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THE EFFECT OF THE TEAM ASSISTED INDIVIDUALIZATION LEARNING MODEL ASSISTED BY WORDWALL ON STUDENTS' MATHEMATICAL PROBLEM-SOLVING ABILITY

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Abstract

The mathematical problem-solving skills of students in Indonesia remain comparatively weak, a pattern evident both in the 2022 PISA outcomes and among eighth-grade learners at SMP Swasta Cerdas Murni, where the majority failed to reach the Minimum Completeness Criteria (KKM) on problem-solving tasks, especially those involving statistics. This research seeks to determine how the Wordwall-supported Team Assisted Individualization (TAI) learning model influences students' ability to solve mathematical problems in the topic of statistics. A quantitative method was applied using a Pretest-Posttest Control Group Design, involving 48 eighth-grade students who were assigned to experimental and control groups through cluster random sampling. Data were gathered using essay-based tests grounded in Polya's problem-solving indicators, and analyzed through the Independent Sample T-Test alongside Cohen's d. Findings showed a statistically significant effect ($p < 0.001$) with a very large effect size (Cohen's d = 6.028), demonstrating that the experimental group's improvement in problem-solving ability far outpaced that of the control group. Overall, the results indicate that the Wordwall-assisted TAI model offers a promising alternative for mathematics instruction, one that encourages students to engage actively and collaboratively while studying statistics.

Keywords: Team Assisted Individualization, Wordwall, mathematical problem-solving ability, statistics, digital gamification

INTRODUCTION

Education holds a strategic position in advancing a nation, as the quality of its human resources is largely determined by the educational process (Pradesa et al., 2024). The 21st-century education system demands that students possess critical thinking, creativity, collaboration, and problem-solving skills (Alawiyah et al., 2024), and among the subjects that contribute significantly to building these competencies is mathematics, which functions not only as a tool but also as a language across disciplines (Farisah et al., 2023). Teachers therefore play a vital role in guiding students to strengthen and enrich fundamental mathematical concepts, so that their thinking skills become increasingly robust (Jumri & Murdiana, 2022).

In line with this, the NCTM places problem-solving as one of the core competencies in mathematics learning, alongside reasoning, communication, connections, and representation (Nduru et al., 2023), as also affirmed in Ministerial Regulation (Permendiknas) No. 22 of 2006.

Polya (1973), problem-solving ability as consisting four stages: understanding the problem, devising a plan, carrying out the plan, and looking back at the solution a framework used as the primary reference in this study and considered essential for helping students build a strong grasp of mathematical concepts (Mukarromah et al., 2024). Operationally, this ability is reflected in students' efforts to understand the problem, identify the known and asked information, formulate a mathematical model, select an appropriate solving strategy, and verify the correctness of the solution obtained (Firda et al., 2023). Although mathematical problem-solving ability holds an important position, Indonesian students' national achievement remains relatively low, as reflected in the 2022 PISA results, which ranked Indonesia 70th out of 81 countries with an average score of 366, far below the OECD average of 472 (Nisa & Faradiba, 2023). This aligns with the findings of Kesuma et al. (2022) that most students have not been able to solve problems systematically, from understanding the problem through to interpreting the answer.

A similar pattern was identified more specifically at SMP Swasta Cerdas Murni: an initial observation on 9 February 2026 showed that mathematics learning was still dominated by one-way lecturing, causing students to be passive and rarely trained to devise solving strategies independently. Interviews with the mathematics teacher confirmed that most eighth-grade students scored below the Minimum Completeness Criteria (KKM) on problem-solving questions, particularly in statistics material the focus of intervention in this study. This classroom-level finding indicates that the low problem-solving ability is not merely a national issue but also a concrete problem directly linked to the learning patterns applied in that class.

One factor suspected to contribute to this low ability is the dominance of teacher-centered learning, particularly the lecture method, which limits students' active involvement in thinking and discussion (Sya'bani et al., 2024). To address this, teachers can pursue a change in approach or learning model so that students' learning potential both physical and mental can develop more optimally (Reflina & Ananda, 2022). This calls for a learning model capable of accommodating differences in individual ability while also encouraging collaborative interaction within groups. The Team Assisted Individualization (TAI) model developed by Slavin (1995) is a relevant alternative, as it theoretically combines individual learning with heterogeneous group work grounded in the principles of positive interdependence and individual accountability within cooperative learning. Through the peer-tutoring structure in TAI, more capable students help their peers understand problem-solving strategies, while teachers can focus more closely on guiding groups that need additional assistance (Mandiangan et al., 2024). This model's effectiveness in enhancing mathematical problem-solving ability has been confirmed across multiple educational levels (Harahap et al., 2022).

Beyond the learning model itself, the use of appropriate media also determines the quality of mathematics instruction. Wordwall is a web-based digital gamification application that presents interactive games and quizzes while providing immediate feedback on students' answers, thereby functioning both as a learning medium and as an evaluation tool (Siregar et al., 2023). Its use has been shown to increase students' engagement, confidence, and understanding of the material (Kurnia et al., 2025). Conceptually, TAI and Wordwall are complementary: TAI manages differences in student ability through group-work structures and peer tutoring, while Wordwall strengthens the affective dimension of learning through game elements and instant feedback that boost learning motivation (Roliasari et al., 2025).

A number of earlier studies have tested how effective the TAI model. Yundiana et al. (2020) found that TAI produced a significant effect on the mathematical problem-solving ability of eighth-grade students at SMP Negeri 26 Bandar Lampung without any particular supporting medium, with the experimental class average (80.17) higher than the control class (62.07). Fadlilah et al. (2021) combined the TAI model with interactive video in distance learning at SMP Negeri 172 Jakarta and obtained a significant effect with an effect size of 79% (Cohen's ES = 0.844, high category). Harahap et al. (2022) demonstrated that applying TAI to eighth-grade students at MTs Swasta Harapan Jasa Makmur significantly improved mathematical problem-solving ability, from 17.5% on the initial test to 90% by the end of Cycle II. Nduru et al. (2023) reported a significant TAI effect on the mathematical problem-solving ability of eighth-grade students at SMP Negeri 31 Medan, with the experimental class average higher than the control class. Aswil et al. (2025) demonstrated that TAI assisted by structured student worksheets (LKPD) had a significant effect on the mathematical problem-solving ability of students at SMP Negeri 118 Jakarta, with a Cohen's d of 0.82 (large category). These five studies consistently confirm the effectiveness of the TAI model, both without supporting media (Yundiana et al., 2020; Nduru et al., 2023) and with static supporting media such as interactive video (Fadlilah et al., 2021) and structured LKPD (Aswil et al., 2025). None of this media, however, has drawn on digital gamification mechanisms that deliver instant, competitive feedback even though such mechanisms could strengthen the motivational dimension that is a prerequisite for successful cooperative learning (Rahmayanti et al., 2023). Integrating Wordwall into the TAI syntax, particularly at the fact-test stage, allows students to obtain direct feedback on both individual and group work something not yet accommodated by the LKPD- or interactive-video-based media used in prior studies. This study therefore does not merely replicate the application of TAI, but tests whether adding an interactive gamification element can further reinforce the effectiveness of the TAI model reported previously.

This research contributes to the existing literature by integrating the Team-Assisted Individualization (TAI) model with the Wordwall digital gamification medium a combination not yet examined in previous research together with its focus on eighth-grade statistics material, which empirically shows low achievement at the research site. Based on this gap, the study aims to examine whether, and to what extent, the Wordwall-assisted TAI learning model affects the mathematical problem-solving ability of eighth-grade students at SMP Swasta Cerdas Murni in statistics material.

METHOD

This study applied a quantitative approach with a quasi-experimental design. Quantitative research is defined as a scientific approach used to test theories or hypotheses by numerically measuring social phenomena and subjecting them to statistical analysis (Sugiyono, 2022). The research made use of a Pretest-Posttest Control Group Design involving two groups, namely the experimental and the control group. A pretest was administered to both groups to determine the students' initial level of ability. Each group received a different instructional treatment, followed by a posttest to assess changes in students' mathematical problem-solving ability after the learning intervention.

This study was conducted at SMP Swasta Cerdas Murni, located on Jl. Beringin Pasar VII Tembung, Percut Sei Tuan District, Deli Serdang Regency, North Sumatra Province, during the even semester of the 2026/2027 academic year. The population for this study consisted of all eighth-grade students of SMP Swasta Cerdas Murni, consisting of four parallel classes totaling 99 students. The sampling technique applied was cluster random sampling, i.e., sampling based on pre-existing groups or classes. This technique was chosen because students had already been distributed into intact classes according to school policy, making individual-level randomization impossible without disrupting existing class schedules and structures a common practice in quasi-experimental research (Sugiyono, 2022).

Through this technique, two classes were randomly selected from the four parallel classes as the research sample, each comprising 24 students: one class served as the experimental group, receiving treatment through the Wordwall-assisted TAI model, and one class served as the control group, using conventional instruction, for a total sample of 48 students. The equivalence of the two groups' baseline ability prior to treatment was confirmed through a pretest administered to both groups; the results, presented in the findings section, show that the average scores of the two classes were descriptively quite similar (a difference of 1.46 points) before the different treatments were applied.

The research procedure consisted of three stages. The preparatory stage included initial observation, coordination with the mathematics teacher, determination of the population and sample, development of a teaching module based on the Wordwall-assisted TAI model, and the preparation and validation of test instruments. The implementation stage began with a pretest administered to both groups, followed by three learning sessions in which the experimental class applied the Wordwall-assisted TAI model through eight structured syntax steps (Placement Test, Teams, Teaching Group, Student Creative, Team Study, Wordwall-assisted Fact Test, Team

Scores and Team Recognition, and Whole-Class Unit), while the control class followed conventional lecture-based instruction; the study concluded with a posttest for both groups. The data-processing and analysis stage included prerequisite tests (normality and homogeneity) and hypothesis testing using the Independent Sample T-Test and Cohen's d, as elaborated below, leading to conclusions that address the research questions.

Data collection was carried out using written assessments administered as pretests and posttests to evaluate students' mathematical problem-solving abilities. The instrument comprised 10 essay items (5 pretest items and 5 posttest items) developed from Polya's (1973) four problem-solving indicators: (1) understanding the problem, (2) devising a plan, (3) carrying out the plan, and (4) looking back. Prior to trial testing, the instrument underwent a content-validity process through expert judgment by two mathematics education experts, Rosliana Harahap, M.Pd., and Sri Rahma Yani Harahap, M.Pd. Both experts assessed each item's alignment with the problem-solving indicators, the clarity of the language, and the appropriateness of the difficulty level for eighth-grade students using a validation sheet, and provided suggestions for improving the wording and construction of the items. The instrument was deemed suitable for use after revision based on both experts' feedback, and was then empirically trialed to establish item validity and reliability.

The trial result indicated that all 10 pretest and posttest items had r-count values (0.969–0.987) exceeding the r-table value (0.355), and were therefore declared valid, while the Cronbach's Alpha reliability coefficient of 0.995 was categorized as very high, based on standard validity and reliability testing criteria (Sugiyono, 2022). The difficulty-index test showed that all items fell into the medium category ($0.30 \leq TK < 0.70$) items that are too easy or too difficult risk lowering students' motivation to attempt them (Asrul et al., 2022) and the discrimination-index test showed that all items had good discriminating power. The instrument was thus declared valid and reliable for use in this study.

The analysis process included: (1) descriptive analysis to describe the pretest and posttest results of both groups; (2) a normality test using the Shapiro-Wilk test at a 5% significance level ($\alpha = 0.05$), given a sample size below 50; (3) Levene's Test was conducted to assess the homogeneity of variances between the groups; and (4) the Independent Samples t-test was performed at a 5% significance level ($\alpha = 0.05$) to examine differences in students' mathematical problem-solving abilities between the two groups; and (5) effect-size analysis using Cohen's d for two independent groups, i.e., d = (M_experimental − M_control) / SD_pooled, Where $M_{\text{experimental}}$ and M_{control} represent the posttest mean scores of the experimental and control groups, respectively, while SD_{pooled} denotes the pooled standard deviation of the two groups (Cohen, 1988), used to gauge the magnitude of the effect of the Wordwall-assisted TAI model on students' mathematical problem-solving ability. All analyses were performed using IBM SPSS 27.0.

RESULT AND DISCUSSION

Prior to the learning intervention, a pretest was administered to both groups to determine their initial mathematical problem-solving ability. In the experimental group, learning was implemented using the Wordwall-assisted TAI model through eight structured syntax steps: (1) Placement Test, in which the teacher analyzes students' initial ability as the basis for forming heterogeneous groups; (2) Teams, in which students are divided into small groups of 4–5 members with varying ability levels; (3) Teaching Group, in which the teacher systematically presents statistics content (mean, median, mode) to the whole class; (4) Student Creative, in which each student individually studies and works on problems; (5) Team Study, in which students discuss their individual work within the group, help one another, check answers, and correct mistakes; (6) Fact Test via Wordwall, in which students individually complete quizzes through Wordwall to gauge their understanding; (7)

Team Scores and Team Recognition, in which the teacher assesses and rewards the best-performing group; and (8) Whole-Class Unit, in which the teacher and students summarize the material covered. Meanwhile, the control group followed conventional instruction using lecture and question-and-answer methods, with learning activities carried out over three sessions.

The following section presents an overview of students' mathematical problem-solving ability before and after the implementation of the learning intervention.

Table 1. Descriptive Analysis Result of Pretest and Posttest Scores

	Pre-test Control	**Post-test Control**	**Pre-test Experimental**	**Post-test Experimental**
N	24	24	24	24
Mean	45.3125	63.3333	46.7708	86.5104
Median	45.6250	62.5000	46.2500	87.5000
Mode	46.25	61.25	46.25	87.50
Std. Deviation	3.95714	3.86010	3.47578	3.83028
Range	16.25	16.25	13.75	15.00
Minimum	37.50	56.25	38.75	78.75
Maximum	53.75	72.50	52.50	93.75

Referring to the pretest results in Table 1, the average mathematical problem-solving score of students in the experimental class was 46.77, while the control class averaged 45.31 a difference of only 1.46 points. The two classes therefore had a relatively equivalent starting point before receiving different learning treatments.

After treatment, the experimental class's average posttest score reached 86.51, while the control class averaged 63.33. The experimental class improved by 39.74 points from pretest to posttest, whereas the control class improved by only 18.02 points, yielding a posttest mean difference of 23.18 points between the two classes.

The distribution of pretest and posttest scores is presented in the following tables to give a clearer picture of the spread of students' abilities in each class.

Table 2. Frequency Distribution of Pretest Scores for the Control and Experimental Classes

Interval (Control)	**Freq.**	**Percentage**	**Interval (Experimental)**	**Freq.**	**Percentage**
37.50–40.00	2	8.33%	38.75–41.25	2	8.33%
40.00–42.50	2	8.33%	41.25–43.75	2	8.33%
42.50–45.00	5	20.83%	43.75–46.25	9	37.50%
45.00–47.50	8	33.33%	46.25–48.75	6	25.00%
47.50–50.00	4	16.67%	48.75–51.25	3	12.50%
50.00–52.50	1	4.17%	51.25–53.75	2	8.33%
52.50–55.00	2	8.33%	-	-	-
Total	24	100%	Total	24	100%

Based on Table 2, the control class pretest results show the highest-frequency interval at 45.00–47.50 with 8 students (33.33%), while the lowest frequency was at 50.00–52.50 with 1 student (4.17%). For the experimental class, the highest frequency was in the 43.75–46.25 interval with 9 students (37.50%), while the lowest frequency occurred at 38.75–41.25 and 41.25–43.75, each with 2 students (8.33%).

Table 3. Frequency Distribution of Posttest Scores for the Control and Experimental Classes

Interval (Control)	Freq.	Percentage	Interval (Experimental)	Freq.	Percentage
56.25–58.75	3	12.50%	78.75–81.25	3	12.50%
58.75–61.25	8	33.33%	81.25–83.75	2	8.33%
61.25–63.75	3	12.50%	83.75–86.25	2	8.33%
63.75–66.25	3	12.50%	86.25–88.75	10	41.67%
66.25–68.75	3	12.50%	88.75–91.25	4	16.67%
68.75–71.25	0	0.00%	91.25–93.75	3	12.50%
71.25–73.75	1	4.17%	-	-	-
Total	24	100%	Total	24	100%

Based on Table 3, the control class posttest results show the highest frequency at 58.75–61.25 with 8 students (33.33%). The experimental class posttest results, meanwhile, show the highest frequency in the 86.25–88.75 interval with 10 students (41.67%), and 17 of 24 students (70.83%) scored above 86.25.

Table 4. Normality Test Result (Shapiro-Wilk)

Data	Shapiro-Wilk W	Sig.	Conclusion
Pre-test Experimental	0.933	0.112	Normal
Post-test Experimental	0.944	0.195	Normal
Pre-test Control	0.982	0.922	Normal
Post-test Control	0.967	0.600	Normal

Referring to Table 4, all significance values (Sig.) in both groups exceed 0.05, indicating that all data satisfied the normality assumption and were therefore suitable for parametric statistical testing.

Next is the homogeneity test, used to determine whether the two groups' data have equal variance. The results are presented in Table 5.

Table 5. Homogeneity Test Result (Levene's Test)

Data	Levene Statistic	df1	df2	Sig./ Conclusion
Pre-test	0.477	1	46	0.493–Homogeneous
Post-test	0.174	1	46	0.679–Homogeneous

Based on the Table 5, both significance values exceed 0.05, indicating that the variances of the two groups are homogeneous and that the analysis can proceed to hypothesis testing.

An Independent Samples t-test, using a significance level of 5% (α = 0.05), was employed to determine whether the post-treatment mathematical problem-solving abilities differed significantly between the experimental and control groups.

Table 6. Independent Sample T-Test Result

	t	df	Sig. (2-tailed)	Mean Difference	95% CI Lower	95% CI Upper
Equal variances assumed	-20.880	46	< 0.001	-23.178	-25.412	-20.945

Based on the Independent Sample T-Test results in Table 6, the significance value in the Sig. (2-tailed) column is $p < 0.001 < 0.05$, so H0 is rejected and Ha is accepted.

The analysis revealed a statistically significant difference in posttest mathematical problem-solving ability between the experimental and control groups. The experimental group obtained a mean score of 86.51, whereas the control group achieved a mean score of 63.33, representing a mean difference of 23.18 points.

Cohen's *d* effect size analysis was conducted to quantify the impact of the Wordwall-assisted TAI model on students' mathematical problem-solving ability. The corresponding results are presented in Table 7.

Table 7. Effect Size Analysis Results (Cohen's d)

Cohen's d	Standardizer	95% CI Lower	95% CI Upper	Category
6.028	3.845	-7.372	-4.669	Very Large Effect

Based on Table 7, a Cohen's d value of 6.028 (the absolute value of -6.028) was obtained, with a Standardizer of 3.845. The Cohen's d value was calculated by dividing the posttest mean difference between the experimental and control groups by the pooled standard deviation, namely $d = (86.51 - 63.33) / 3.845 = 6.028$. Because the sign depends on group coding, the effect is interpreted using its absolute value. This value lies far above the threshold for the Very Large Effect category (> 1.20) according to Sawilowsky (2009), and the 95% confidence interval (-7.372 to -4.669) does not cross zero, indicating that this effect size is robust.

The discussion below connects these analytical findings with relevant learning theories and findings from previous studies. Pretest scores revealed that students in the experimental and control groups began the study with similarly low levels of mathematical problem-solving ability (a difference of 1.46 points). This indicates that many students still struggled with understanding the problem, planning an appropriate strategy, and systematically organizing solution steps, consistent with the findings of Sari et al. (2024) and Putri & Warmi (2022). This equivalence in initial conditions is an important basis for interpreting the posttest difference between the two groups as an effect of the treatment given, rather than simply a difference in students' initial characteristics.

After treatment, the experimental class improved by an average of 39.74 points, far higher than the control class's improvement of only 18.02 points, producing a final difference of 23.18 points that proved statistically significant ($p < 0.001$) with a very large effect size (Cohen's d = 6.028).

The experimental class's advantage can be explained through several interrelated mechanisms. First, the syntax of the TAI model requires students to work on the material individually first (the Student Creative phase) before discussing it within heterogeneous groups (the Team Study phase). This sequence gives students the opportunity to independently construct their initial understanding including at the stages of understanding the problem and planning a strategy within Polya's (1973) framework before their misconceptions are corrected through discussion and peer tutoring. This process of students explaining concepts to one another aligns with the principles of positive interdependence and individual accountability in Slavin's (1995) cooperative learning, which positions more capable students as facilitators for their peers while simultaneously deepening their own understanding through the act of re-explaining (Rahmayanti et al., 2023). Second, integrating Wordwall into the Fact Test phase provides instant feedback on students' answers. This immediate feedback allows students to recognize errors at the carrying-out-the-plan and looking-back stages the two Polya stages most often neglected by students before those errors carry over into subsequent problems, so that the cycle of practice and correction proceeds faster than in conventional instruction, which typically offers correction only after all problems have been completed. Wordwall presents statistics practice problems as interactive games with real-time score displays, making students more enthusiastic and motivated to work through problems, consistent with Awal Sabiila (2024) and Roliasari et al. (2025), who likewise reported that integrating Wordwall into cooperative learning enhances students' understanding. Third, the gamification elements of scoring and competition in Wordwall are thought to increase students' affective engagement, making them more persistent in trying alternative solving strategies when their initial approach fails, rather than giving up as tends to occur in one-way lecture-based instruction.

In contrast, in the control class using conventional instruction, student activity tended to be passive and centered on the teacher's explanations. Students mostly imitated the example problems provided without being trained to articulate their thinking process or devise strategies independently. This caused the improvement in mathematical problem-solving ability in the control class to be less optimal than in the experimental class. This finding supports Sya'bani et al. (2024), who noted that teacher-centered instruction leads to low student engagement, leaving students passive with limited opportunities to independently develop problem-solving ability.

It should be noted that this study has several limitations that must be considered when interpreting the findings above. First, the study was conducted at only one school with a relatively short intervention duration (three sessions), so it cannot yet confirm whether the observed effect persists over the long term. Second, the study is limited to a single topic namely statistics so generalizing to other mathematics topics should be done with caution. Third, the effect size obtained (Cohen's d = 6.028), which far exceeds values reported in similar previous studies, may also have been influenced by the specific characteristics of the sample and the school context.

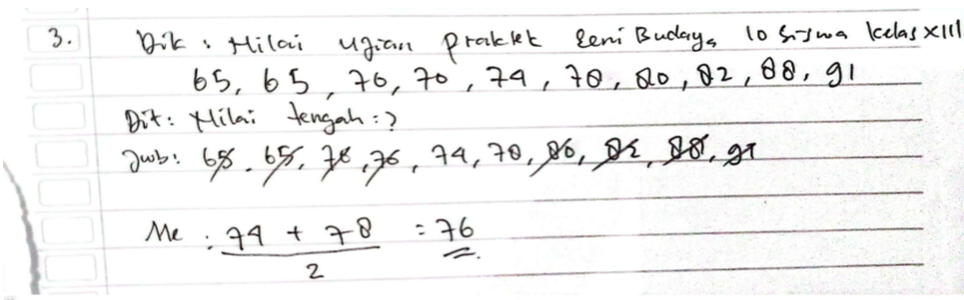

Figure 1. Sample Student Answer, Experimental Class

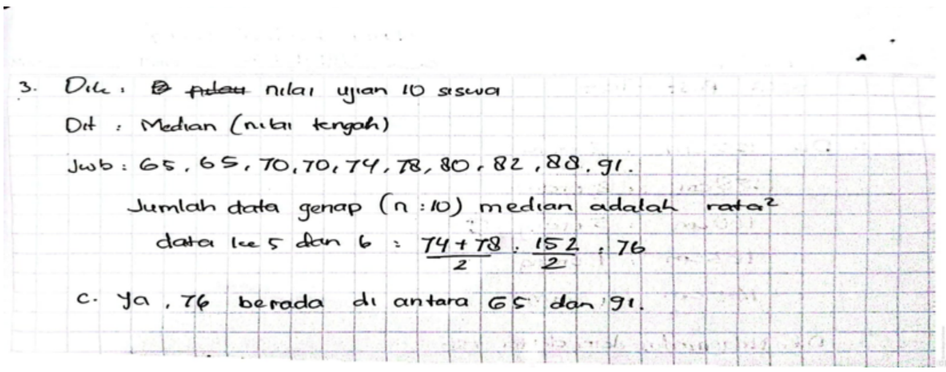

Figure 2. Sample Student Answer, Control Class

A comparison of sample posttest answers from students (Figures 1 and 2) reveals a clear difference between the two classes based on Polya's stages. The experimental class students' answers were organized systematically according to Polya's stages from recording the known and asked information, planning a strategy, correctly carrying out the procedure, through to drawing a conclusion. Control class students' answers, by contrast, tended to jump directly to calculation without systematic problem-solving steps and did not include a final conclusion. This difference illustrates that the Wordwall-assisted TAI model successfully trained students to solve problems in an orderly, structured manner.

These findings align with the study by Harahap et al. (2022), who found that the TAI model significantly improved problem-solving ability from 17.5% to 90%. Nduru et al. (2023) likewise showed that the TAI model produced a higher posttest average than conventional instruction. Similarly, Yundiana et al. (2020) demonstrated a significant effect of the TAI model without supporting media on the problem-solving ability of eighth-grade students, while Fadlilah et al. (2021), who combined TAI with interactive video, obtained a high-category effect size (ES = 0.844). Aswil et al. (2025) confirmed that TAI with structured LKPD produced a significant effect with a Cohen's d of 0.82 (large category).

This study obtained a substantially larger Cohen's d value of 6.028, indicating that integrating Wordwall as a digital gamification medium further strengthens the effectiveness of the TAI model compared with similar previous studies that did not employ interactive digital media. The consistency across these studies lies in the consistent direction of TAI's effect on problem-solving ability, while the difference lies mainly in the magnitude of the effect size, which is considerably higher in this study a difference most plausibly attributable to the contribution of Wordwall's gamification elements rather than to the characteristics of the TAI model alone. The gamification elements within Wordwall create an enjoyable, competitive learning environment that motivates students to participate actively and persist in solving problems, thereby contributing to a substantial improvement in mathematical problem-solving ability relative to previous studies that applied the TAI model without digital media support.

CONCLUSION

This study demonstrates that the Wordwall-assisted Team Assisted Individualization (TAI) learning model has a significant and very large effect on the mathematical problem-solving ability of eighth-grade students at SMP Swasta Cerdas Murni in statistics material, with the experimental class's improvement far exceeding that of the control class. This finding reinforces Slavin's (1995) cooperative learning theory and shows that integrating digital gamification can serve as an alternative strategy for more active and collaborative mathematics learning at the junior secondary level. Given that this study was limited to one school, one topic, and a short treatment duration, future research is recommended to test this model with other topics, educational levels, and longer intervention durations.

REFERENCES

Alawiyah, T. N., Sridana, N., Kurniawan, E., & Hayati, L. (2024). Analisis kemampuan pemecahan masalah matematika siswa berdasarkan langkah Polya. *Mandalika Mathematics and Educations Journal, 6(1), 151–164*. https://doi.org/10.29303/jm.v6i1.6925

Asrul, Hasan, A., & Mukhtar. (2022). Evaluasi Pembelajaran. Perdana Publishing.

Aswil, A. T., Murdiyanto, T., & Partasiwi, N. (2025). Pengaruh model pembelajaran kooperatif tipe Team Assisted Individualization (TAI) berbantuan LKPD terstruktur terhadap kemampuan pemecahan masalah matematis peserta didik SMP Negeri 118 Jakarta. *Jurnal Riset Pembelajaran Matematika Sekolah, 9(2), 52–60*. https://doi.org/10.21009/jrpms.092.06

Awal Sabiila, O. P. (2024). Penggunaan Wordwall sebagai media berbasis game edukasi untuk meningkatkan minat belajar siswa kelas IV SDN Polehan 1. *Jurnal Pembelajaran, Bimbingan, dan Pengelolaan Pendidikan, 4(5), 12*. https://doi.org/10.17977/um065.v4.i5.2024.12

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences (2nd ed.)*. Lawrence Erlbaum Associates.

Fadlilah, M. F., Purwanto, S., & El Hakim, L. (2021). Pengaruh model pembelajaran Team Assisted Individualization (TAI) berbantuan video interaktif dalam pembelajaran jarak jauh terhadap kemampuan pemecahan masalah matematis siswa SMP Negeri 172 Jakarta. *Jurnal Riset Pembelajaran Matematika Sekolah, 5(2), 14–26*. https://doi.org/10.21009/jrpms.052.02

Farisah, L., Salim, & Siregar, T. J. (2023). Perbedaan hasil belajar dan kemandirian belajar siswa yang diajar menggunakan metode SQ3R dan konvensional. *RELEVAN: Jurnal Pendidikan Matematika, 3(1), 49–56.*

Firda, N., Suryadi, D., & Dahlan, J. A. (2023). Mathematical problem-solving ability of junior high school students based on Polya. *Edumatica: Jurnal Pendidikan Matematika, 13(03), 273–284*. https://doi.org/10.22437/edumatica.v13i03.29287

Harahap, Y. N., Siswadi, S., & Surdiyanti, S. (2022). Peningkatan kemampuan pemecahan masalah matematik siswa melalui model pembelajaran Team Assisted Individualization (TAI). *OMEGA: Jurnal Keilmuan Pendidikan Matematika, 1(1), 12–17*. https://doi.org/10.47662/jkpm.v1i1.157

Jumri, R., & Murdiana, M. (2022). Kemampuan representasi matematis siswa dengan Resource Based Learning. *Aksioma, 11(1), 1–7*. https://doi.org/10.22487/aksioma.v11i1.1901

Kesuma, P. F., Syaripudin, T., & Iriawan, S. B. (2022). Penerapan model TAI untuk meningkatkan kemampuan pemecahan masalah matematis siswa kelas IV. *Jurnal Pendidikan Guru Sekolah Dasar, 7(1)*.

Kurnia, M. D., Febianti, Y. N., & Ambarwati, A. (2025). Media pembelajaran interaktif Word Wall terhadap hasil belajar siswa pada materi etika profesi kelas X akuntansi SMK Pariwisata Kosgoro Kota Cirebon. *Jurnal Visi Ilmu Pendidikan, 16(3), 341–349*. https://doi.org/10.26418/jvip.v16i3.60192

Mandiangan, I. E., Wenas, J. R., & Angmalisan, H. Y. (2024). Penerapan model pembelajaran kooperatif tipe Team Assisted Individualization (TAI) terhadap hasil belajar siswa pada materi bentuk aljabar di kelas VII SMP Negeri 3 Tondano. *Journal on Education, 7(2), 8699–8705*. https://doi.org/10.31004/joe.v7i2.7744

Mukarromah, S., Rahmawati, N. D., Ariyanto, L., & Ashari, S. R. A. (2024). Kemampuan pemecahan masalah matematis ditinjau dari belief in mathematics siswa dalam menyelesaikan soal turunan fungsi. *Jurnal Pendidikan dan Pembelajaran Indonesia (JPPI), 4(2), 733–745*. https://doi.org/10.53299/jppi.v4i2.539

Nduru, E. B. P., Sitepu, I., & Simorangkir, F. M. (2023). Pengaruh model pembelajaran kooperatif tipe Team Assisted Individualization (TAI) terhadap kemampuan pemecahan masalah matematika siswa kelas VIII SMP Swasta Cerdas Murni. *Jurnal Ilmu Ekonomi dan Manajemen, 1(3), 300–308*. https://doi.org/10.61722/jiem.v1i3.245

Nisa, F., & Faradiba, S. S. (2023). Profil literasi matematis peserta didik berdasarkan level kemampuan pemecahan masalah soal PISA. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *7(2), 1003–1019*. https://doi.org/10.31004/cendekia.v7i2.2211

Polya, G. (1973). How to solve it: A new aspect of mathematical method (2nd ed.). Princeton University Press.

Pradesa, K., Mintawati, H., Albert, J., Sipayung, I., & Verianti, G. (2024). Analisis peran pendidikan dalam meningkatkan kualitas dan keterampilan sumber daya manusia di Indonesia: Kajian literatur. *VOCATIONAL: Jurnal Inovasi Pendidikan Kejuruan, 4(1), 35–41*. https://doi.org/10.51878/vocational.v4i1.3941

Putri, D., & Warmi, A. (2022). Kemampuan pemecahan masalah matematis siswa dalam menyelesaikan soal PISA matematika pada konten bilangan. *Jurnal Penelitian dan Pembelajaran Matematika, 15(1), 138*. https://doi.org/10.30870/jppm.v15i1.14102

Rahmayanti, D., Friansah, D., & Yuneti, A. (2023). Penerapan model kooperatif tipe Team Assisted Individualization (TAI) pada pembelajaran matematika. *Jurnal Pendidikan Matematika (JUDIKA EDUCATION), 6(2), 93–102*. https://doi.org/10.31539/judika.v6i2.7109

Reflina, L. T., & Ananda, R. (2022). Perbedaan hasil belajar kemampuan pemecahan masalah matematika siswa yang diajar dengan model pembelajaran kooperatif tipe Numbered Heads Together (NHT) dan Team Games Tournament (TGT) kelas IX MTs PP. Tarbiyah Islamiyah Hajoran Tahun Pelajaran 2020/2021. *Continuous Education: Journal of Science and Research, 2(3), 16–29*. https://doi.org/10.51178/ce.v2i3.315

Roliasari, D., Hidayah, N., & Negara, H. S. (2025). Team Assisted Individualization model assisted by Wordwall media: Elementary school students' understanding of mathematical concepts. *ETDC: Indonesian Journal of Research and Educational Review, 4(3), 845–860*. https://doi.org/10.51574/ijrer.v4i3.3753

Sari, P. P., Maidiyah, E., & Annisa, D. (2024). Analisis kesulitan pemecahan masalah matematika berdasarkan tingkat kemampuan siswa. *Jurnal Pendidikan, 12(2), 12–24*.

Sawilowsky, S. S. (2009). New effect size rules of thumb. *Journal of Modern Applied Statistical Methods, 8(2), 597–599*. https://doi.org/10.22237/jmasm/1257035100

Siregar, M. A. P., Ammamiarihta, A., & Rohimah, N. (2023). Pengembangan media pembelajaran papan pintar pada pembelajaran matematika berbasis Drill and Practice. *AXIOM: Jurnal Pendidikan dan Matematika, 12(1), 106*. https://doi.org/10.30821/axiom.v12i1.15117

Slavin, R. E. (1995). *Cooperative learning: Theory, research, and practice (2nd ed.)*. Allyn & Bacon.

Sugiyono. (2022). *Metode penelitian kuantitatif, kualitatif, dan R&D (Edisi 2)*. Bandung: Alfabeta.

Sya'bani, Y. A., Sukidin, & Tiara. (2024). Pengaruh model pembelajaran kooperatif tipe Teams Games Tournament (TGT) berbantuan media Wordwall terhadap hasil belajar. *Education Jurnal: Jurnal Education Research and Development, 8(2), 63–74*.

Yundiana, Y., Nurdiana, A., & Hestinova, M. (2020). Model Pembelajaran Team Assisted Individualization dan Kemampuan Pemecahan Masalah Matematika Siswa Kelas VIII. *Indiktika: Jurnal Inovasi Pendidikan Matematika, 2(2), 189–197*. https://doi.org/10.31851/indiktika.v2i2.4162