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Gamified digipuzzle-based instruction to support early reading development in elementary learners

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Abstract

Reading is a foundational competency in early-grade education; however, many students experience delays in developing basic decoding and comprehension skills. This study aims to examine the effect of gamified learning using the Digipuzzle application on the reading skills of first-grade students at SDN Sukajaya 2. A quantitative one-group pretest–posttest design was employed involving 25 students. Reading performance was measured using a structured assessment administered before and after the intervention. The results indicate that the mean pretest score increased from 50.12 to 75.76 in the posttest. Statistical analysis using a paired-sample t-test confirmed a significant difference between the two measurements ($p = 0.000 < 0.05$). The gain analysis produced an average N-gain score of 0.486, indicating a moderate level of improvement. These findings demonstrate that integrating gamification through Digipuzzle is associated with measurable gains in early reading performance. This study provides empirical evidence supporting the use of game-based digital media as an instructional strategy to enhance foundational literacy skills in primary education.

INTRODUCTION

Background of the Study

Reading is a fundamental skill that plays a crucial role in the learning process at the elementary school level. Mastery of reading is essential to understand information and as a basis for learning across multiple subjects (D. K. Putri et al., 2024; Harahap et al., 2022); Baharizqi et al., 2023). Despite its importance, many elementary (Ain & Ain, 2024). These challenges are often linked to a lack of interest, repetitive teaching approaches, and limited access to engaging yet interesting learning resources (Encep et al., 2023). In this context, gamification has emerged as a promising strategy to increase student motivation and participation in reading activities.

From a cognitive learning perspective, reading development involves the gradual construction of meaning through interaction between prior knowledge and textual information, as proposed in constructivist theory (Piaget) and sociocultural theory (Vygotsky), which emphasize active engagement and meaningful learning experiences.

At the global level, international assessments and policy reports consistently indicate that early literacy remains a major educational concern. UNESCO identifies foundational literacy as a critical determinant of educational equity, while the OECD, through PISA and related studies, reports that a significant proportion of students in developing countries fail to achieve minimum reading proficiency by the end of primary education**.** These trends suggest that traditional instructional approaches may be insufficient to address the cognitive and motivational needs of young learners in increasingly digital learning environments (Saufi, 2025).

In Indonesia, similar challenges persist. Empirical studies report that many elementary students experience difficulties in early reading acquisition, including letter recognition, decoding, and comprehension (Ain & Ain, 2024). These difficulties are frequently associated with low learning motivation, repetitive instructional methods, and limited availability of interactive learning resources (Encep et al., 2023).

According to motivation theory in education, particularly Self-Determination Theory, students' engagement increases when learning activities support autonomy, competence, and enjoyment. However, conventional teacher-centered practices often fail to provide such conditions in early reading instruction.

In response to these challenges, gamification has emerged as an instructional approach grounded in behavioral and motivational learning theories. By integrating game elements such as rewards, levels, and feedback into non-game contexts, gamification aims to stimulate engagement, persistence, and intrinsic motivation. One digital platform applying this approach is Digipuzzle, which is designed to support early literacy by enabling students to recognize letters, form words, and practice reading through interactive puzzle-based activities. Previous studies suggest that such digital environments can enhance students' interest and attention during learning tasks (Mislia, 2025).

Nevertheless, the pedagogical effectiveness of specific gamified applications in early-grade reading instruction remains insufficiently examined through rigorous empirical analysis.

The Problem of The Study

Despite growing awareness of the need to improve reading outcomes in elementary education, many classrooms still rely on teacher-centered methods that do not fully engage students. Although gamification has been found to enhance learning outcomes (Ismiyanti et al., 2025). Research on specific platforms such as Digipuzzle remains limited. Furthermore, Bashith (2025) argues that the success of gamified learning is highly dependent on the design and contextual integration of the tools being used. These observations highlight the importance of examining how gamified platforms can be effectively utilized in early reading instruction. This study responds to that need by investigating the use of Digipuzzle in developing reading skills among first-grade students, with the aim of exploring its practical impact and implementation.

Based on these conditions, the central problem addressed in this study is: to what extent does the implementation of the Digipuzzle gamified application contribute to improving the reading skills of first-grade elementary school students?. Addressing this question is essential to determine whether gamified digital media can function not only as an engaging supplement but also as an effective instructional strategy in early literacy education.

Research's State of the Art

Several studies have highlighted the benefits of gamification in educational settings. Zahara et al. (2021) found that game-based learning can increase student interest and involvement. Likewise, Hong et al (2024) showed that gamification

enhances academic outcomes across various subject areas. In addition, using game elements in the classroom promotes collaboration and active participation. Saleem et al. (2022) also emphasized that interactive learning environments can help students gain a stronger understanding of the material while keeping them motivated. Although these findings point to the effectiveness of gamification in general, few studies have focused specifically on platforms like Digipuzzle and their role in supporting reading skills, particularly in elementary education contexts such as Indonesia.

Despite these advances, most previous studies have examined gamification at a general level or within secondary and higher education contexts. Research focusing on early-grade literacy, particularly using specific platforms such as Digipuzzle in Indonesian elementary schools, remains limited. Consequently, there is insufficient empirical evidence to explain how gamified digital applications function pedagogically in supporting foundational reading skills among young learners (Shao, 2025).

Novelty, Research Gap, & Objective

While gamification has demonstrated considerable potential in educational contexts (Krath et al., 2021), Research specifically investigating platforms such as Digipuzzle and their role in enhancing reading skills among elementary students remains limited. Although digital tools and games are increasingly used in classrooms to implement gamified learning, these practices are often not adequately supported by empirical research.

The novelty of this study lies in its empirical examination of Digipuzzle as a structured gamified learning medium for early reading instruction in the Indonesian elementary education context. Unlike prior research that primarily discusses the gamification conceptually, this study quantitatively evaluates learning outcomes using pretest–posttest measurements and statistical analysis (Sabri, 2022).

Accordingly, the objective of this research is to analyze the effect of Digipuzzle-based gamified learning on the reading skills of first-grade students and to provide evidence-based insights into the pedagogical potential of digital gamification for strengthening foundational literacy. The findings are expected to contribute both theoretically to learning innovation research and practically to instructional design in primary education (Crompton, 2021).

METHOD

Type and Design

The study leverages experimental methods within a quantitative paradigm, where students experience tailored learning media to determine their efficacy in driving results. This study adopted a one-group pretest-posttest design, which is widely used in classroom-based research to examine the short-term impact of educational interventions in real-world settings (Daruhadi, 2024). While the absence of a control group limits causal interpretation, the design is considered suitable for exploratory studies aiming to assess practical outcomes of emerging educational technologies. The study initiates with a pretest administered to students prior to implementing the learning model. This baseline assessment ensures that posttest results can be accurately compared to measure changes post-intervention. The following is the research design used:

O1 X 02

O1: Pretest = Before introducing the Digipuzzle app as a teaching tool in the classroom

O2: Final score (Posttest) = Post-intervention, after utilizing Digipuzzle for teaching and learning

X: Treatment by applying the Digipuzzle application.

Data and Data Sources

1. Primary Data

   Primary data were obtained from pretest and posttest results administered to first-grade students at SDN Sukajaya 2 (Daruhadi, 2024) Student reading ability was measured using a structured response-based reading assessment, in which learners were required to demonstrate decoding accuracy, word recognition, and basic comprehension through guided oral and written responses. This assessment format was selected to capture not only final answers but also students' reading processes and error patterns, thereby providing more diagnostic and instructionally relevant data.

2. Secondary Data

   Secondary data consisted of recent scholarly literature related to gamification, digital learning media, and early literacy development. These sources were used to support the interpretation of statistical findings and to situate the results within broader theoretical and empirical discussions

(Daruhadi, 2024). The integration of primary and secondary data enabled a more comprehensive analysis of how gamified instruction influences early reading outcomes.

Data Collection Technique

Data were collected using achievement testing as the primary technique. Two structured reading assessments were administered:

1. Pretest, conducted prior to the implementation of Digipuzzle, to measure students' initial reading competence.
2. Posttest, administered after the intervention to evaluate changes in reading performance following exposure to the gamified learning environment.

Both assessments employed the same response-based format to ensure measurement consistency and comparability across testing phases.

Data Analysis

To ensure the credibility and accuracy of the findings, several stages of statistical analysis were conducted:

a. Validity Test

Item validity was examined to determine whether each test item appropriately measured targeted reading skills. Items meeting the established correlation threshold were retained for analysis, while items failing to meet the criteria were excluded to prevent measurement distortion.

If $t_{count} > t_{table}$ then the instrument is valid, or

If $t_{count} \leq t_{table}$ then the instrument is invalid

b. Reliability Test

Reliability analysis was conducted using Cronbach's Alpha coefficient to assess internal consistency. Reliability values were interpreted using commonly accepted statistical standards, ranging from very low to very high consistency. Only instruments demonstrating adequate reliability were used in subsequent analyses.

Table 1. Classification of Reliability Coefficients

Reliability Coefficient (r)	Interpretation
0,00 ≤ r < 0,20	Very Low
0,20 ≤ r < 0,40	Low
0,40 ≤ r < 0,60	Medium
0,60 ≤ r < 0,80	High
0,80 ≤ r < 1,00	Very high

c. Item discrimination analysis

Item discrimination analysis was performed to evaluate the extent to which each test item differentiated between students with higher and lower reading proficiency levels. This step ensured that retained items were pedagogically meaningful and sensitive to variation in student ability.

d. Difficulty Index

Item difficulty was calculated to classify questions into categories ranging from difficult to easy. This procedure was necessary to verify that the assessment contained a balanced range of item complexities suitable for first-grade learners.

Table 2. Classification of Level of Difficulty

Coefficient of Difficulty	Interpretation
TK = 0,00	very difficult
0,00 < TK ≤ 0,30	Difficult
0,30 < TK ≤ 0,70	Medium/Sufficient
0,70 < TK ≤ 0,100	Easy
TK=1,00	very easy

e. Normality Test

The Shapiro–Wilk test was applied to determine whether pretest and posttest scores were normally distributed. A significance value greater than 0.05 indicated that the data satisfied the assumptions required for parametric statistical testing.

f. *Paired t-test*

A paired-sample t-test was conducted to examine whether the difference between pretest and posttest mean scores was statistically significant. This analysis focused on within-group change following the intervention and served as the primary indicator of instructional impact.

g. Gain Test

Normalized gain scores (N-gain) were calculated to quantify the magnitude of improvement in students' reading skills. The gain values were categorized into low, moderate, or high improvement levels, allowing a more nuanced interpretation of the effectiveness of the Digipuzzle intervention beyond statistical significance alone.

RESULTS

Implemented at SDN Sukajaya 2, the study measures how gamification via Digipuzzle contributes to reading skill development in grade 5 learners. The study began by conducting an initial test (pretest) to determine students' reading skills before the application. This work applied a One-Group Pretest-Posttest method, with data collected from 25 students in one classroom. Reading skill data was obtained via test instruments and examined statistically using a paired-sample t-test in SPSS. The recapitulation of students' pretest and posttest scores can be seen in the following table:

Table 3. Recapitulation of students' pretest and posttest scores

Total number of students	25
Total Pretest Score	1253
Average Pretest Score	50,12
Total Posttest Score	1894
Average Posttest Score	75,76

Before the Digipuzzle intervention, the pretest average score stood at 50.12. Post-intervention, scores surged significantly to a mean of 75.76, highlighting the application's impact. Of the 20 assessment items, validity tests confirmed 10 questions met statistical criteria. Reliability outcomes, summarized in Table 5, supported the instrument's dependability.

Table 4. Realiability Test

Reliability Test	
Reliability	Category
0,740	High

A reliability score of 0.74 was obtained, indicating high consistency and affirming the stability of the measurement tool. This value indicates that the questions used can be relied upon to measure students' reading skills accurately and consistently, so that the results obtained from the test can be trusted and accurately reflect students' abilities. Meanwhile, the differentiating power shows that of the 20 questions tested, there is 1 question in the excellent category, 9 questions in the good category, 5 questions in the fair category, and 5 questions in the poor category. In this study, the level of difficulty of the questions is measured to determine how

difficult or easy the questions given to students are. Out of a total of 20 questions tested, 16 questions were categorized as “difficult,” while the other 4 questions fell into the category of “moderate.” This classification demonstrates that a large proportion of the questions are characterized by significant difficulty. Overly challenging questions may compromise students’ accuracy in responses and retention of key concepts. Then, after testing the instrument, the pretest and posttest scores were tested for normality:

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Pre_Test	,180	25	,036	,937	25	**,128**

a. Lilliefors Significance Correction

Figure 1. Pretest Normality Test Results

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Post_Test	,127	25	,200*	,952	25	**,284**

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Figure 2. Posttest Normality Test Results

Researchers must first assess whether the data meet normality criteria to ensure valid statistical inferences. The Shapiro-Wilk normality test confirmed that both pretest and posttest data followed a normal distribution. The pretest yielded a significance value of 0.128 (Figure 1), while the posttest showed a significance value of 0.284 (Figure 2). Results from the Paired Sample t-test (p = 0.000) indicate a significant improvement in scores from pretest to posttest, with findings visualized in Figure 4.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre_Test - Post_Test	-25,640	14,911	2,982	-31,795	-19,485	-8,598	24	**,000**

Figure 3. Paired Sample t Test Results

A gain test was administered to evaluate the enhancement of students' skills following the intervention. The average gain score of 0.4857 suggests a moderate improvement in students' skills post-intervention. This study confirms that the use of Digipuzzle leads to notable gains in students' reading competencies. Consistent with existing literature, this study reinforces that gamification-based learning tools enhance student motivation and academic performance.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Ngain	25	,00	,82	**,4857**	,23498
Valid N (listwise)	25				

Figure 4. Gain Test Results

The Digipuzzle application, which integrates game elements, successfully attracts students' attention and makes the process of learning to read more enjoyable. In terms of scholarly contribution, this study provides empirical evidence that platform-specific gamification tools can generate measurable improvements in foundational literacy, an area that has received limited quantitative attention in previous research.

Practically, the results imply that digital gamified media may serve as a viable complement to conventional reading instruction in primary schools,

particularly in contexts where student motivation and engagement remain persistent challenges. These findings may inform curriculum designers, teachers, and educational technology developers in selecting and designing instructional tools that align with the developmental characteristics of early-grade learners.

DISCUSSIONS

This study examined the effect of Digipuzzle-based gamification on the reading skills of first-grade students at SDN Sukajaya 2. The significant increase in posttest scores indicates that gamified instruction can function as an effective learning scaffold in early literacy development. From the perspective of constructivist learning theory, students acquire reading skills more effectively when they actively interact with learning materials and construct meaning through experience. The interactive tasks embedded in Digipuzzle appear to facilitate this process by enabling learners to manipulate letters and words directly, rather than passively receiving information.

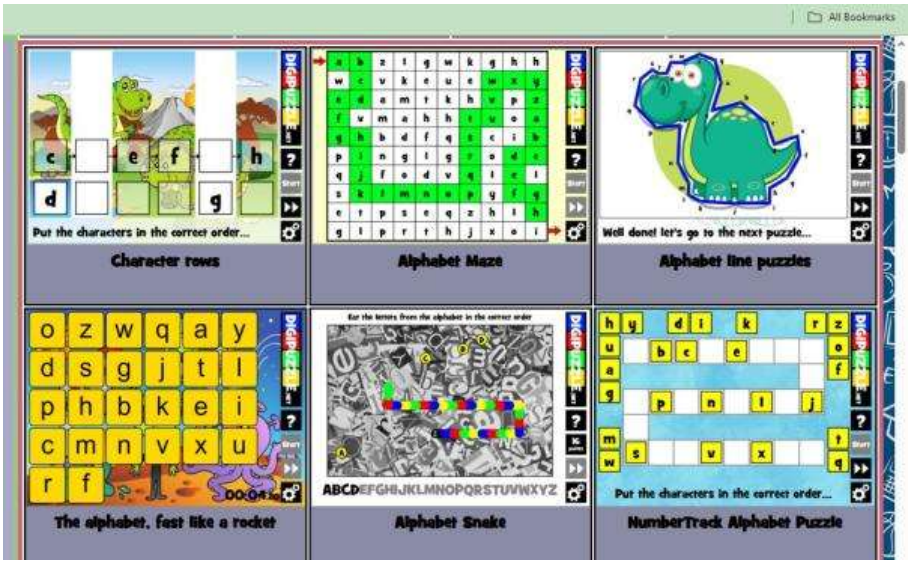

Figure 5. Fitur Digipuzzle

In addition, the findings can be interpreted through Self-Determination Theory, which emphasizes the role of autonomy, competence, and feedback in sustaining learning motivation. The moderate N-gain score (0.4857) suggests that the observed improvement was not merely incidental but resulted from systematic engagement supported by game elements such as task progression and immediate response mechanisms. Similar motivational effects were reported by Fauzan (2024), who found that gamification increases learners' persistence and task commitment in

digital learning environments. However, unlike Fauzan's study, which focused primarily on secondary education contexts, the present findings demonstrate that such motivational mechanisms are also applicable to early-grade literacy instruction.

The reliability and discrimination analyses further indicate that the improvement in learning outcomes was measured using a statistically dependable instrument. Nevertheless, the high proportion of difficult test items suggests that the magnitude of students' progress may have been partially constrained by cognitive overload. According to Cognitive Load Theory, instructional materials that exceed learners' processing capacity can reduce performance even when conceptual understanding improves. This may explain why the gain score remained within the moderate range rather than reaching a high category, despite the substantial mean score increase.

The statistical significance of the paired-sample *t*-test aligns with the findings of (Kian et al., 2022), who reported that structured gamified platforms promote measurable academic progress through repeated practice and feedback loops (Tahsinia et al., 2021). However, the present study extends their conclusions by demonstrating that gamification not only enhances general academic achievement but also supports specific micro-skills in early reading, such as decoding accuracy and word recognition.

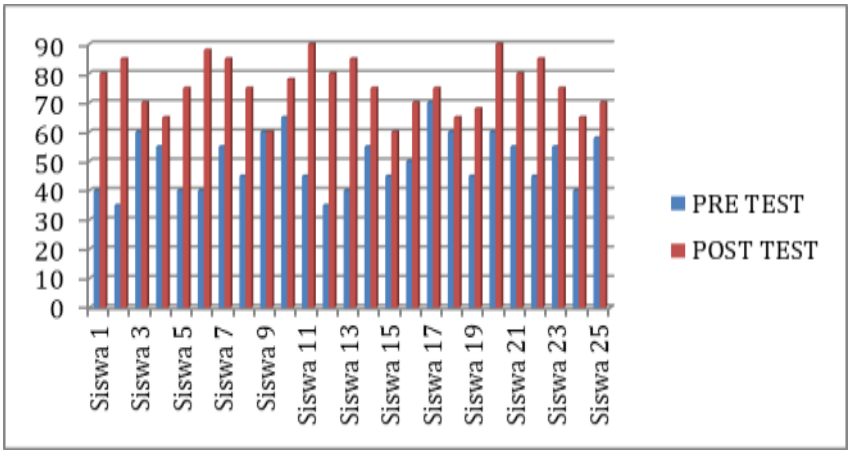

Figure 6. Comparison Results Graph of Pretest and Posttest

The functional features of Digipuzzle-particularly instant feedback and level progression-serve as external regulators of learning behavior that gradually foster internal motivation. Malik et al (2025) similarly observed that immediate corrective

feedback reduces persistent reading errors in young learners. While Naaman et al (2022) Emphasized reward-based motivation, the present findings suggest that feedback clarity may play a more decisive role than reward magnitude in sustaining engagement among first-grade students.

Comparatively, studies by Tohet & Alfaini, 2023), V. N. Putri (2025), and Syaflin (2022), reported improvements in reading comprehension through interactive technologies; however, their research focused on blended or hybrid learning models. The current study contributes additional empirical evidence that standalone gamified applications can also yield significant instructional value when designed with structured tasks and cognitive alignment to learners' developmental stages.

From a broader pedagogical perspective, the results indicate that gamification should not be viewed merely as an engagement strategy but as a cognitive learning support system capable of reinforcing foundational literacy skills. This shifts the role of educational games from supplementary tools to potential core components of early reading instruction.

Nevertheless, the absence of a control group limits causal generalization, and the short intervention period restricts conclusions regarding long-term retention. Future studies should therefore adopt experimental designs with comparison groups and longitudinal measurement to determine whether the observed gains persist over time and transfer to more complex reading competencies.

CONCLUSION

This study demonstrates that the integration of gamification through the Digipuzzle application significantly improves the reading skills of first-grade students at SDN Sukajaya 2, thereby achieving the primary objective of evaluating its effectiveness in early literacy instruction. The findings provide empirical evidence that gamified learning media can serve as an effective instructional alternative to address low reading achievement in primary education by creating more engaging and supportive learning conditions for beginner readers.

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