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THE EFFECTIVENESS OF WAYGROUND MEDIA IN IMPROVING STUDENTS' MATHEMATICAL CRITICAL THINKING SKILLS

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ABSTRACT

This study is designed to test the effectiveness of Wayground learning media in improving the mathematical critical thinking skills of grade X students of SMA Muhammadiyah 2 *Tangerang* on the material of the Three-Variable Linear Equation System. The method used was a one-group pretest-posttest design, and purposive sampling of 24 students was selected in class X6. The instrument is in the form of 4 valid description questions that measure the critical thinking aspect. Data were analyzed by Kolmogorov-Smirnov normality test, paired sample t-test, and N-Gain using SPSS 26. The findings showed that the average pretest score of 37.2 (SD = 6.7) increased to 51.9 (SD = 5.1). The Kolmogorov–Smirnov normality test yielded a value of Sig. = 0.1 (> 0.05), so that the data was declared to be normally distributed; The paired sample t-test showed t = –11.5 (Sig. = 0.0 < 0.05) which means there was a significant improvement. The homogeneity test was not applied because the analysis involved only one group (pretest–posttest) without a comparison between groups that required a variance homogeneity test. An average N-Gain of 0.5 (medium category) indicates that Wayground is quite effective, but has not yet reached the high effectiveness category; This means that a significant increase in scores occurs, but the impact is still at a moderate level and needs additional media support or strategies to further increase effectiveness.

Keywords: Wayground, Critical Thinking, Effectiveness, SPLTV

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PRELIMINARY

Mathematics, as a subject that includes logical-based material and systematic thinking and is closely related to daily activities (Laia & Harefa, 2021). Therefore, mathematics has a crucial role in shaping optimal abilities for the younger generation as the basis for life decision-making (Maizar et al., 2023). Mathematics learning is not only directed at mastering concepts, but also at developing critical thinking skills as one of the main competencies of the 21st century, along with communication skills, collaboration, creativity, and mastery of information technology (Sulastri & Ahmatika, 2020).

In research Lukman et al., (2023) and (Duri et al., 2021) It is explained that through critical thinking skills, students can have a consistent mindset because problems are solved

in a structured manner and the quality of mathematical understanding is greatly improved. By thinking critically, students can identify problems precisely, connect relevant concepts, evaluate the arguments they make, and follow up with logical conclusions to draw valid conclusions (Rahmaini & Chandra, 2024).

Based on a preliminary study conducted through observation at one of the private high schools in the city *Tangerang* for grade X students, it was found that learning activities still tended to be teacher-centered. Observations focused on student participation, especially the habit of questioning, answering, and discussing which showed relatively low student involvement. This condition has implications for students' lack of honing in their mathematical problem-solving skills. These findings are in line with Widiyanto & Afghohani, (2025) states that students' active participation significantly affects mathematics learning outcomes, where the more active students are, the better their learning outcomes. In addition, (Suci & Supardi, 2024) and Rahmatulloh et al., (2026) shows that teacher-centered learning can decrease learning engagement, make students passive and not optimally engaged in the learning process.

Students who are inactive in learning are likely due to a lack of encouragement during the learning process that can trigger them to think more deeply and critically. This condition makes students less motivated to actively ask, analyze, and express opinions critically during studying. The lack of motivation is caused by the same way of delivering the material, so that students do not feel the challenge or pleasure in learning. On the contrary Sholikah et al., (2024) found that the Game-Based Learning approach increases students' activity, enthusiasm, and participation in discussions, thereby encouraging social interaction and critical thinking during math learning.

Students are more easily provoked, curious, and enthusiastic, if learning is done in an engaging, fun, and interactive way. As revealed in the study Cahyaningrum et al., (2024) Game-based media and apps or interactive quizzes are able to motivate students while making the learning process more enjoyable and tailored to their learning style preferences. In addition, research Aprianti et al., (2024) and Fitriyah et al., (2025) shows that the use of educational games as a learning medium can create a pleasant learning atmosphere, increase student engagement, enthusiasm, and critical thinking skills.

Gamification supported by deep learning technology has great potential to increase learning effectiveness, because deep learning is able to process student interaction data in depth, recognize individual thinking patterns and difficulties. According to Yunita, (2025) A deep learning approach that is integrated with gamification and artificial intelligence can

strengthen student motivation through an active, reflective and fun learning experience. Other research confirms that deep learning-based gamification enhances the learning experience by personalizing challenges, strengthening problem-solving skills and promoting healthy collaboration and competition between students, so this method is particularly relevant to meet the educational challenges of the digital age 5.0 (Rusdiana, 2024).

Digital gamification apps used for learning, such as Wayground (formerly Quizizz), Kahoot, Quizlet, and the like play an important role in increasing student motivation and participation (Haq et al., 2025). Wayground is an interactive learning platform that combines gaming elements with digital quizzes, making the learning process more engaging and entertaining (www.wayground.com, nd). The main advantage of Wayground lies in its features that are easily accessible to students. In fact, in offline mode, students can work on questions using paper mode provided by Wayground, so that the learning process is not interrupted by limited internet connections.

Wayground was chosen because it combines pedagogical and practical advantages. Pedagogically it provides direct feedback, formative assessments, and graded questions that support the development of analysis, evaluation, and reasoning. Practically, Wayground offers an easy-to-use interface, real-time learning outcome tracking capabilities and gamification features that increase student motivation and engagement. Several studies support the effectiveness of the use of digital learning media, one of which is Quizizz (now known as Wayground) which is able to improve student learning outcomes (Cantika et al., 2025). Other research supports that Wayground, formerly known as Quizizz, is one of the relevant digital media because it combines interactive quizzes with game elements so that it can encourage student engagement in math learning (Musfiroh, 2025).

In contrast to previous studies that generally highlighted learning motivation or learning outcomes in general, this study specifically examined the effectiveness of Wayground in improving the mathematical critical thinking skills of high school students in the context of learning with limited internet access. This research began from the results of the researcher's observation while carrying out internship II at a private high school in Tangerang. The results of observations show that the mathematics learning process still tends to be teacher-centered, so that students' activeness in asking questions, answering, and discussing is relatively low. This condition encourages researchers to further study the use of Wayground as an interactive learning medium which is expected to be a more interesting, fun, and effective alternative in supporting the improvement of students' mathematical critical thinking skills.

METHODS

This study uses a one-group pretest-posttest design. The initial measurement (pretest) is carried out to determine the students' basic ability to learn materials before being given treatment. Specific treatment is in the form of the application of Wayground media, then posttest questions are given for the class to assess the impact of the treatment (Nasution et al., 2023).

Pretest	Treatment	Posttest
O_1	X	O_2

Figure 1. One Group Pretest-Posttest Control Design

Description:

O_1 = pretest results

X = special treatment for Wayground media implementation

O_2 = post-results

The sampling technique used in this study is purposive sampling, which is the selection of subjects based on suitability for the purpose of the research. The research was carried out in the even semester of the 2025/2026 academic year at SMA Muhammadiyah 2 *Tangerang.* The selection of subjects was based on the results of the researcher's observation during internship II at one of the private high schools in Tangerang, which showed that mathematics learning was still centered on teachers and student activity was still low. In addition, this school has relevant conditions for the application of digital learning media, especially because internet access is not evenly distributed in every class.

The subjects of the study were class X students with a population of 154 students spread across 6 classes, and class X6 with 24 students were selected as a sample because they had not studied the material that was the focus of the research, had diverse abilities, and were suitable to observe the effectiveness of the use of Wayground in improving students' mathematical critical thinking skills. Thus, class X6 is considered to meet the criteria as a representative sample to provide valid data in accordance with the research objectives.

The free variable in this study is the Wayground learning medium, while the bound variable is the mathematical critical thinking ability of students. The measurement of bound variables was carried out using a mathematical critical thinking ability test consisting of 6 essay questions, compiled based on a critical thinking ability grid. The data collection technique in this study was carried out with a test to assess students' critical thinking skills.

This test is designed based on indicators of critical thinking ability, as can be observed in the table (Fitri et al., 2023) below.

Table 1. Critical Thinking Grid

Critical Thinking Indicators	Inquiry Number	Domain Kognitif
Interpretasi	1	C2 (Understand)
Analysis	2, 3	C4 (Analysis)
Inference	4, 5	C5 (Evaluate)
Evaluation	6	C6 (Make)

Table 2. Aspects of critical thinking skills

Indicator	Remarks	Score
Interpretasi	- Known and searched information is not recorded.	0
	- Known and searched information is recorded but not precise.	1
	- Only known or searched information is accurately recorded.	2
	- The known and searched information of the questions is recorded but not complete.	3
	- The known and searched information of the questions is recorded accurately and completely.	4
Analysis	- A mathematical representation of the given question is not formed.	0
	- A mathematical representation of the given question is formed but not precise.	1
	- The mathematical representation of the given question is formed precisely without explanation.	2
	- The mathematical representation of the given question is formed precisely but the description is incorrect.	3
	- The mathematical representation of a given problem is precisely formed with correct and complete information.	4
Evaluation	- Strategies are not used to solve problems.	0
	- Inappropriate and incomplete strategies are used in solving problems.	1
	- Proper strategies are used to solve problems but are not complete, or inaccurate but complete strategies are used in solving problems.	2
	- Using the right strategy to solve the problem, finished but made mistakes in calculation or explanation.	3
	- The right strategy is used in solving problems, with comprehensive and precise calculations/explanations.	4
Inference	- Conclusions are not drawn.	0
	- Incorrect conclusions and inappropriate to the context of the question are formulated.	1
	- Incorrect conclusions are formulated even though they are adjusted to the context of the problem.	2
	- Correct and contextual conclusions are formulated but not exhaustive.	3
	- Proper conclusions, according to the background of the question, and comprehensively, are made.	4

The data analysis method is carried out through correction of students' work results, followed by an assessment of students' mathematical critical thinking skills. The data on students' mathematical critical thinking scores were analyzed using the percentage formula, as follows.

$$\text{Grades} = \frac{\text{Student Score}}{\text{Ideal Score (96)}} \text{x } 100\%$$

The value of mathematical critical thinking skills obtained from the calculations is then classified according to the table (Putri, 2018) The following.

Table 3. Criteria for Students' Mathematical Critical Thinking Ability

Value (%)	Criteria
89% < X ≤ 100%	Very High
78% < X ≤ 89%	Height
64% < X ≤ 78%	Medium
55% < X ≤ 64%	Low
0% < X ≤ 55%	Very Low

Data processing techniques used to determine the effectiveness of Wayground media in improving students' mathematical critical thinking skills. including data normality tests to determine whether the data is distributed normally or not. Then followed by a Paired Sample T-test An effectiveness test to check for significant improvements between the pretest and posttest average scores. The statistical hypothesis used is H_0: $\mu_{pretest} = \mu_{posttest}$, that there is no difference in the average mathematical critical thinking ability of students before and after treatment, and H_1: $\mu_{pretest} \neq \mu_{posttest}$, that means that there is a difference in the average mathematical critical thinking ability of students before and after treatment. If the results of the t-test show a significant difference, then it is followed by the calculation of Normalized Gain (N-Gain) to determine the level of effectiveness of using Wayground media in improving students' mathematical critical thinking skills (Dewi et al., 2017).

$$g = \frac{S_{posttest} - S_{pretest}}{S_{max} - S_{pretest}} \quad (1)$$

Description:

g = Strengthening Index

S_{max} = maximum test score

$S_{pretest}$ = initial test score

$S_{posttest}$ = final test score

Based on the findings of the validity test on 28 respondents in grade 12 of MIPA 2 SMA Muhammadiyah 2 *Tangerang*, it is known that six items of the description questions

were declared valid. This is indicated by the value of each question item that is entirely greater than 0.3739, which is consecutively 0.5537; 0,4273; 0,6318; 0,7846; 0,4805; and 0.7076. It is proven that all question items have met the validity criteria and are suitable for use as research instruments.$r_{count} r_{table}$

Although all questions met the validity criteria, after further review of the suitability of the indicators and the level of similarity in the content between the items, the researcher determined only 4 questions used in the study, namely numbers 1, 2, 5, and 6. This selection was made because question item number 3 has a substantial similarity to number 2, while number 4 has a similarity to number 5, so the use of all 6 items will cause the repetition of the same indicator. Thus, the selection of 4 questions aims to maintain the efficiency of the instrument while ensuring that each indicator of mathematical critical thinking skills is represented in a more proportional manner. Therefore, in this study, the instruments used effectively are 4 description questions that have been declared valid and representative to measure students' mathematical critical thinking skills.

RESULTS AND DISCUSSION

This research was conducted offline. The implementation of the pretest and posttest was directly supervised by researchers and teachers of SMA Muhammadiyah 2 *Tangerang* as members of the research team. Before the study, test validation was carried out with several experts in related fields. Then, the test was carried out in the form of a validity test on respondents outside the experimental class who had studied the SPLTV material. The trial was carried out in grade 12 of MIPA 2 SMA Muhammadiyah 2 *Tangerang* by involving 28 respondents with 6 exam questions.

The results of data processing using SPSS 26 produced descriptive statistics that can be observed in the following Table 4:

Table 4. Descriptive Statistics

	N	Minimum	Maximum	Means	Deviation hours	Variance
Score Pretest	24	23.00	50.00	37.2083	6.65275	44.259
Score Posttest	24	40.00	59.00	51.8750	5.14412	26.462
Valid N (in the direction of the list)	24					

In Table 4, the data from the calculation of SPLTV material can be described that the exam participants before the implementation of Wayground media (pretest) amounted to 24

students, with an average of 37.2083, a standard deviation of 6.65275, a minimum of 23, and a maximum of 50. Meanwhile, the number of students who took the exam after using the Wayground media (post-test) was 24 students, with an average of 51.8750, a standard deviation of 5.14412, and a minimum of 40 and a maximum of 59.

Before the t-test (paired sample t-test) is performed, there is a normality test as a prerequisite. The results of the data normality test through the Kolmogorov-Smirnov Test One Sample can be observed in the following Table 5:

Table 5. Normality Results of Pre-test and Post-test Data

Kolmogorov-Smirnow Test One Sample		
		Non-Standard Rest
N		24
Normal Parameters[a,b]	Means	.0000000
	Deviation hours	5.90906682
The Most Extreme Differences	Absolute	.172
	Positive	.172
	Negatives	-.172
Test Statistics		.172
Asimpa. Sig. (2 Oaks)		.063[c]

a. The distribution of the test is Normal.
b. Calculated from data.
c. Significant correction cover Liliefors.

In Table 5 based on the SPSS 26 output obtained, the value of Asymp. Sig. (2-tailed) reaches 0.063. This value is greater than the significance level of $\alpha = 0.05$ ($0.063 > 0.05$), so the residual data is concluded to be distributed normally. That way, the data in this study has met the requirements for the normality test. This test was carried out with the Kolmogorov-Smirnov test with the information that (a) the distribution tested was a normal distribution, (b) the statistical value was tested from the sample data obtained by the research, and (c) the significance value was corrected using the Lilliefors method, so that the test results became more accurate.

The homogeneity test was not applied in this study because the test tool used (e.g., the Kolmogorov-Smirnov test on regression residual data) only required the fulfillment of the residual normality assumption, not the homogeneity of the variance between groups. In addition, the analysis did not involve comparisons of variance between groups (such as

ANOVA or independent t-tests) (Usmadi, 2020), so the homogeneity test is irrelevant and does not need to be performed.

Hypothesis testing in this study was carried out using a paired sample t-test to determine the significant difference between pretest and posttest values. In addition, to determine the effectiveness of the use of Wayground media on improving students' mathematical critical thinking skills, an n-gain analysis was conducted. Thus, hypothesis tests were used to test the significance of differences, while n-gain was used to see the level of effectiveness of learning outcome improvement in more detail.

Table 6. Paired sample t-test results

Paired Sample Test

	Pairing Differences							
				95% Confidence Interval of Difference				
	Means	Deviation hours	Std. Meaningful Error	Lower	Top	t	df	Sig. (2-tailed)
Partner 1 Pretest Score & Posttest Score	-14.66667	6.26701	1.27925	-17.31299	-12.02034	-11.465	23	.000

In Table 6 above, based on the SPSS 26 output obtained, the value of t = -11.465 with the value of Sig. (2 heads) = 0.000 < α = 0.05, even lower than α = 0.01. Therefore, H0 was rejected and H1 was accepted, which shows a significant difference between the pretest and posttest ability to use Wayground-based SPLTV learning media. The higher average score of the posttest than the pretest shows that the use of this learning media has a positive influence on students' mathematical critical thinking skills. The improvement can be seen in the ability of students to understand SPLTV problems, compile appropriate mathematical models, choose solution strategies, and interpret and re-examine the results obtained.

Furthermore, to see the extent to which Wayground media contributes to the effectiveness of students' mathematical critical thinking skills, an n-gain analysis was conducted. The n-gain range category is presented in table 7, while the results of the n-gain calculation are shown in table 8.

Table 7. Table Categories of n-gain tests

Range	Category
$g \geq 0,7$	Height
$0.3 < g \leq 0.7$	Medium
$g < 0.3$	Low

Table 8. Results of n-gain test analysis

Descriptive Statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Hours of deviation**
Pretest	24	23	50	37.21	6.653
Posttest	24	40	59	51.88	5.144
N-Gain	24	.17241	.76667	.5413484	.18013050
Valid N (listwise)	24				

Based on table 7, the average value of n-gain is 0.541, with a minimum value of 0.172 and a maximum value of 0.767. This value is in the range of $0.3 \leq g \leq 0.7$ so it is categorized as moderate. The effectiveness of the use of Wayground media in improving students' critical thinking skills is demonstrated by this. In addition, a standard deviation value of 0.180 indicates that the variation in the effectiveness of students' abilities is relatively low, so the effectiveness that occurs tends to be evenly distributed in most students.

In line with research Saputra et al., (2026) emphasized that Wayground media deserves to be an innovative alternative in mathematics teaching that emphasizes the development of high-level thinking.

Figure 2 & 3 Media Wayground Implementation Activities
https://wayground.com/join/quiz/69664c5ab5e98260b3ae04b2/start?studentShare=true

It is proven that Wayground media is effective in helping math learning through digital quiz features, hands-on evaluation, and a more interactive learning atmosphere. In another study, the development of Wayground media was also reported to be able to encourage more meaningful learning activities, including aspects related to communication and mathematical reasoning (Kurniati et al., 2026).

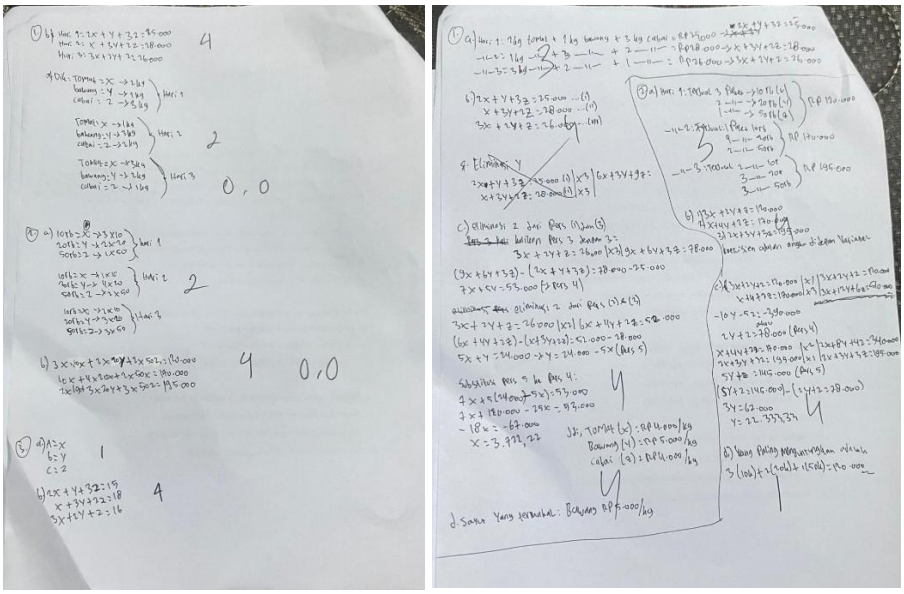

Figure 4 & 5 Pretest and Posttest Results

The increase in pretest after the implementation of Wayground is not just an increase in scores, but a reflection of changes in cognitive and social processes mediated by gamification features. The live feedback from the digital quiz encourages metacognitive reflection and error correction, thus triggering a high-level problem-solving strategy.

In addition, the improvement in pretest and posttest scores showed that students were not only more active, but also better able to analyze, evaluate, and draw conclusions in the context of math problems after using Wayground. Wayground, as an interactive digital platform, integrates quizzes, repetitive exercises, and discussions that support high-level cognitive exercise without excessive emotional stress, so that students are more courageous to face complex problems and reflect on answers systematically. These findings are in line with the research of Lukman & Setiani, (2025) mathematical gamification shows that game-based models can improve critical thinking, problem-solving, and student engagement. Thus, Wayground can be positioned as a learning tool that supports the development of mathematical critical thinking skills and 21st century skills through interactive, fun, and student-centered learning.

CONCLUSION

Based on the results of the research that has been discussed, it can be concluded that the use of Wayground media has an effect on students' critical thinking skills. This can be seen from the Sig. (2-tailed) value on the 0.000 < 0.05 t-test, so H0 is rejected and H1 is accepted. In addition, the increase in the average pretest and posttest scores shows that Wayground media is quite effective in improving students' critical thinking skills.

This conclusion is in line with the findings of a systematic review that shows that Wayground's features such as digital quizzes, interactive discussions, real-time evaluations, and Paper Mode are able to create more interactive learning, increase motivation, active participation, and understanding of mathematical concepts (Pamungkas et al., 2026). Research results Ahmad et al., (2025) also showed that the utilization of Wayground has been successful in increasing student participation and engagement through digital quizzes, interactive discussions, and live feedback. Thus, the results of this study are relevant to various previous studies that show that Wayground is an innovative learning medium that is effective in encouraging students' activeness, engagement, and critical thinking skills in the mathematics learning process.

However, this research is inseparable from its limitations. First, research is still limited to specific samples and contexts so the findings cannot be generalized to all different levels or characteristics of students. Second, this study focuses more on aspects of mathematical critical thinking skills, while other aspects such as learning motivation, student response, and long-term retention have not been studied in depth. Third, differences in individual student characteristics, including learning styles, initial abilities, and levels of adaptation to digital media, have not been specifically analyzed in this study. Therefore, further research is recommended to further examine the impact of the use of Wayground media on student enthusiasm and participation, as well as differences in learning outcomes based on students' learning styles or initial abilities, so that the use of this media can be understood more comprehensively in learning.

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