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The Effectiveness of the Jigsaw Cooperative Learning Model Assisted by Wordwall on Students' Collaborative Character and Mathematics Learning Achievement

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ABSTRACT
This study was motivated by students' low participation, suboptimal collaboration during the learning process, and unsatisfactory mathematics learning achievement due to the predominance of conventional teaching methods. The study aimed to examine changes in students' collaborative character and mathematics learning achievement following the implementation of the Wordwall-assisted Jigsaw cooperative learning model. This research employed a quantitative approach using a pre-experimental method with a one-group pretest–posttest design. The participants consisted of 31 eighth-grade junior high school students selected through cluster random sampling. The research instruments included a mathematics achievement test, a collaborative character questionnaire, observation sheets, and a student response questionnaire. The data were analyzed using descriptive statistics, N-gain analysis, one-sample t-tests to examine mathematics learning achievement, and the Wilcoxon signed-rank test to examine changes in students' collaborative character. The results showed that the mean posttest mathematics learning achievement score exceeded the Minimum Mastery Criterion (75), while the mean N-gain was 0.6885, indicating moderate improvement. Furthermore, students' collaborative character scores increased significantly based on the Wilcoxon signed-rank test ($p < 0.001$). Classroom observations indicated active student participation, while the student response questionnaire showed positive perceptions of the learning activities. These findings suggest that the implementation of the Wordwall-assisted Jigsaw cooperative learning model was followed by improvements in students' collaborative character and mathematics learning achievement. However, due to the absence of a control group, these improvements cannot be attributed exclusively to the intervention.

KEYWORDS
Jigsaw, Wordwall, collaborative character, mathematics learning achievement

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A. Introduction

Twenty-first-century learning requires students to actively participate in the learning process while developing essential skills such as collaboration, communication, and critical thinking. Learning is no longer teacher-centered but instead emphasizes students' active involvement in constructing knowledge independently and through social interaction. An effective learning process integrates cognitive, social, and emotional aspects to support students' holistic development (De dkk., 2022; Wang dkk., 2024).

However, classroom practices indicate that mathematics instruction is still predominantly based on conventional teaching methods, resulting in students being passive and less engaged in group interactions. This condition has contributed to low mathematics learning achievement and the underdevelopment of students' collaborative character. In fact, active engagement through collaborative learning has been shown to enhance students' critical thinking, problem-solving skills, and overall learning achievement (Hamzah dkk., 2024; Rehman dkk., 2023).

One alternative learning approach that can be implemented is the Jigsaw cooperative learning model. This model emphasizes collaboration in small groups, where each student is responsible for learning a specific portion of the material and then teaching it to the other members of the group. This process promotes active interaction, individual accountability, and meaningful knowledge sharing among students (Jeppu dkk., 2023; Slavin dkk., 2016). In addition to the learning model, the use of interactive learning media also plays an important role in enhancing students' engagement. Wordwall is a digital platform that provides a variety of game-based learning activities designed to increase students' motivation, participation, and involvement throughout the learning process. (Izzati dkk., 2024).

Previous studies have demonstrated that the Jigsaw cooperative learning model and Wordwall as an interactive learning medium can independently improve students' learning achievement and classroom engagement. However, studies investigating the combined implementation of these two approaches, particularly in junior high school mathematics education, remain limited. (Afsan dkk., 2024). Therefore, this study aims to determine the effectiveness of the Wordwall-assisted Jigsaw cooperative learning model in improving students' collaborative character and mathematics learning achievement.

B. Research Method

1. Research Design

This study employed a quantitative research approach using a pre-experimental method with a one-group pretest–posttest design (Sugiyono, 2013). This design was selected to examine changes in students' mathematics learning achievement and collaborative character before and after the implementation of the Wordwall-assisted Jigsaw cooperative learning model. The study involved a single group of students who received the instructional intervention without a separate control group. At the beginning of the study, participants were administered a pretest to assess their initial mathematics learning achievement and collaborative character. Subsequently, students participated in mathematics learning activities using the Jigsaw cooperative learning model integrated with Wordwall interactive learning media. Following the instructional intervention, a posttest was administered to measure changes in both research variables. The comparison between pretest and posttest results was used to identify improvements in students' outcomes following the intervention. However, the absence of a control group limits the extent to which the observed improvements can be attributed exclusively to the intervention. Other factors, such as testing effects, students' natural

development (maturation), and regular classroom instruction, may also have contributed to the observed changes. Furthermore, since the Jigsaw cooperative learning model and Wordwall media were implemented simultaneously, their individual contributions to students' outcomes could not be distinguished. Therefore, the findings should be interpreted as improvements observed following the intervention rather than definitive evidence of a causal effect. The research design is illustrated in Table 1:

TABLE 1. One-Group Pretest–Posttest Research Design

Grup	*Pre-test*	Perlakuan	*Post-test*
E	O_1	X	O_2

Source: (Sugiyono, 2013)

Notes:
O_1 = Pretest administered before the treatment
O_2 = Posttest administered after the treatment.
X = Treatment (implementation of the Wordwall-assisted Jigsaw cooperative learning model).

2. Research Participants

The participants of this study were 31 eighth-grade students at SMP Negeri 2 Takalar, Indonesia, during the 2025/2026 academic year. The population consisted of 12 eighth-grade classes comprising 380 students. The sample was selected using cluster random sampling, with intact classes serving as the sampling units. One class was randomly selected from the available eighth-grade classes, consisting of 31 students who participated in all research activities, including the pretest, instructional intervention, and posttest.

3. Research Instruments

Five research instruments were used to collect data on students' mathematics learning achievement, collaborative character, learning implementation, student activities, and student responses. The mathematics learning achievement test consisted of 5 items covering SPLDV. The test was developed based on the learning objectives and indicators of mathematics learning achievement relevant to the instructional material. It was administered before and after the instructional intervention to measure changes in students' mathematics learning achievement. The collaborative character questionnaire consisted of 30 statements covering four indicators: communication, respect for others' opinions, responsibility, and contribution to group work. The questionnaire employed a four-point Likert scale, ranging from 1 to 4. The questionnaire was administered before and after the intervention to assess changes in students' collaborative character. The resulting scores were converted into a 0–100 scale for descriptive analysis.

The learning implementation observation sheet was used to assess the extent to which the instructional activities were carried out in accordance with the planned learning procedures. The student activity observation sheet was employed to record students' participation and engagement throughout the learning process. Meanwhile, the student response questionnaire was administered to obtain students' perceptions of the implementation of the Wordwall-assisted Jigsaw cooperative learning model. Prior to implementation, the research instruments and instructional materials were validated by two experts to assess their content relevance, construct suitability, and alignment with the research objectives. The validation results were used to guide revisions and improvements before the instruments were administered to the participants.

4. Data Analysis Technique

The collected data were analyzed using descriptive and inferential statistical techniques. Before conducting the one-sample t-tests, the normality assumption of the posttest mathematics learning achievement scores and N-gain values was examined. The Shapiro–Wilk test was used to assess normality, with a significance level of 0.05. The one-sample t-test was conducted when the normality assumption was satisfied.

Descriptive statistical analysis was used to summarize students' mathematics learning achievement and collaborative character before and after the instructional intervention. The analysis included the mean, median, minimum score, maximum score, and standard deviation. These statistics were used to describe the distribution and characteristics of students' pretest and posttest scores. The normalized gain (N-gain) was calculated to determine the level of improvement in students' mathematics learning achievement and collaborative character following the instructional intervention. The N-gain values were classified into three categories based on Hake (1998): high ($g \geq 0.70$), medium ($0.30 \leq g < 0.70$), and low ($g < 0.30$). This classification was used to describe the extent of improvement in both research variables.

For students' collaborative character, the normality of the difference scores between pretest and posttest was examined using the Shapiro–Wilk test. Since the difference scores were not normally distributed, the Wilcoxon signed-rank test was used to examine the differences in collaborative character before and after the intervention. Meanwhile, one-sample t-tests were conducted to examine whether the mean posttest mathematics learning achievement exceeded the Minimum Mastery Criterion (75) and whether the mean N-gain score exceeded the reference value of 0.30. The significance level was set at 0.05. Effect size was also calculated for the Wilcoxon test to determine the magnitude of the observed difference in students' collaborative character.

Classical learning mastery was analyzed by calculating the percentage of students who achieved the predetermined Minimum Mastery Criterion (Kriteria Ketuntasan Minimal/KKM), which was set at 75. Classical learning mastery was considered achieved when at least 75% of the students obtained scores equal to or higher than the established KKM. The percentage of classical learning mastery was calculated by dividing the number of students who achieved the KKM by the total number of students and multiplying the result by 100%.

Furthermore, student activities and responses were analyzed descriptively based on the percentage scores obtained from the student activity observation sheet and student response questionnaire, respectively. The resulting percentages were interpreted according to the predetermined assessment categories to describe the level of student participation and their responses to the implementation of the Wordwall-assisted Jigsaw cooperative learning model. Finally, the learning implementation observation sheet was analyzed descriptively to determine the extent to which the instructional activities were conducted in accordance with the planned learning procedures. The observation results were used to describe the fidelity of the implementation of the Wordwall-assisted Jigsaw cooperative learning model throughout the instructional intervention.

C. Results and Discussion

This study was conducted at SMP Negeri 2 Takalar during the 2025/2026 academic year, involving 31 eighth-grade students. The research consisted of seven meetings: one pretest session, five instructional intervention sessions, and one posttest session. The instructional intervention focused on Systems of Linear Equations in Two Variables (SPLDV), covering its basic concepts and solution methods, including graphical, substitution, and elimination

methods. During the five intervention sessions, students learned through the Wordwall-assisted Jigsaw cooperative learning model. The students were organized into seven heterogeneous home groups and four expert groups according to the assigned subtopics. Students first discussed their respective materials in expert groups before returning to their home groups to explain their findings and participate in collaborative discussions. Wordwall was integrated through interactive quizzes, games, and practice exercises related to the topics being studied. At the seventh meeting, students completed the posttests and collaborative character and student response questionnaires.

1. Research Results

a. Descriptive Statistical Analysis

1) Learning Implementation

Based on observations conducted by three observers across five instructional meetings, the implementation of the Wordwall-assisted Jigsaw cooperative learning model showed consistent improvement. The implementation scores for each meeting are presented in Table 2.

TABLE 2. Learning Implementation Observation Results

Pertemuan	Observer 1	Observer 2	Observer 3	Skor rata-rata	Persentase	Kategori
I	3.32	2.84	2.92	3.03	76%	Terlaksana Cukup Baik
II	3.68	3.44	3.44	3.52	88%	Terlaksana Sangat Baik
III	3.84	3.84	3.60	3.76	94%	Terlaksana Sangat Baik
IV	3.88	3.80	3.88	3.85	96%	Terlaksana Sangat Baik
V	4.00	4.00	4.00	4.00	100%	Terlaksana Sangat Baik
Rata-Rata				**3.63**	**91%**	**Terlaksana Sangat Baik**

As presented in Table 2, the implementation scores increased from 76% in the first meeting to 100% in the fifth meeting, with an overall average of 91%, categorized as very good. All instructional stages, including home group formation, expert group discussions, peer teaching, and group presentations, were implemented in accordance with the planned instructional procedures.

2) Student Activities

Student activities were observed across 11 indicators during the five instructional meetings. The observation results for each meeting are presented in Table 3.

TABLE 3. Student Activity Observation Results

Aspek Aktivitas	Pertemuan ke-				
	I	**II**	**III**	**IV**	**V**
1	1	3	4	4	4
2	2	3	3	4	4
3	3	2	3	3	4
4	4	2	4	4	4
5	5	4	4	4	4
6	6	3	3	3	4
7	7	3	3	3	4
8	8	3	4	3	4
9	9	4	4	4	4

10	10	2	3	3	3
11	11	4	4	4	4
Jumlah	33	39	39	43	44
Persentase	75%	89%	89%	98%	100%
Kategori	**Cukup Aktif**	**Sangat Aktif**	**Sangat Aktif**	**Sangat Aktif**	**Sangat Aktif**

As presented in Table 3, the percentage of student activity increased throughout the five instructional meetings, from 75% in the first meeting to 100% in the fifth meeting. The average activity percentage was 90.2%, indicating a very active level of student participation. Students were involved in group discussions, exchanging ideas, explaining learning materials to peers, and completing interactive activities using Wordwall.

3) Student Responses

Student responses to the implementation of the Wordwall-assisted Jigsaw cooperative learning model were collected through a questionnaire consisting of 20 assessment items administered to 31 students using a four-point Likert scale. The results are presented in Table 4.

TABLE 4. Student Response Questionnaire Results

Description	**Result**
Number of students	31
Number of questionnaire items	20
Likert scale	1–4
Average score/item	101.8
Maximum score/item	124
Percentage	82%
Category	**Positive**

As shown in Table 4, the student response questionnaire yielded an average score of 101.8 out of a maximum possible score of 124 per item, equivalent to 82.1%. This result was classified as positive, indicating that students generally responded favorably to the implementation of the Wordwall-assisted Jigsaw cooperative learning model.

4) Mathematics Learning Achievement

TABLE 5. Descriptive Statistics of the Pretest and Posttest for Mathematics Learning Achievement

Statistics	**Pretest Statistical Values**	**Postest Statistical Values**
Sample Size	31	31
Ideal Score	100	100
Maximum Score	98.00	100.00
Minimum Score	1.00	65.00
Median	37.00	83.00
Mean	42.80	82.09
Standard Deviation	28.67	10.13
Variance	822.02	102.62
Range	97.00	35.00
Coefficient of Variation	66,98%	12,34%

Based on Table 5, the descriptive statistical results indicate an improvement in students' mathematics learning achievement following the implementation of the Wordwall-assisted Jigsaw cooperative learning model. This improvement is reflected in the higher posttest scores

compared with the pretest scores. Furthermore, the coefficient of variation decreased from 66.98% in the pretest to 12.34% in the posttest, indicating a more homogeneous distribution of students' scores after the instructional intervention. However, this reduction in score variability should be interpreted cautiously, as it may also be associated with a ceiling effect, particularly if many students obtained scores approaching the maximum possible score of 100. Therefore, the observed reduction in variability cannot be attributed exclusively to the instructional intervention. Nevertheless, the descriptive findings indicate that students' mathematics learning achievement improved following the implementation of the Wordwall-assisted Jigsaw cooperative learning model.

TABLE 6. Normalized Gain Classification

N-Gain	Category	Frequency	Percentage
$N - gain \geq 0{,}7$	High	14	45%
$0{,}3 < N - Gain < 0{,}7$	Medium	15	48%
$N - gain \leq 0{,}3$	Low	2	7%

The normalized gain analysis presented in Table 6 shows that students' improvements in mathematics learning achievement varied across the three categories. Of the 31 students, 14 (45%) achieved a high N-gain, 15 (48%) fell into the medium category, and 2 (7%) were classified in the low category. The overall mean N-gain was 0.6885, which falls within the medium category according to Hake (1998) classification. Although this value is close to the threshold for the high category (0.70), it remains classified as medium. These findings indicate that most students experienced moderate to high improvements in their mathematics learning achievement following the implementation of the Wordwall-assisted Jigsaw cooperative learning model.

5) Students' Collaborative Character

The descriptive statistical results showed an improvement in students' collaborative character. The mean score increased from 77.36 in the pretest to 87.71 in the posttest, representing an average increase of 10.35 points. Furthermore, the standard deviation decreased from 8.38 to 4.48, indicating that the posttest scores were less dispersed than the pretest scores. The descriptive statistics are presented in Table 7.

TABLE 7. Descriptive Statistics of the Pretest and Posttest for Students' Collaborative Character

Statistics	Pretest Statistical Values	Postest Statistical Values
Sample Size	31	31
Ideal Score	100	100
Maximum Score	90.83	95.83
Minimum Score	58.33	79.17
Median	77.50	88.33
Mean	77.36	87.71
Standard Deviation	8.38	4.48
Variance	70.28	20.09
Range	32.50	16.67
Coefficient of Variation	10,83%	5,10%

The normalized gain (N-gain) analysis was conducted to examine the extent of improvement in students' collaborative character. Based on the classification proposed by Hake

(1998), the N-gain scores were categorized into high ($g \geq 0.70$), medium ($0.30 \leq g < 0.70$), and low ($g < 0.30$). The results are presented in Table 8.

TABLE 8. Normalized Gain Classification

N-Gain	Category	Frequency	Percentage
$N - gain \geq 0{,}7$	High	0	0%
$0{,}3 \leq N - Gain < 0{,}7$	Medium	31	100%
$N - gain < 0{,}3$	Low	0	0%
Total		31	100%
Mean N-gain		**0.4494**	**Medium**

Hake (1998)

The normalized gain analysis presented in Table 8 shows that all 31 students (100%) achieved scores in the medium category, with no students classified in the high or low categories. The average N-gain score was 0.4494, indicating a moderate level of improvement in students' collaborative character following the instructional intervention.

b. Inferential Statistical Analysis

1) Mathematics Learning Achievement

One-Sample Test

	Test Value = 75					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Posttest Prestasi Belajar	3.900	30	.001	7.09677	3.3809	10.8126

Figure 1. Hypothesis Test Results for the Posttest of Mathematics Learning Achievement

Based on the one-sample t-test results presented in Figure 1, the significance value (Sig. (2-tailed)) was 0.001, which is lower than the significance level of 0.05. This result indicates that the null hypothesis (H_0) was rejected and the alternative hypothesis (H_1) was accepted. Therefore, the mean posttest score for students' mathematics learning achievement was significantly higher than the reference value used in this study. Furthermore, the mean posttest score of 82.10 was higher than the established Minimum Mastery Criterion of 75, indicating that students' average mathematics learning achievement exceeded the predetermined benchmark.

One-Sample Test

	Test Value = 0.3					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
N-gain Prestasi Belajar	12.963	30	.000	.38854	.3273	.4498

Figure 2. Hypothesis Test Results for the Improvement in Mathematics Learning Achievement

Based on the one-sample t-test results for the N-gain values presented in Figure 2, the significance value (Sig. (2-tailed)) was less than 0.001, which is lower than the significance level of 0.05. This result indicates that the null hypothesis (H_0) was rejected and the alternative hypothesis (H_1) was accepted. Therefore, the mean N-gain score was significantly higher than the reference value of 0.30, indicating that the average improvement exceeded the lower boundary of the moderate category.

2) Students' Collaborative Character

Before conducting the hypothesis test, the normality of the difference scores between the pretest and posttest was examined using the Shapiro–Wilk test. The results indicated that the difference scores were not normally distributed (W = 0.846, p < 0.001). Therefore, the Wilcoxon signed-rank test was employed to examine the differences in students' collaborative character before and after the implementation of the Wordwall-assisted Jigsaw cooperative learning model. The normality test results are presented in figure 3.

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Selisih	.234	31	<.001	.846	31	<.001

a. Lilliefors Significance Correction

Figure 3. Shapiro–Wilk Normality Test Results for Students' Collaborative Character Difference Scores.

As the normality assumption was not satisfied, the Wilcoxon signed-rank test was used as a non-parametric alternative to the paired-samples t-test. The results are presented in figure 4.

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
Posttest - Pretest	Negative Ranks	0[a]	.00	.00
	Positive Ranks	31[b]	16.00	496.00
	Ties	0[c]		
	Total	31		

a. Posttest < Pretest

b. Posttest > Pretest

c. Posttest = Pretest

Figure 4. Wilcoxon Signed-Rank Test Results for Students' Collaborative Character

The Wilcoxon signed-rank test revealed a statistically significant difference between students' pretest and posttest collaborative character scores (Z = -4.861, p < 0.001). The Ranks table showed that all 31 students obtained higher posttest scores than pretest scores, with no negative ranks or ties. Furthermore, the calculated effect size was r = 0.873, indicating a large effect based on Cohen's conventional benchmarks (0.10 = small, 0.30 = medium, and 0.50 = large). These findings indicate a substantial improvement in students' collaborative character scores following the instructional intervention.

2. Discussion

The findings indicate that students' mathematics learning achievement improved following the implementation of the Wordwall-assisted Jigsaw cooperative learning model. This improvement was reflected in the higher posttest scores compared with the pretest scores and was supported by the inferential statistical analysis. These results suggest that the integration of Jigsaw cooperative learning and Wordwall provided a learning environment that supported students' understanding of mathematical concepts.

The observed improvement may be related to the characteristics of the Jigsaw learning model, which emphasizes collaboration among students within groups. During the learning process, students not only received information but also took responsibility for explaining learning materials to their group members. This condition encourages students to develop a deeper understanding of the learning materials. This finding is in line with the opinion of Slavin (2016) who stated that cooperative learning can improve learning outcomes through social interaction and individual responsibility within groups.

In addition, the use of Wordwall media contributed to increasing students' motivation and engagement in the learning process. This media provides an interactive and game-based learning environment, which encourages students to participate more enthusiastically during learning activities. This finding is supported by previous studies indicating that interactive learning media can enhance students' participation and understanding of learning materials. (Izzati dkk., 2024).

Based on the analysis of improvement using the N-Gain, it was found that the increase in students' mathematics learning achievement was classified in the moderate category. This finding indicates that students experienced varying levels of improvement in mathematics learning achievement, with the overall mean N-gain falling within the moderate category. These differences may have been influenced by students' initial abilities, their level of participation in group discussions, and their adaptation to the use of technology-based learning media.

In addition to learning achievement, the results also showed an improvement in students' collaborative character. This improvement was reflected in the changes in students' scores after the learning process and the hypothesis test results, which indicated a significant increase. These findings demonstrate that the implemented learning model not only focused on cognitive aspects but also contributed to the development of students' social skills.

The observed improvement in students' collaborative character may be associated with the collaborative activities embedded in the Jigsaw learning model. Expert group discussions and home group interactions provided opportunities for students to communicate ideas, respect different opinions, and take responsibility for completing group tasks. These activities were also reflected in classroom observations, which showed students' active participation in discussions and peer teaching. This finding is consistent with the study of Jeppu dkk., (2023) which stated that cooperative learning can develop students' social skills and collaboration abilities.

The N-Gain analysis results showed that the improvement in students' collaborative character was classified in the moderate category. This finding indicates that most students experienced a sufficient improvement in their collaborative aspects. However, the improvement did not fully reach the high category, which may have been influenced by the limited duration of the learning process and differences in students' individual characteristics in interacting and collaborating with others.

Furthermore, students' activities during the learning process were categorized as active, and their responses toward the learning activities were classified as positive. These findings suggest that the implementation of the Wordwall-assisted Jigsaw cooperative learning model provided an interactive learning environment and encouraged student engagement. The observed activities and positive responses provide complementary information about students' participation and perceptions during the instructional process.

Overall, the findings suggest that the integration of the Jigsaw cooperative learning model and Wordwall media can serve as an alternative approach to support mathematics learning

achievement and students' collaborative character. Nevertheless, because the study employed a one-group pretest–posttest design without a control group, the observed improvements should be interpreted cautiously and cannot be attributed exclusively to the instructional intervention.

D. Conclusion

The findings indicate that students' mathematics learning achievement and collaborative character improved following the implementation of the Wordwall-assisted Jigsaw cooperative learning model. The improvements were reflected in the higher posttest scores, N-gain classifications, and inferential statistical results. Classroom observations also showed increased student participation, while the response questionnaire indicated positive perceptions of the learning activities. These findings suggest that the integration of Jigsaw cooperative learning and Wordwall can serve as an alternative approach to support mathematics learning and students' collaborative character. However, because this study employed a one-group pretest–posttest design without a control group, the observed improvements cannot be attributed exclusively to the instructional intervention. Further studies involving control groups are needed to establish stronger evidence of the intervention's effects.

PERNYATAAN PENGGUNAAN KECERDASAN ARTIFISIAL

	Penulis menggunakan Claude AI untuk membantu mengecek typo dan menyunting bahasa, menyusun revisi naskah berdasarkan komentar reviewer, serta analisis awal permasalahan penelitian. Bantuan analisis awal tersebut terbatas pada pemetaan permasalahan penelitian pada tahap awal, sedangkan pengumpulan data, analisis, interpretasi, dan penarikan kesimpulan dilakukan sendiri oleh penulis. Seluruh keluaran telah diperiksa dan diverifikasi oleh penulis, dan penulis bertanggung jawab penuh atas isi artikel.

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PERNYATAAN PENDANAAN

	Penelitian ini tidak menerima pendanaan dari lembaga mana pun, baik pemerintah, swasta, maupun nirlaba.

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	Penulis menyatakan tidak terdapat konflik kepentingan terkait penelitian, kepenulisan, maupun penerbitan artikel ini.

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