and those taught using conventional STAD assisted by Zep Quiz. The instructional treatment was conducted over three meetings, with each meeting lasting 2×40 minutes. The instructional topic was circles. The experimental class received STAD integrated with the deep learning approach, emphasizing mindful, meaningful, and joyful learning, while the control class received conventional STAD. Zep Quiz was used in both classes as interactive technological support. Both classes received the same instructional material and allocated instructional time. All teaching activities were conducted by the researcher using the prepared lesson plans to ensure consistency of the treatment. The research activities, including proposal preparation, instrument development and testing, data collection, data analysis, and final report preparation, were carried out from January to May 2026.

Research Design

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Table 1. Research Design

Group	Pre-Test	Treatment	Post-Test
Experimental	O_1	X_1	O_2
Control	O_3	X_2	O_4

Population, Sample, and Data Collection Technique

The population of this study consisted of all eighth-grade students at Junior High School 1 Paron, totaling 220 students distributed across seven classes (VIII A–VIII G). Cluster random sampling was used to select the research sample. First, the seven classes were considered eligible clusters. Two classes were then randomly selected as the research sample, namely class VIII E and class VIII D. Class VIII E was assigned as the experimental group, receiving the STAD learning model with a deep learning approach assisted by Zep Quiz, while class VIII D was assigned as the control group, receiving STAD assisted by Zep Quiz. Each group consisted of 30 students.

Data were collected using written essay tests administered as pretests and posttests to measure students' mathematical problem-solving abilities. The instrument consisted of four essay items based on Pólya's problem-solving indicators: (1) understanding the problem, (2) devising a plan, (3) carrying out the plan, and (4) looking back. Each item was scored using a 0–4 scoring rubric, resulting in a maximum total score of 16, which was subsequently converted to a 100-point scale. The items were designed to represent the four Pólya indicators, with each item assessing students' ability to understand the given problem, formulate an appropriate solution strategy, execute the strategy correctly, and review the obtained solution. Students' responses were scored by the researcher using the predetermined scoring rubric.

Before the instrument was used for data collection, the essay items were tested to determine their validity, reliability, difficulty level, and discrimination index. The item validity analysis showed that all items met the validity criteria and were suitable for use. The reliability coefficient of the instrument was 0.7913, indicating high reliability. The difficulty analysis showed that the items were within the acceptable range, with the items categorized as easy to moderate. The discrimination analysis indicated that all items had acceptable to very good discrimination power. These results indicated that the instrument was suitable for measuring students' mathematical problem-solving abilities.

Data Analysis Technique

Data analysis in this study consisted of prerequisite tests, hypothesis testing, and N-Gain analysis. The normality test was conducted using the Lilliefors test, while the homogeneity test was conducted using the F-test to determine whether the posttest data met the assumptions of normality and homogeneity. The primary hypothesis analysis was performed using the independent-samples t-test on the posttest scores to determine whether there was a significant difference in students' mathematical problem-solving abilities between the experimental and control groups. The pretest scores were used to describe students' initial abilities, while the posttest scores were used as the primary data for comparing the two treatments.

In addition, N-Gain analysis was used as a supporting analysis to describe the improvement in students' mathematical problem-solving abilities from pretest to posttest. The N-Gain score was calculated for each student using the following formula:

$$\text{N-Gain} = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Maximum Score} - \text{Pretest Score}} \times 100\%$$

In this study, the maximum score was 100. The individual N-Gain scores were then averaged for each group. The N-Gain values were interpreted as high when ($g \geq 0{,}70$), moderate when ($0{,}70 > g \geq 0{,}30$), and low when ($g < 0.30$), based on the classification proposed by Hake (1998). Thus, the independent-samples t-test was used as the primary analysis to examine the difference between the two treatments, whereas N-Gain was used to provide additional information about the level of improvement in each group.

RESULTS AND DISCUSSION

This study was conducted from April 8 to April 16, 2026, at Junior High School 1 Paron using a quasi-experimental method to compare students' mathematical problem-solving abilities based on Pólya's indicators. The population consisted of all eighth-grade students, totaling 220 students across seven classes. Using cluster random sampling, Class VIII E was selected as the experimental group and Class VIII D as the control group, with 30 students in each class. The experimental group received the STAD learning model integrated with a deep learning approach assisted by Zep Quiz, while the control group received conventional STAD assisted by Zep Quiz.

The treatment was implemented in three meetings, with each meeting lasting 2×40 minutes. The same researcher conducted the instruction in both groups using the prepared lesson plans. To ensure the fidelity of the deep learning approach, each experimental session explicitly incorporated the three principles of mindful, meaningful, and joyful learning into the STAD stages. Mindful learning was implemented through students' awareness of learning objectives, problem identification, monitoring of solution processes, and reflection. Meaningful learning was implemented by connecting circle concepts with prior knowledge and contextual problems, while joyful learning was promoted through active collaboration, discussion, and interactive activities using Zep Quiz. The implementation of these activities was guided by the prepared lesson plans and treatment mapping for each meeting to maintain consistency across the intervention sessions.

Students' mathematical problem-solving abilities were measured using four essay items on circle material based on Pólya's four indicators: understanding the problem, devising a plan, carrying out the plan, and looking back. Before administration, the instrument was tested for validity, reliability, difficulty level, and discrimination index. The detailed results of the instrument testing are presented in Table 2.

Table 2. Instrument Testing Results

Instrument	Reliability Coefficient	Interpretation
Pretest	0.6604	0.161
Posttest	0.7913	0.161

The instrument testing results are presented in Table 2. All four items met the predetermined validity criteria and were therefore considered suitable for use. The reliability coefficient was 0.6604 for the pretest instrument and 0.7913 for the posttest instrument, indicating moderate and high reliability, respectively. The difficulty indices showed that the items were within the acceptable range of difficulty, while the discrimination indices indicated acceptable to very good discrimination. Therefore, the instrument was considered appropriate for measuring students' mathematical problem-solving abilities.

Following the instrument evaluation, data on students' mathematical problem-solving abilities were obtained through pretests and posttests administered to both the experimental and control groups. The pretest was administered before the treatment to identify students' initial abilities, while the posttest was administered after the learning process to measure their mathematical problem-solving abilities following the treatment. The test instrument consisted of four essay items covering the four indicators of mathematical problem-solving based on Pólya's theory: understanding the problem, devising a plan, carrying out the plan, and looking back. Each indicator was scored on a scale of 0–4 according to the predetermined scoring criteria.

The pretest and posttest scores for both groups were summarized using the number of students (N), mean, standard deviation, minimum score, and maximum score. These statistics provide an overview of the students' initial abilities and their performance after the treatment before inferential statistical analyses were conducted.

Table 3. Pretest Normality Test Results

Group	N	L Count	L Table	Decision	Results
Experimental	30	0.134	0.161	H_0 Accepted	Normal
Control	30	0.152	0.161	H_0 Accepted	Normal

Based on the data above, the normality test results showed that the pretest data of both the experimental and control classes were normally distributed. In the experimental class, the obtained values were $L_{\text{count}} = 0.134$ and $L_{\text{table}} = 0.161$, while in the control class the obtained values were $L_{\text{count}} = 0.152$ and $L_{\text{table}} = 0.161$. Because $L_{\text{count}} < L_{\text{table}}$ for both classes, H_0 was accepted. Therefore, the data from both classes fulfilled the assumption of normality.

Table 4. Posttest Normality Test Results

Group	N	L Count	L Table	Decision	Results
Experimental	30	0.145	0.161	H_0 Accepted	Normal
Control	30	0.161	0.161	H_0 Accepted	Normal

Furthermore, the posttest normality test results also indicated that the data from both the experimental and control classes were normally distributed. In the experimental class, the obtained values were $L_{\text{count}} = 0.145$ and $L_{\text{table}} = 0.161$, while in the control class the obtained values were $L_{\text{count}} = 0.161$ and $L_{\text{table}} = 0.161$. Because $L_{\text{count}} \leq L_{\text{table}}$ for both classes, H_0 was accepted. Thus, the research data from both classes met the assumption of normality.

Table 5. Pretest Homogeneity Test Results

Group	Variance	F Count	F Table	Decision	Results
Experimental Control	38.092 56.185	1.475	1.861	H_0 Accepted	Homogeneous

The pretest homogeneity test results showed that the variances of the experimental and control classes were homogeneous. This was indicated by the values of $F_{\text{count}} = 1.475$ and $F_{\text{table}} = 1.861$. Since $F_{\text{count}} < F_{\text{table}}$, H_0 was accepted. Therefore, the data from both classes had equal variances and fulfilled the requirement for conducting the t-test.

Table 6. Posttest Homogeneity Test Results

Group	Variance	F Count	F Table	Decision	Results
Experimental Control	217.426 229.275	1.054	1.861	H_0 Accepted	Homogeneous

Furthermore, the posttest homogeneity test results indicated that the variances of the data in classes VIII D and VIII E were homogeneous. This was shown by the values of $F_{\text{count}} = 1.054$ and $F_{\text{table}} = 1.861$. Since $F_{\text{count}} < F_{\text{table}}$, H_0 was accepted. Therefore, both datasets were declared homogeneous and met the requirement for further analysis using the t-test.

Based on the results of the normality and homogeneity tests, which showed that both datasets were normally distributed and homogeneous, hypothesis testing was continued using the t-test and N-Gain test. The independent-samples t-test was conducted to determine whether there was a significant difference between the STAD learning model with a deep learning approach assisted by Zep Quiz and the STAD learning model assisted by Zep Quiz in terms of students' mathematical problem-solving abilities.

H_0: There is no statistically significant difference in students' mathematical problem-solving abilities between the experimental and control groups.

H_1: There is a significant effect between the two learning models on students' mathematical problem-solving abilities.

Table 7. Posttest t-Test Results

Group	Variance	t Count	t Table	Decision	Results
Experimental Control	217.426 229.275	1.589	2.002	H_0 Accepted	No Statistically Significant Difference

The hypothesis test results showed that $t_{\text{count}} = 1.589$ and $t_{\text{table}} = 2.002$. Since $t_{\text{count}} < t_{\text{table}}$, H_0 was accepted. Therefore, there was no significant difference between the experimental and control class treatments in improving students' mathematical problem-solving abilities.

N-Gain Test

The N-Gain test was used to determine the effectiveness of the learning models in improving students' mathematical problem-solving abilities.

Table 8. Experimental Class N-Gain Results

	Pre-Test	Post-Test	N-Gain	Category
Mean	20,33	40,77	0,48	Moderate

The experimental class obtained an average N-Gain score of 0.48, which falls into the moderate category. This result indicates that the STAD learning model with a deep learning approach assisted by Zep Quiz was moderately effective in improving students' mathematical problem-solving abilities.

Table 9. Control Class N-Gain Results

	Pre-Test	Post-Test	N-Gain	Category
Mean	19,80	34,63	0,32	Moderate

The control class obtained an average N-Gain score of 0.32, which also falls into the moderate category. This indicates that the STAD learning model assisted by Zep Quiz was moderately effective in improving students' mathematical problem-solving abilities.

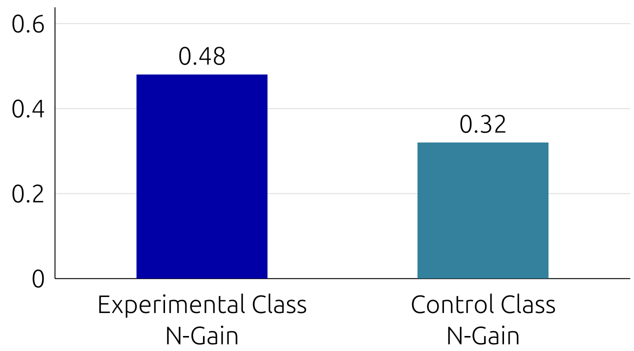

Figure 1. Problem-Solving N-Gain

The relative increase between the two groups was described using the ratio of the mean N-Gain scores. The ratio was calculated by dividing the mean N-Gain score of the experimental group by that of the control group. Based on the unrounded N-Gain values, the resulting ratio was 1.52. This value indicates that the descriptive increase in the experimental group was higher than that in the control group. However, both groups were categorized as having moderate N-Gain scores, and the independent-samples t-test showed no statistically significant difference between the two groups. Therefore, the finding should be interpreted cautiously: the experimental group showed a higher descriptive increase, but this difference was not statistically significant:

$$\text{Effectiveness} = \frac{\text{N-Gain Experimental Class}}{\text{N-Gain Control Class}} = 1.52$$

The experimental group showed a higher descriptive increase in students' mathematical problem-solving abilities than the control group. However, the independent-samples t-test indicated that the difference between the two groups was not statistically significant.

The results showed that the mathematical problem-solving abilities of students in the experimental class who received STAD learning with the deep learning approach assisted by Zep Quiz increased more than those of students in the control class who received STAD learning assisted by Zep Quiz. This was indicated by an effectiveness value of 1.52. However, the results of the hypothesis test showed that the difference in improvement was not statistically significant, with $t_{\text{count}} = 1.589$ and $t_{\text{table}} = 2.002$.

These findings indicate that the addition of the deep learning approach did not result in a statistically significant difference in students' mathematical problem-solving abilities compared with STAD assisted by Zep Quiz. Rahmawati et al. (2021) explained that student learning outcomes are not entirely determined by the variables examined, as other factors may also influence learning achievement. Therefore, the absence of a statistically significant difference in this study may be associated with factors beyond the treatment provided. Classroom observations and students' learning activities during the treatment provided contextual information regarding the implementation of the deep learning approach. However, these observations were used only as supporting information and were not subjected to separate quantitative analysis. Thus, the findings should not be interpreted as establishing that the implementation of the deep learning approach was the primary cause of the non-significant difference.

Classroom observations showed that most students remained focused on completing assignments and obtaining correct answers. During group discussions, students tended to focus on quickly obtaining answers rather than exploring the mathematical rationale behind the strategies used. This was evident in the responses on the student worksheets and the results of group discussions in Zep Quiz, which mostly focused directly on solution procedures without in-depth conceptual explanations. As a result, concept elaboration, mathematical argumentation, and reflection, which are central to deep learning, did not develop optimally.

Another finding indicated that students were able to reach the stages of understanding the problem and implementing solutions but still experienced difficulties at the stage of reviewing the results according to Pólya's indicators. Based on the post-test answer sheets, most students did not double-check the procedures or results obtained and did not write complete conclusions. In fact, the ability to reflect on and evaluate results is one of the main characteristics that should be developed through deep learning. This finding is in line with the results of research by Sawastie et al. (2022), which showed that students are often able to obtain answers through the solution procedures used but are not consistent in reviewing the results obtained or drawing complete conclusions at the end of the problem-solving process. This finding indicates that students are not yet accustomed to carrying out the process of reflective thinking independently.

Furthermore, video recordings of the learning process were reviewed as supporting evidence of group discussion activities in the experimental class. The review focused on students' participation, the distribution of opportunities to express mathematical reasoning, and their involvement in explaining and evaluating solution strategies. The recordings indicated that discussion participation was not fully distributed among group members, as some groups were dominated by students with higher academic abilities, while other members tended to follow the results of the discussion without actively explaining their reasoning. These observations were supported by students' worksheets and group responses in Zep Quiz. This condition is consistent with Sasomo's (2021) view that limited interaction among students and difficulties in maintaining learning motivation may hinder the achievement of learning objectives. Thus, the deep learning experience may not have been equally experienced by all students. However, these observations are considered supporting contextual information and do not constitute a direct causal explanation for the non-significant difference between the two groups.

The most important finding in this study is that Deep Learning does not automatically result in significant improvements in mathematical problem-solving abilities when students do not yet have reflective thinking habits and a culture of in-depth discussion. Although theoretically Deep Learning is designed to encourage students to build conceptual understanding, reflect, and connect knowledge to broader contexts, the results show that students still tend to use a procedural approach and are oriented towards final answers.

Thus, the findings of this study show that the main challenge of implementing deep learning in mathematics learning lies not in delivering the material but in changing students' learning culture. Deep learning requires more time to form habits of reflection, mathematical argumentation, and self-evaluation. Therefore, in the context of this study, the advantages of deep learning have not been significantly apparent because the process of internalizing reflective thinking and metacognitive skills is still in the developmental stage. This finding is an important contribution because it shows that the success of deep learning depends heavily on students' readiness to engage in higher-order thinking processes, not solely on the application of the learning model used. This finding is consistent with the study conducted by Evendi et al. (2026), which reported that the main challenges in implementing deep learning include students' low participation in group discussions, difficulties in independent learning, and limited reflective thinking skills. The study also found that the reflection aspect obtained the lowest achievement compared with the understanding and application stages, indicating that students often struggle to evaluate their own learning processes. These findings support the results of the present study, where students tended to focus on obtaining correct answers rather than engaging in deeper reflection and mathematical reasoning. Consequently, the potential benefits of deep learning were not fully realized, resulting in a less significant improvement in mathematical problem-solving abilities.

Furthermore, the use of Zep Quiz appeared to encourage active participation during the learning process. Through interactive quizzes, students were observed to engage in group collaboration and exchange ideas when solving mathematical problems. These observations suggest that Zep Quiz provided an interactive learning environment that supported student participation. However, because students' motivation and enthusiasm were not measured using a specific instrument, these findings are interpreted only as limited observational evidence rather than evidence of increased motivation.

CONCLUSION AND RECOMMENDATION

The findings should be interpreted within the limitations of the study. The treatment was implemented in only three meetings with a duration of 2×40 minutes per meeting and was conducted in a single school with a relatively limited sample. In addition, although the same researcher conducted the instruction in both groups, differences in students' participation and the implementation of the deep learning approach may have affected the learning process. The deep learning principles of mindful, meaningful, and joyful learning were not optimally experienced by all students during group activities. Therefore, the findings do not provide sufficient evidence to recommend the experimental model as superior to the control treatment. Nevertheless, the higher descriptive N-Gain observed in the experimental group suggests that the integration of the deep learning approach with STAD and Zep Quiz warrants further investigation. Future studies are recommended to employ longer treatment durations, larger and more diverse samples, multiple schools, and more systematic monitoring of treatment fidelity to examine whether the observed descriptive advantage can be replicated and produce statistically significant differences.

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