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Mobile Game-Based Learning Assisted by Wordwall to Improve Digital Literacy and Creativity of Elementary School Students

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ABSTRACT

Purpose of the study: This study aimed to examine the effect of a mobile-based educational game assisted by Wordwall on the digital literacy and creativity of fifth-grade elementary school students. Rapid technological development in the 21st century requires students to master digital literacy and creativity, yet classroom instruction at the research site still relies on conventional media that limits students' active engagement.

Methodology: This research employed a quantitative approach with a quasi-experimental method using a nonequivalent control group design. The sample consisted of 60 fifth-grade students from SDN Tarikolot 01, Cibinong Subdistrict, Bogor Regency, selected through simple random sampling and divided into an experimental group (30 students), who received instruction using the Wordwall-assisted mobile educational game, and a control group (30 students), who were taught using PowerPoint slides and YouTube videos. Data were collected through observation sheets, a digital literacy questionnaire, and creativity assignment sheets, and were analyzed using Multivariate Analysis of Variance (MANOVA).

Main Findings: The results showed a significant increase in the experimental group's mean scores, from 51.57 to 68.37 for digital literacy and from 18.37 to 25.90 for creativity. The MANOVA results revealed Pillai's Trace = 0.718, F = 72.571, Sig. = 0.000 ($p < 0.05$), indicating a significant simultaneous effect of the treatment on both variables. Partial analysis further confirmed significant effects on digital literacy ($F = 147.143$; $R^2 = 0.717$) and creativity ($F = 95.774$; $R^2 = 0.623$).

Novelty/Originality of this study: These findings indicate that the Wordwall-assisted mobile educational game is an effective, interactive, and enjoyable learning medium that can enhance elementary students' digital literacy and creativity in line with the demands of 21st-century learning..

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1. INTRODUCTION

Digital literacy and creativity have become essential competencies for twenty-first-century learners. Digital literacy refers to an individual's ability to access, evaluate, utilize, share, and create content through information technology and the internet, while creativity encompasses the capacity to generate original ideas, explore alternative solutions, and adapt to change [1]-[3]. Students with strong digital literacy tend to demonstrate better problem-solving abilities than those with limited digital skills, particularly when teachers provide adequate

scaffolding through language development, participation in scientific discussion, and the exchange of ideas during learning activities [4], [5]. The rapid advancement of information and communication technology has transformed nearly every aspect of education, making the integration of web-based learning, e-learning, mobile learning, and interactive educational games a growing necessity rather than an option especially at the elementary school level, where both digital literacy and creativity must be cultivated from an early age.

Previous studies support the potential of technology-based learning media in improving learning outcomes [6], [7]. Research by nisa[8] found a significant difference in learning outcomes between students taught using the Wordwall educational game and those taught through conventional methods, noting that the game made lessons more enjoyable and transformed passive classrooms into more active learning environments. This is consistent with the Indonesian Ministry of Education, Culture, Research, and Technology's (2022) view that ideal learning should be meaningful, enjoyable, technology-based, and participatory, as well as with Regulation of the Minister of Education and Culture No. 22 of 2016 concerning Process Standards for Basic and Secondary Education, which emphasizes the importance of innovative and contextual use of technology in the classroom [7].

Despite this potential, empirical evidence indicates that Indonesian elementary students' creativity generally remains at a moderate-to-low level [9]-[11]. Utami and Wulandari [12] reported that the limited use of innovative digital learning media contributes to students' low capacity for generating original ideas independently, a finding reinforced by Rahmawati [13] who noted that monotonous, teacher-centered instruction hinders the development of divergent thinking. Conversely, Putra [14] using a quasi-experimental design, demonstrated that students engaged with digital educational games showed significant improvement in fluency, flexibility, and originality. The Center for Curriculum and Books (2023) further reported that fewer than 45% of elementary students met twenty-first-century creativity standards, particularly in generating innovative ideas and solving problems creatively underscoring the urgent need for learning media that stimulate exploration, imagination, and rapid feedback [15]-[17].

A gap nonetheless persists between these expectations and classroom realities [18], [19]. Although internet penetration in Indonesia exceeded 77% in 2023 (Indonesian Internet Service Providers Association, 2023), the use of digital technology for educational purposes in elementary schools remains limited, as teachers continue to rely predominantly on conventional methods rather than interactive digital media [20]-[22]. Data from the Ministry of Education, Culture, Research, and Technology's Center for Data and Information Technology (2022) indicate that fewer than 40% of elementary students possess adequate digital literacy skills. This gap is also evident at the local level: observations from the Teacher Working Group in Cibinong, Bogor Regency, together with the 2024/2025 education report of SDN Tarikolot 01, showed that only 67% of the literacy target was achieved, reflecting persistent challenges in learning quality that traditional media and limited teacher training have been unable to resolve.

Among the various mobile-based educational game platforms available such as Wordwall, Minecraft, Lingokids, Prodigy, Kahoot, Quizizz, and Storyjumper Wordwall was selected for this study due to its ease of use and its diverse range of interactive features, which allow teachers to design engaging, game-based learning activities suited to students' interests and characteristics. Building on this rationale, the present study integrates a mobile-based educational game supported by Wordwall within a Game-Based Learning framework and simultaneously examines two dependent variables digital literacy and creativity to provide a more comprehensive picture of the effectiveness of technology-based learning for elementary students [23], [24]. Accordingly, this study aims to analyze the effect of a Wordwall-assisted mobile educational game on fifth-grade elementary students' digital literacy, their creativity, and both variables simultaneously [25].

2. RESEARCH METHOD

2.1 Research Design

This study employed a quantitative approach with a quasi-experimental method, using a nonequivalent control group design [26], [27]. This design was chosen because random assignment of individual students was not feasible; instead, two intact classes were assigned as the experimental and control groups [28]-[30]. Both groups were given a pretest to determine students' initial ability, followed by different treatments, and a posttest to measure the change after treatment. The experimental group received instruction using a mobile-based educational game supported by Wordwall, while the control group received conventional instruction using PowerPoint slides and YouTube videos, with both groups taught the same learning content to ensure that any difference in outcomes could be attributed to the learning medium rather than the material itself.

2.2. Population and Sample

The population comprised all fifth-grade students from six public elementary schools within Cluster 5, Cibinong District, Bogor Regency (360 students in total). The sample was determined through a multistage simple random sampling procedure: one school (SDN Tarikolot 01) was randomly selected from the six schools, after

which its two fifth-grade classes were randomly assigned as the experimental group (30 students) and the control group (30 students), yielding a total sample of 60 students. A homogeneity test was conducted beforehand to confirm that both classes had comparable initial ability prior to the intervention.

2.3. Research Instruments

Data were collected using three instruments: (1) an observation sheet to monitor the implementation of learning activities, (2) a digital literacy questionnaire covering eight dimensions cultural, cognitive, constructive, communicative, confident, creative, critical, and civic and (3) a creativity assignment sheet measuring six indicators: originality, divergent thinking, idea modification, solution accuracy, real-world application, and relevance of implementation. The instruments were validated through expert judgment (content validity) by three validators a science-education content expert, a learning-media expert, and an educational assessment expert yielding an average feasibility score of 92.88% (very good category). Empirical (construct) validity was subsequently tested on 30 students outside the sample using Pearson product-moment correlation; 16 of 20 digital literacy items (80%) and all six creativity items (100%) were declared valid (r-count > r-table = 0.361). Reliability testing using Cronbach's Alpha yielded coefficients of 0.843 for the digital literacy instrument and 0.820 for the creativity instrument, both categorized as very high ($\alpha \geq 0.70$), confirming that the final instruments 16 digital literacy items and 6 creativity tasks were valid and reliable for data collection.

2.4. Data Collection Procedure

Data collection was carried out in three stages. In the preparation stage, the researcher developed the learning materials and instruments, obtained expert validation, and coordinated with the school to determine the experimental and control classes [31], [32]. In the implementation stage, both groups were given a pretest, after which the experimental group received five learning sessions using the Wordwall-assisted mobile educational game, while the control group followed conventional instruction using PowerPoint slides and YouTube videos; learning implementation was monitored throughout using the observation sheet [33]-[35]. In the final stage, both groups completed a posttest, and the resulting data were checked, coded, and processed for statistical analysis.

2.5. Data Analysis Technique

Data were analyzed using IBM SPSS Statistics version 27. Descriptive statistics (mean, standard deviation, minimum, and maximum) were first calculated to characterize the pretest and posttest scores of both groups. Prerequisite tests were then conducted, comprising the Shapiro–Wilk test for normality and Levene's test for homogeneity of variance ($\alpha = 0.05$). Hypotheses one and two—concerning the effect of the treatment on digital literacy and creativity individually—were tested using a Paired Sample t-Test to compare each group's pretest and posttest scores. Hypothesis three, concerning the simultaneous effect of the treatment on both dependent variables, was tested using Multivariate Analysis of Variance (MANOVA), with the learning model as the independent variable and digital literacy and creativity as the dependent variables; a significance value below 0.05 on the Multivariate Tests indicated a significant simultaneous effect. In addition, a Normalized Gain (N-Gain) analysis (Hake, 1999) was performed to determine the degree of improvement in each variable, with scores classified as high ($g \geq 0.70$), moderate ($0.30 \leq g < 0.70$), or low ($g < 0.30$).

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Experimental (n = 30)	T_1	Learning with the Wordwall-assisted mobile educational game (X)	T_2
Control (n = 30)	T_1	Conventional learning using PowerPoint slides and YouTube videos (O)	T_2

Notes:
T_1 = initial measurement before treatment;
T_2 = measurement after treatment;
X = treatment given to the experimental group;
O = control group receiving no treatment with the educational game.

3. RESULTS AND DISCUSSION

3.1 Characteristics of the Research Sample

This study was conducted at SDN Tarikolot 01, Cibinong Subdistrict, Bogor Regency, involving fifth-grade students of the 2025/2026 academic year. The research procedure consisted of three stages: administering a pretest, implementing the learning treatment, and administering a posttest. A total of 60 students participated as the research sample, divided into two groups of 30 students each: class V-A as the experimental group, which received instruction using a mobile-based educational game assisted by Wordwall, and class V-B as the control group, which received instruction using PowerPoint slides and YouTube videos as supporting media. The characteristics of the sample are summarized in Table 1.

Table 1. Characteristics of the Research Sample

Characteristic	Category	n	Percentage
Class	V-A (Experimental)	30	50.0%
	V-B (Control)	30	50.0%
Gender	Male	30	50.0%
	Female	30	50.0%
Age	10 years	23	38.3%
	11 years	37	61.7%
Digital device ownership	Smartphone	60	100%

As shown in Table 1, the sample was evenly distributed between the experimental and control groups, as well as between male and female students. Participants' ages ranged narrowly between 10 and 11 years, and all students reported having access to a smartphone. These characteristics indicate that the sample was relatively homogeneous and representative for testing the effect of the Wordwall-assisted mobile educational game on digital literacy and creativity.

3.2 Descriptive Statistics

Descriptive statistics for the pretest and posttest scores of digital literacy and creativity in both groups are presented in Table 2.

Table 2. Descriptive Statistics of Digital Literacy and Creativity

Variable	Group	Test	N	Min	Max	Mean (SD)
Digital Literacy	Experimental	Pretest	30	38	63	51.57 (8.464)
		Posttest	30	61	78	68.37 (4.303)
	Control	Pretest	30	30	64	47.00 (7.474)
		Posttest	30	42	65	53.77 (4.994)
Creativity	Experimental	Pretest	30	11	29	18.37 (4.560)
		Posttest	30	20	30	25.90 (2.203)
	Control	Pretest	30	12	24	17.17 (2.768)
		Posttest	30	14	24	20.37 (2.297)

As presented in Table 2, the experimental group showed a substantial increase in the mean digital literacy score, from 51.57 in the pretest to 68.37 in the posttest, accompanied by a decrease in standard deviation, indicating that the posttest scores were more homogeneous than the pretest scores. The control group also showed an increase, from 47.00 to 53.77, although the gain was smaller than that of the experimental group. A similar pattern was observed for creativity: the experimental group's mean score increased from 18.37 to 25.90, while the control group increased more modestly from 17.17 to 20.37. Overall, the descriptive data suggest that both groups

improved after the instructional period, with a comparatively larger gain observed in the experimental group for both variables.

3.3 Prerequisite Analysis Tests

3.3.1 Normality Test

Normality of the data was examined using the Shapiro–Wilk test, given the relatively small sample size in each group (n = 30). Data were considered normally distributed when the significance value exceeded 0.05. The results are summarized in Table 3.

Table 3. Summary of Shapiro–Wilk Normality Test Results

Variable	Group	Data	Statistic	Sig.	Description
Digital Literacy	Experimental	Pretest	.902	.289	Normal
		Posttest	.964	.388	Normal
	Control	Pretest	.972	.609	Normal
		Posttest	.987	.969	Normal
Creativity	Experimental	Pretest	.951	.184	Normal
		Posttest	.966	.446	Normal
	Control	Pretest	.965	.421	Normal
		Posttest	.967	.449	Normal

All significance values in Table 3 were greater than 0.05, indicating that the pretest and posttest data for both digital literacy and creativity, in both the experimental and control groups, were normally distributed. This finding satisfies one of the prerequisite assumptions for the subsequent MANOVA.

Homogeneity Test

The homogeneity of variance was tested using Levene's Test, with data considered homogeneous when the significance value was greater than 0.05. The results are presented in Table 4.

Table 4. Summary of Levene's Test for Homogeneity of Variance

Variable	Group	Levene Statistic	Sig.	Description
Digital Literacy	Experimental	26.565	.000	Not homogeneous
Digital Literacy	Control	5.605	.021	Not homogeneous
Creativity	Experimental	18.453	.000	Not homogeneous
Creativity	Control	1.444	.252	Homogeneous

As shown in Table 4, three of the four variance comparisons did not meet the homogeneity assumption (Sig. < 0.05), while the creativity data in the control group met the assumption (Sig. = 0.252 > 0.05). Because the sample sizes of the experimental and control groups were equal (n = 30 each), the MANOVA procedure was nonetheless considered appropriate, following Tabachnick and Fidell (2019), who noted that MANOVA is relatively robust to violations of the homogeneity assumption under balanced group sizes.

Hypothesis Testing

The first and second hypotheses were tested using the Paired Sample t-Test to examine the within-group difference between pretest and posttest scores in the experimental group. The third hypothesis was tested using MANOVA to examine the simultaneous effect of the treatment on digital literacy and creativity, with a decision criterion of rejecting H_0 when Sig. < 0.05.

Table 5. Paired Sample t-Test Results for Digital Literacy (Experimental Group)

Pair	Mean Diff.	SD	95% CI	t	Sig. (2-tailed)
Pretest – Posttest	-16.800	9.144	-20.214 to -13.386	-10.063	.000

As shown in Table 5, the mean difference between the pretest and posttest scores was -16.800, indicating a 16.80-point increase in students' digital literacy after the treatment. The 95% confidence interval did not include zero, and the test yielded $t(29) = -10.063$, $p = .000$ ($p < 0.05$). Accordingly, H_0 was rejected and H_1 was accepted, indicating a significant difference between the pretest and posttest digital literacy scores of the experimental group.

Table 6. Paired Sample t-Test Results for Creativity (Experimental Group)

Pair	Mean Diff.	SD	95% CI	t	Sig. (2-tailed)
Pretest – Posttest	-7.533	5.296	-9.511 to -5.556	-7.791	.000

Table 6 shows a mean difference of -7.533, corresponding to a 7.53-point increase in students' creativity scores after the treatment. The 95% confidence interval did not include zero, and the test yielded $t(29) = -7.791$, $p = .000$ ($p < 0.05$). H_0 was therefore rejected and H_1 accepted, indicating a significant difference between the pretest and posttest creativity scores of the experimental group.

Table 7. Multivariate Test Results (MANOVA)

Effect	Value	F	Hypothesis df / Error df	Sig.
Pillai's Trace	.718	72.571	2 / 57	.000
Wilks' Lambda	.282	72.571	2 / 57	.000
Hotelling's Trace	2.546	72.571	2 / 57	.000
Roy's Largest Root	2.546	72.571	2 / 57	.000

The multivariate test results in Table 7 show that Pillai's Trace = 0.718, $F(2, 57) = 72.571$, $p = .000$ ($p < 0.05$). Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root produced consistent results, each with $p = .000$. Interpretation was based on Pillai's Trace, following Stevens (2009), given its robustness under violations of the homogeneity-of-covariance assumption. These results indicate a statistically significant simultaneous effect of the Wordwall-assisted mobile educational game on digital literacy and creativity, so that H_0 was rejected and H_1 accepted.

Table 8. Tests of Between-Subjects Effects

Dependent Variable	Type III SS	df	F	Sig.	R^2
Digital Literacy	3197.400	1	147.143	.000	.717
Creativity	442.817	1	95.774	.000	.623

Table 8 shows that the treatment had a significant partial effect on digital literacy, $F(1, 58) = 147.143$, $p = .000$, $R^2 = .717$, indicating that 71.7% of the variance in students' digital literacy scores was accounted for by the treatment. A significant partial effect was also found for creativity, $F(1, 58) = 95.774$, $p = .000$, $R^2 = .623$, indicating that 62.3% of the variance in students' creativity scores was accounted for by the treatment. The remaining variance in both variables was attributable to factors outside the scope of this study.

Table 9. Summary of N-Gain Scores for Digital Literacy and Creativity

Description	Digital Literacy Pretest	Digital Literacy Posttest	Creativity Pretest	Creativity Posttest
N	30	30	30	30
Maximum score	63	78	29	30
Minimum score	38	61	11	20

Description	Digital Literacy Pretest	Digital Literacy Posttest	Creativity Pretest	Creativity Posttest
Mean score	51.6	68.4	18.37	25.90
Mean N-Gain	0.56		0.53	
N-Gain effectiveness	56% (moderately effective)		53% (less effective)	

As shown in Table 9, the mean N-Gain score for digital literacy was 0.56 (56%), classified as moderately effective, while the mean N-Gain score for creativity was 0.53 (53%), classified as less effective. Although both variables improved after the treatment, the increase in digital literacy was comparatively greater than the increase in creativity. In summary, the results indicate that the Wordwall-assisted mobile educational game had a statistically significant effect on students' digital literacy (H_1 accepted), a statistically significant effect on students' creativity (H_2 accepted), and a statistically significant simultaneous effect on both variables (H_3 accepted), thereby supporting all three research hypotheses.

This study examined the effect of a mobile-based educational game assisted by Wordwall on digital literacy and creativity among fifth-grade students at SDN Tarikolot 01, Cibinong Subdistrict, Bogor Regency. The discussion below interprets the results of hypothesis testing in relation to relevant theories and prior findings, and addresses the three research questions concerning the partial effect on digital literacy, the partial effect on creativity, and the simultaneous effect on both variables.

The results indicate that the use of a Wordwall-assisted mobile educational game had a significant effect on the digital literacy of fifth-grade students. This is evidenced by the increase in the experimental group's mean score from 51.57 in the pretest to 68.37 in the posttest, a gain of 16.80 points. The Paired Sample t-Test confirmed that this difference was statistically significant, $t(29) = -10.063$, $p = 0.000$ ($p < 0.05$), leading to the rejection of H_0 and acceptance of H_1. These findings suggest that digitally based learning media can provide a more effective learning experience for developing students' technology-related competencies than the conventional media used in the control group.

This improvement can be attributed to the interactive nature of Wordwall, which engages students directly in digital learning activities rather than positioning them as passive recipients of information. Features such as interactive quizzes, matching tasks, and game-based challenges require students to search for, comprehend, select, and evaluate information before arriving at a decision, thereby fostering more responsible and purposeful use of digital devices. This finding is consistent with Gilster (1997), who defined digital literacy as the ability to understand, evaluate, and use information from diverse digital sources effectively. Learning through Wordwall supports this notion, as students are directed to interpret information presented in digital form, select responses based on comprehension, and use technology as a tool that supports learning rather than merely consuming content.

The results further align with Belshaw (2014), who identified cognitive, constructive, communicative, cultural, and creative elements as the core dimensions of digital literacy. In the present study, the cognitive dimension was reflected in students' problem-solving and reasoning processes while completing Wordwall activities; the constructive dimension was reflected in students building new understanding from the digital information they encountered; the communicative dimension emerged through discussion and the exchange of ideas during the game-based tasks; and the creative dimension was reflected in students' opportunities to use technology as a medium for generating new learning experiences. Taken together, these findings suggest that Wordwall-assisted mobile learning is well aligned with the demands of twenty-first-century education, which emphasizes technological competence, critical thinking, communication, collaboration, and creativity, and that it can serve as an innovative medium for strengthening the digital literacy of elementary school students.

The findings also show a significant effect of the Wordwall-assisted mobile educational game on students' creativity. The mean creativity score of the experimental group increased from 18.37 in the pretest to 25.90 in the posttest, a gain of 7.53 points. The Paired Sample t-Test showed that this increase was statistically significant, $t(29) = -7.791$, $p = 0.000$ ($p < 0.05$), so that H_0 was rejected and H_1 was accepted. This result indicates that game-based digital learning media can create opportunities for students to develop creative thinking skills, providing a more stimulating experience than the conventional slide- and video-based instruction used in the control group.

The increase in creativity can be explained by the fact that Wordwall creates a more active, engaging, and exploratory learning process. Through game-based activities, students practiced identifying problems, generating alternative answers, making decisions, and testing different strategies to complete the given challenges, activities that are known to strengthen flexible thinking and idea generation. This is consistent with Runco and Jaeger (2012), who defined creativity as the ability to produce ideas or products characterized by both novelty and usefulness. The Wordwall-based activities supported the novelty aspect by exposing students to a learning experience that differed from conventional instruction, while the usefulness aspect was reflected in students

applying their acquired knowledge to answer questions, solve challenges, and make independent decisions. The immediate feedback and challenge-based design of Wordwall also appeared to encourage originality, as students were not merely required to memorize content but were given room to develop their own reasoning, evaluate their mistakes, and refine their understanding. Collectively, these results suggest that Wordwall-assisted mobile educational games can foster a learning environment conducive to the development of students' creative thinking.

Prior to hypothesis testing, the assumption tests showed that all pretest and posttest data for digital literacy and creativity were normally distributed (Shapiro–Wilk, $p > 0.05$ for all groups). However, Levene's Test indicated that the homogeneity of variance assumption was not fully met for several data sets. Because the sample sizes of the experimental and control groups were equal ($n = 30$ each), the Multivariate Analysis of Variance (MANOVA) was still considered appropriate, in line with Tabachnick and Fidell (2019), who argued that MANOVA is relatively robust to violations of the homogeneity assumption when group sizes are balanced. In addition, following Stevens (2009), interpretation of the multivariate results was based on Pillai's Trace, given its greater robustness compared with other multivariate statistics under conditions of unequal covariance.

The multivariate test results showed a significant simultaneous effect of the Wordwall-assisted mobile educational game on digital literacy and creativity, as indicated by Pillai's Trace = 0.718, $F = 72.571$, $p = 0.000$ ($p < 0.05$). Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root produced consistent results, each with $p = 0.000$. The Tests of Between-Subjects Effects further showed a significant partial effect on digital literacy ($F = 147.143$; $p = 0.000$; $R^2 = 0.717$) and on creativity ($F = 95.774$; $p = 0.000$; $R^2 = 0.623$). These coefficients of determination indicate that the treatment accounted for 71.7% of the variance in students' digital literacy and 62.3% of the variance in their creativity, while the remaining variance was attributable to factors beyond the scope of this study, such as students' prior technological competence, learning motivation, interest in digital media, access to devices, and support from the learning environment.

The N-Gain analysis supports this pattern, digital literacy improved from a mean score of 51.6 to 68.4, with an N-Gain of 0.56 (56%, moderately effective category), whereas creativity improved from 18.37 to 25.90, with an N-Gain of 0.53 (53%, less effective category). Although both variables improved significantly, the treatment appeared to be somewhat more effective in enhancing digital literacy than creativity. This difference may be explained by the nature of the Wordwall activities used in this study, which were primarily structured around quizzes and matching tasks that emphasize information processing, comprehension, and technology use, activities more directly aligned with digital literacy indicators, while the development of open-ended, divergent thinking associated with creativity may require a longer intervention period or activities that are more explicitly designed to elicit original and flexible ideas.

Overall, these findings demonstrate that the effect of Wordwall-assisted mobile educational games is not limited to a single competency but extends simultaneously to both digital literacy and creativity. This is plausible because the two competencies are interrelated within technology-based learning: as students operate the digital game, they simultaneously engage in cognitive processing, information comprehension, problem-solving, and idea generation. The competitive, interactive, and feedback-rich characteristics of game-based media appear to increase student motivation and engagement beyond what is typically achieved through conventional instruction, supporting the twenty-first-century learning agenda that positions technology as a means of developing students' digital competence alongside their capacity for creative and critical thought. These findings support the conclusion that Wordwall-assisted mobile educational games represent an effective instructional medium for simultaneously strengthening the digital literacy and creativity of elementary school students, and that their integration into classroom practice merits further pedagogical attention.

4. CONCLUSION

This study examined the effect of a Wordwall-assisted mobile educational game on the digital literacy and creativity of fifth-grade students at SDN Tarikolot 01, Cibinong Subdistrict, Bogor Regency. Based on the results of hypothesis testing, three conclusions can be drawn. First, the use of a Wordwall-assisted mobile educational game had a significant effect on students' digital literacy, as indicated by a significant increase in posttest scores following the treatment; the learning activities helped students use technology, comprehend digital information, and utilize digital media more actively, appropriately, and responsibly. Second, the treatment had a significant effect on students' creativity, as game-based digital learning provided opportunities for students to explore ideas, develop original thinking, and solve problems within the learning process. Third, the treatment produced a significant simultaneous effect on both digital literacy and creativity, indicating that a single technology-based intervention can strengthen more than one twenty-first-century competency at once.

These findings confirm that Wordwall-assisted mobile educational games can serve as an interactive and enjoyable alternative learning medium that supports the development of skills required for twenty-first-century learning in elementary education. The results reinforce the theoretical understanding that digital literacy encompasses not only the operational use of technological devices but also the ability to comprehend, manage, evaluate, and responsibly apply digital information, and that game-based learning can concurrently nurture

students' creative thinking through exploration, feedback, and problem-solving. Practically, these findings suggest that teachers can adopt Wordwall-assisted mobile games as an innovative instructional medium suited to the characteristics of elementary school students, while schools can support this effort by providing adequate digital facilities, internet access, and teacher training in developing technology-based learning media.

This study was limited to a single school and a relatively small sample, and it focused only on the variables of digital literacy and creativity. Future research is therefore recommended to involve a larger and more diverse sample, to examine additional variables such as learning outcomes, motivation, critical thinking, and collaboration, and to explore the use of other digital platforms in order to broaden the empirical evidence on technology-based learning in elementary education.

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INFORMED CONSENT STATEMENT

If your research uses humans or animals, please include informed consent statement in your writing. For example: Informed consent was obtained from all subjects involved in the study. Prior to participation, each subject was provided with a detailed explanation of the study's objectives, procedures, potential risks, and benefits. All participants voluntarily agreed to participate and signed a written informed consent form.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

Not applicable

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