IQRO: *Journal of Islamic Education*
2026,Vol.9, No.2, hal.579-589
ISSN(E): 2622-3201
2026 PAI UIN Palopo. https://ejournal.iainpalopo.ac.id/index.php/iqro

The Effectiveness of the Game-Based Learning Model in Improving Students' Critical Thinking Skills

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Abstract
This study aims to analyze the effect of applying the Game Based Learning (GBL) model assisted by Wordwall on improving students' mathematical critical thinking ability, considering students' learning styles. The study used a quasi-experimental design with two groups: an experimental class using the GBL model assisted by Wordwall, and a control class using conventional learning methods. The research sample consisted of seventh-grade students at SMP Negeri Jakarta, classified into visual, auditory, and kinesthetic learning styles. Instruments included mathematical critical thinking tests (pretest and posttest) and a learning style questionnaire. Data were analyzed using two-way ANOVA with SPSS 26. Results showed: (1) no significant difference in mathematical critical thinking based on learning style (sig. = 0.227); (2) a significant difference in mathematical critical thinking between the GBL and conventional classes (sig. = 0.000, F = 24.351); (3) no interaction between learning style and learning model (sig. = 0.499). The N-Gain of the experimental class was higher than the conventional class, demonstrating the effectiveness of GBL assisted by Wordwall in improving students' mathematical critical thinking ability.
Keywords: *Game Based Learning, Wordwall, Mathematical Critical Thinking Ability, Learning Style*

Abstrak
Penelitian ini bertujuan untuk menganalisis pengaruh penerapan model Game Based Learning (GBL) berbantuan Wordwall terhadap peningkatan kemampuan berpikir kritis matematis siswa, dengan mempertimbangkan gaya belajar siswa. Penelitian menggunakan desain kuasi-eksperimen dengan dua kelompok: kelas eksperimen yang menerapkan GBL berbantuan Wordwall dan kelas kontrol yang menggunakan metode konvensional. Sampel penelitian adalah siswa kelas VII SMP Negeri Jakarta yang diklasifikasikan berdasarkan gaya belajar visual, auditorial, dan kinestetik. Instrumen yang digunakan berupa tes kemampuan berpikir kritis matematis (pretest dan posttest) serta angket gaya belajar. Analisis data menggunakan uji two way ANOVA dengan bantuan SPSS 26. Hasil penelitian menunjukkan: (1) tidak terdapat perbedaan kemampuan berpikir kritis matematis berdasarkan gaya belajar (sig. = 0,227); (2) terdapat perbedaan signifikan kemampuan berpikir kritis matematis antara kelas GBL dan kelas konvensional (sig. = 0,000, F = 24,351); (3) tidak terdapat interaksi antara gaya belajar dan model pembelajaran (sig. = 0,499). Nilai N-Gain kelas eksperimen lebih tinggi dibandingkan kelas konvensional, menunjukkan keefektifan GBL berbantuan Wordwall dalam meningkatkan kemampuan berpikir kritis matematis siswa.
Kata Kunci: *Game Based Learning, Wordwall, Kemampuan Berpikir Kritis Matematis, Gaya Belajar*

Introduction

Mathematics is a required subject that plays a crucial role in daily life because it helps students think logically, analytically, and systematically (Wardina, 2020). However, the reality is that Indonesian students' mathematical abilities still fall far short of expectations. Based on the 2022 PISA results, the average mathematics score for Indonesian students was only 366, far below the average standard set by the OECD (OECD, 2023). Mathematical critical thinking is the ability to think rationally and deeply in order to understand, analyze, and solve mathematical problems (Facione, 1996). In this study, the indicators of critical thinking skills used include: (1) interpretation, the ability to process and convey information effectively; (2) analysis, the ability to identify relationships between concepts; (3) inference, the ability to draw conclusions based on available data; (4) evaluation, the ability to assess statements or propositions; and (5) review the ability to reexamine findings and conclusions.

Various studies indicate that junior high school students' mathematical critical thinking skills remain relatively low. According to Febriarini and Zanthy (2019), only 43% of students met the "problem comprehension" indicator, 38% met the "induction" indicator, and the lowest was the "decision-making" indicator at 33%. Field data from a public junior high school in Jakarta corroborates these findings. Observation results show that the average math scores for all four 7th-grade classes (A, B, C, and D) remain below the Minimum Proficiency Criteria (KKM). This situation is caused by a lack of understanding of basic mathematical concepts, instruction that is overly focused on solving routine problems, and minimal use of technology as a learning medium (Diva & Purwaningrum, 2023; Nugraha et al., 2022).

In addition to instructional models, learning styles have also been identified as variables that can influence students' mathematical critical thinking skills. A learning style is an individual's unique way of receiving, processing, and understanding information (Keefe, 1979). The VAK (Visual, Auditory, Kinesthetic) model, introduced by Walter Burke Barbe and developed by Neil Fleming, has become the most widely used classification (Mulyawati et al., 2023). The VAK learning style divides students' learning preferences into three types. Visual learners are more effective at learning through images and diagrams. Auditory learners better understand information through hearing, such as lectures or discussions. Meanwhile, kinesthetic learners prefer to learn through physical movement and hands-on practice. According to Ghofur et al.

(2016), aligning teaching methods with students' learning styles has a significant impact on critical thinking skills.

In response to these issues, one solution is to implement a Game-Based Learning (GBL) model using Wordwall. GBL is a learning model that integrates digital or traditional games as learning media (Plass et al., 2015). Through enjoyable interactions, GBL encourages students to think logically and systematically when solving math problems (Laili & Wathon, 2020). According to Debrenti (2024), GBL can serve as an effective pedagogical resource in the classroom to support mathematics learning. Research by Kasi (2023) adds that games in learning not only increase motivation but also help students develop critical thinking skills through problem-solving and decision-making.

Wordwall is a web-based educational game application that provides various types of interactive game templates accessible online. Wordwall serves as a learning aid, a learning resource, and an engaging online assessment tool (Sari & Yarza, 2021). Furthermore, as a web-based educational game platform, Wordwall allows teachers to design various types of interactive games that can be tailored to the subject matter (Sari & Yarza, 2021). Research by Launin et al. (2022) found a 6.35-point increase in scores through the use of Wordwall, while Arimbawa (2021) reported an improvement in learning outcomes from the "very poor" category (average 21.43) to "very good" (average 84.00) after implementing Wordwall in biology classes.

Based on the above discussion, this study aims to determine: (1) differences in mathematical critical thinking skills based on learning styles; (2) differences in mathematical critical thinking skills between GBL classes and conventional classes; and (3) the interaction between learning styles and instructional models in determining students' mathematical critical thinking skills.

Method

This study employed a quantitative approach using a quasi-experimental design of the nonequivalent control group type. There were two groups: an experimental class that received instruction using the GBL model aided by Wordwall, and a control class that used conventional teaching methods. Both groups took pretests and posttests of mathematical critical thinking skills. The study population consisted of all seventh-grade students at Jakarta Public Junior High Schools. The sample was selected purposively from two classes, which were then classified based on VAK learning styles using a

questionnaire. The total sample consisted of more than 50 students, with a distribution of visual, auditory, and kinesthetic learning styles in each class.

The instruments used consisted of two types, the Mathematical Critical Thinking Skills Test. It comprised five essay questions that measured the five indicators of critical thinking based on Facione's (1996) scoring rubric, with a maximum score of 4 per indicator. The empirical validity test, using product-moment correlation, showed that all questions had high to very high validity (calculated r: 0.621–0.809). The reliability of the instrument was measured by Cronbach's Alpha at 0.780 (high category). The difficulty level of all items fell into the moderate category (0.31–0.61), and the discriminant validity of all items was classified as good (0.416–0.702). The learning Style Questionnaire. This non-test instrument consists of a 4-point Likert scale that measures tendencies toward visual, auditory, and kinesthetic learning styles. The questionnaire has been validated and has an adequate level of reliability. Improvements in critical thinking skills were analyzed using normalized N-Gain scores. Preliminary tests included a normality test (Kolmogorov-Smirnov) and Levene's test of homogeneity. Hypothesis testing was conducted using a two-way ANOVA with SPSS 26 at a significance level of $\alpha = 0.05$.

Results and Discussion

The results of the descriptive analysis show that the average posttest scores for the experimental class were higher than those for the conventional class. The process improvement test involved analyzing data obtained from the pretest and posttest to measure mathematical critical thinking skills. This test aimed to assess the level of improvement in mathematical critical thinking skills among students using the GBL and those using conventional learning. The N-Gain calculations are as follows:

Table 1. N-Gain Calculation Results

Class	***N-Gain Score***	**Description**
Experimental	0,603	Moderate
Conventional	0,294	Low

Table 1 shows the N-Gain scores for both groups in this study. The experimental group, which was taught using the GBL model, had an N-Gain score of 0.603, which is categorized as a moderate improvement. Meanwhile, the control group, which followed conventional learning, obtained an N-Gain score of 0.294, which falls into the low improvement category. This indicates that the GBL model is more effective in improving students' mathematical critical thinking skills compared to the conventional learning approach. The results of the normality test were calculated using Asymptotic Significance (Asymp. Sig) with $\alpha = 0.05$.

The normality test in Table 2 shows that for the experimental group, the Asymp. Sig. value for the pretest was 0.432 and for the posttest was 0.062; both values are greater than 0.05, indicating a normal data distribution. The same applies to the conventional class, where the Asymp. Sig. values for the pretest and posttest were 0.234 and 0.242, respectively, both of which are also greater than 0.05, indicating that the pretest and posttest data for the conventional class are also normally distributed. Additionally, a homogeneity test must be conducted, as it is a prerequisite for hypothesis testing.

Table 2. Results of the Normality Test for Questionnaire Data Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Learning Styles	,099	60	,200*	,940	60	,006

a. Lilliefors Significance Correction

Table 3 presents the results of the homogeneity homogeneity of variances test for the pretest and posttest data in the experimental and conventional groups. In the experimental group, the homogeneity test results indicate that the variances for the pretest data are homogeneous (Asymp. Sig. = 0.061 > 0.05), while the variances for the posttest data are also homogeneous (Asymp. Sig. = 0.084 < 0.05). Similarly, in the conventional group, the variances of the pretest data and the posttest data are homogeneous. This indicates that the variances between groups for both the pretest and posttest met the assumption of homogeneity. Next, was the hypothesis testing, where the hypotheses in this study were, first, the effect of implementing the GBL learning model on mathematical critical thinking skills; and second, the improvement in mathematical critical thinking skills between classes using the GBL model and conventional classes.

Table 3. Results of the Homogeneity Test for Questionnaire Data

Kelas	α	*Asymp. Sig* (2-tailed)	Description
Experimental	0,05	0,749	Homogen
Conventional	0,05	0,749	Homogen

Hypothesis 1: Differences in critical thinking skills based on learning style.

The results of the two-way ANOVA test showed a significance value (sig.) of 0.227 > 0.05, so H_0 was accepted. This means there is no significant difference in mathematical critical thinking skills among students with visual, auditory, and kinesthetic learning styles. This finding is consistent with Nugroho and Sari (2020), who found that learning styles do not have a significant effect on academic achievement in mathematics. Other factors, such as learning motivation and the quality of teaching methods, appear to be more dominant.

The first hypothesis test used a Paired-Sample t-test to compare critical thinking skills before and after the intervention in the experimental class. The results of the Paired-Sample t-test are as follows:

Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Posttest Eksperimen - Pretest Eksperimen	28.40000	12.48061	2.27864	23.73967	33.06033	12.464	29	.000

Figure 1. Result of Paired Sample T Test

The results of the paired samples t-test in Figure 1 show a significant difference between the posttest and pretest scores in the experimental group. The mean difference between the posttest and pretest scores is 28.400 with a standard deviation of 12.4806, indicating a fairly large change between the two tests. The t-value obtained was 12.4 with 29 degrees of freedom (df) and a significance level (2-tailed) of 0.000. Since the p-value (0.000) is less than 0.05, the null hypothesis stating that there is no difference between the pretest and posttest can be rejected. This indicates that the GBL learning model applied to the experimental group successfully improved students' abilities

significantly. Subsequently, a second hypothesis test was conducted to examine the improvement in mathematical critical thinking skills between the class using the GBL model and the conventional class using an independent t-test. The following are the results of the independent t-test using SPSS 26 for Windows:

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
ngain_score	Equal variances assumed	3.089	.084	7.208	58	.000	.30954	.04295	.22357	.39550
	Equal variances not assumed			7.208	55.399	.000	.30954	.04295	.22348	.39559

Figure 2. Result of Independent t-Test

Hypothesis 2: Differences in critical thinking skills between the GBL and conventional models.

The results of the two-way ANOVA test showed a significance value of 0.000 < 0.05 with F = 24.351; therefore, H_0 was rejected and H_1 was accepted. There is a significant difference in mathematical critical thinking skills between the GBL class and the conventional class. The GBL class showed a greater improvement. These findings are consistent with the research by Hartanto et al. (2024), who found a positive effect of GBL on critical thinking skills, as well as Hamari et al. (2016), who stated that GBL has great potential to improve students' cognitive skills.

Tests of Between-Subjects Effects

Dependent Variable: Tes Kemampuan Berpikir Kritis

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6300,673[a]	5	1260,135	7,023	,000
Intercept	275412,025	1	275412,025	1534,921	,000
Gaya_Belajar	547,692	2	273,846	1,526	,227
Model_Pemb	4369,393	1	4369,393	24,351	,000
Gaya_Belajar * Model_Pemb	252,889	2	126,444	,705	,499
Error	9689,260	54	179,431		
Total	327318,000	60			
Corrected Total	15989,933	59			

a. R Squared = ,394 (Adjusted R Squared = ,338)

Figure 3. Result of *Independent t-Test*

Hypothesis 3: The interaction between learning styles and instructional models.

The results of the two-way ANOVA test showed a significance value (sig.) of 0.499 > 0.05 with F = 0.705, so H_0 was accepted. There was no significant interaction between learning styles and instructional models in determining mathematical critical thinking skills. This means that the effect of GBL on critical thinking skills is consistent regardless of students' learning styles.

Tests of Between-Subjects Effects

Dependent Variable: Tes Kemampuan Berpikir Kritis

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6300,673[a]	5	1260,135	7,023	,000
Intercept	275412,025	1	275412,025	1534,921	,000
Gaya_Belajar	547,692	2	273,846	1,526	,227
Model_Pemb	4369,393	1	4369,393	24,351	,000
Gaya_Belajar * Model_Pemb	252,889	2	126,444	,705	,499
Error	9689,260	54	179,431		
Total	327318,000	60			
Corrected Total	15989,933	59			

a. R Squared = ,394 (Adjusted R Squared = ,338)

Figure 3. Result of *Independent t-Test*

Implementation of Wordwall-Assisted GBL

The implementation of Wordwall-assisted GBL in the experimental class was carried out through six interconnected stages. First, the teacher selected and designed Wordwall games containing questions on direct and inverse proportions, with cognitive levels that assessed critical thinking skills. Before the game began, the teacher introduced the concepts first so that students would have a sufficient foundation of understanding, followed by an explanation of the rules and technical aspects of the game. Students then played the game individually on their own devices, with seats spaced apart to maintain independence. After the game ended, students noted key points from the questions in the game for later group discussion. At the end of the session, students reflected on the material they have learned and relate it to a broader context.

Wordwall's strengths lie in its engaging visual design, immediate feedback, and flexible question design that can be tailored to learning objectives. This creates a fun yet academically rigorous learning environment, in line with brain science theories that suggest positive experiences can enhance memory retention.

Conclusion

Based on the results of the two-way ANOVA analysis, this study concludes that students' learning styles whether visual, auditory, or kinesthetic do not result in significant differences in mathematical critical thinking skills; thus, the Wordwall has been proven effective for all learning styles. On the other hand, there was a significant difference between the classes that implemented Wordwall assisted GBL and the conventional classes, with the GBL classes showing greater improvement. Furthermore, no significant interaction was found between learning styles and the instructional model, meaning that the superiority of GBL over conventional instruction is consistent and independent of students' learning styles.

This study recommends the use of GBL supported by Wordwall as an alternative method for teaching mathematics in junior high school, particularly for topics that require in-depth conceptual understanding. In addition, teachers are advised to develop more varied teaching techniques, taking into account the availability of technological infrastructure at their schools.

References

Adawiyah, A., & Kowiyah, K. (2021). Pengembangan Media Kartu Domino Pada Pembelajaran Matematika Operasi Perkalian Siswa Sekolah Dasar. Jurnal Basicedu, Query Date:2023-11-2713:59:59. Http://Jbasic.Org/Index.Php /Basicedu/Article/View/1224

Arimbawa, I. G. P. A. (2021). Penerapan Word Wall Game Quis Berpadukan Classroom Untuk Meningkatkan Motivasi Dan Prestasi Belajar Biologi. *Indonesian Journal Of Educational Development (IJED)*. Vol. 2 (2), Article 2. DOI: https://doi.org/10.5281/zenodo.5244716

Debrenti, E. (2024). Game-Based Learning Experiences in Primary Mathematics Education. *Frontiers in Education*. Vol. 9. DOI: https://doi.org/10.3389/feduc.2024.1331312

Diva, S. A., & Purwaningrum, J. P. (2023). Strategi Mathematical Habits Of Mind Berbantuan Wolfram Alpha Untuk Meningkatkan Kemampuan Berpikir Kritis Siswa Dalam Menyelesaikan Bangun Datar. Plusminus: Jurnal Pendidikan Matematika, 3(1), Article 1. https://Doi.Org/10.31980/ Plusminus.V3i1.1219

Facione, N. C., & Facione, P. A. (1996). Externalizing the Critical Thinking in Knowledge Development and Clinical Judgment. *Nursing Outlook*. Vol. 44 (3), 129-136. DOI: https://doi.org/10.1016/S0029-6554(06)80005-9

Febriarini, Y., & Zanthy, L. (2019). Analisis Kemampuan Berpikir Kritis Matematis Siswa SMP. Pembelajaran Matematika Query Date: 2024-09-12 09:19:46. http://Journal.Ikipsiliwangi.Ac.Id/Index.Php/Jpmi/Article/View/3349

Ghofur, A., Nafisah, D., & Eryadini, N. (2016). Gaya Belajar Dan Implikasinya Terhadap Kemampuan Berfikir Kritis Mahasiswa. *Journal An-Nafs: Kajian Penelitian Psikologi*. Vol. 1 (2), Article 2. DOI: https://doi.org/10.33367/psi.v1i2.285

Hamari, J., Koivisto, J., & Sarsa, H. (2016). Does Gamification Work? A Literature Review of Empirical Studies on Gamification. *Proceedings of the 47th Annual Hawaii*

International Conference on System Sciences, 3025-3034. DOI: https://doi.org/10.1109/HICSS.2014.377

Hartanto, R., & Hamidah, H. (2024). Penerapan Model Pembelajaran Game Based Learning Dengan Quiz Game Baambloze Terhadap Kemampuan Berpikir Kritis Matematik Siswa SMP. *Pendidikan Matematika*. URL: https://proceeding.unindra.ac.id/index.php/dpnpmunindra/article/view/7382

Kasi, R. (2023). *Pembelajaran Aktif: Mendorong Partisipasi Siswa*. OSF. DOI: https://doi.org/10.31219/osf.io/f6d7x

Keefe, J. W. (1979). Learning style: An overview. NASSP's Student learning styles: Diagnosing and proscribing programs/National Association of Secondary School Principles.

Laili, F., & Wathon, A. (2020). *Perkembangan Matematika dan Sains Anak Melalui Alat Permainan Edukatif. Sistim Informasi Manajemen, 3(1), 46-58.*

Launin, S., Nugroho, W., & Setiawan, A. (2022). Pengaruh Media Game Online Wordwall Untuk Meningkatkan Minat Belajar Siswa Kelas IV. *JUPEIS: Jurnal Pendidikan Dan Ilmu Sosial*. Vol. 1 (3), Article 3. DOI: https://doi.org/10.55784/jupeis.vol1.iss3.176

Mulyawati, M. S., & Us, S. (2023). Pengaruh Gaya Belajar Terhadap Kemampuan Berpikir Kritis Siswa. *Strategy: Jurnal Inovasi Strategi Dan Model Pembelajaran*. Vol. 3 (3), Article 3. DOI: https://doi.org/10.51878/strategi.v3i3.2425

Nugraha, M. S., Rosdianto, H., & Sulistri, E. (2022). Korelasi Antara Pemahaman Konsep Terhadap Kemampuan Berpikir Kritis Siswa SMA. Phi: Jurnal Pendidikan Fisika Dan Terapan, 8(1), Article 1. Https://Doi.Org/10.22373/P-Jpft.V8i1.14843

OECD. (2023). PISA 2022 Results: Preparing Students For A Changing World. OECD. URL: https://www.oecd.org/publication/pisa-2022-results/

Olivia, A., Prasetyo, T., & Wati, M. (2024). The Effects of Game-Based Learning on Students' Critical Thinking Skills in Mathematics Education. *Journal of Educational Psychology. Vol. 29 (3),* 134-146.

Paramitha, W., Pujiastuti, E., & Asih, T. S. N. (2024). Analisis Kemampuan Berpikir Kritis Matematis Pada Pembelajaran Project Based Learning Berbasis Aplikasi MathCityMap Ditinjau Dari Gaya Belajar Siswa. *Teorema: Teori dan Riset Matematika. Vol. 9 (1)*, Article 1. DOI: https://doi.org/10.25157/teorema.v9i1.13962

Plass, J. L., Homer, B. D., & Kinzer, C. K. (2015). Foundations Of Game-Based Learning. Educational Psychologist, 50(4), 258–283. Https://Doi.Org/10.1080/00461520.2015.1122533

Radityastuti, E. Y., Lukman, H. S., & Agustiani, N. (2023). implementasi digital game-based learning untuk meningkatkan kemampuan berpikir kritis dan pemecahan masalah matematis siswa smp. axiom : Jurnal Pendidikan Dan Matematika, 12(1), Article 1. https://Doi.Org/10.30821/Axiom.V12i1. 16047

Sari, P. M., & Yarza, H. N. (2021). Pelatihan Penggunaan Aplikasi Quizizz Dan Wordwall Pada Pembelajaran Ipa Bagi Guru-Guru SDIT AL-Kahfi. *SELAPARANG: Jurnal Pengabdian Masyarakat Berkemajuan*. Vol. 4 (2), 195-199. DOI: https://doi.org/10.31764/jpmb.v4i2.4112

Setiana, D., & Purwoko, R. (2020). Analisis Kemampuan Berpikir Kritis Ditinjau Dari Gaya Belajar Matematika Siswa. *Jurnal Riset Pendidikan Matematika.* https://journal.uny.ac.id/index.php/jrpm/article/view/34290

Silitonga, H., Hutauruk, A. J. B., Pangaribuan, L. R., & Naibaho, T. (2024). Analisis Kemampuan Berpikir Kritis Dan Koneksi Matematis Siswa Dalam Menyelesaikan

Soal Hots Pada Materi Trigonometri. *Jurnal Pendidikan Dan Pembelajaran Matematika Indonesia. Vol. 13 (2),* Article 2. DOI: https://doi.org/10.23887/jppmi.v13i2.4073

Syifa', H., Zawawi, I., & Huda, S. (2024). Analisis Kemampuan Berpikir Kritis Matematis Siswa Berdasarkan Kesiapan Belajar. *Ideguru: Jurnal Karya Ilmiah Guru. Vol. 9 (1),* Article 1. DOI: https://doi.org/10.51169/ideguru.v9i1.803

Wardina, A. S. (2020). Kemampuan Koneksi Matematis Siswa SMP Ditinjau Dari Big Five Personality Traits.