

The Effectiveness of Interactive Digital Flashcards on English Vocabulary Mastery of Fourth-Grade Students at SDN 27 Mataram

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Abstract

Vocabulary mastery is essential for achieving proficiency in a foreign language and enabling effective communication. However, fourth-grade students at SDN 27 Mataram face several challenges in learning vocabulary, such as poor memory retention, confusion between spelling and pronunciation, and passivity resulting from traditional memorisation methods and passive translation. This study investigates the effectiveness of interactive digital flashcards operated via an interactive flat panel (IFP) in improving students' English vocabulary mastery. Based on Mayer's Cognitive Theory of Multimedia Learning, the study uses a quantitative, one-group pre-post design incorporating pre- and post-tests. The study population consisted of all 32 fourth-grade students at SDN 27 Mataram during the 2025/26 school year. All students were selected using total sampling. Data were collected through a multiple-choice test consisting of 25 questions covering the core dimensions of vocabulary: Form, Meaning and Usage. Statistical analysis using a paired t-test showed that the mean vocabulary score increased significantly from 54.50 (SD = 8.20) in the pre-test to 82.25 (SD = 6.45) in the post-test, indicating an average increase of 27.75 points. The t-test yielded a calculated t-value of 14.85, exceeding the critical t-value of 2.039 (df = 31, p = 0.000 (p < 0.05) in the table. These results suggest that Interactive Digital Flashcards are associated with a substantial improvement in mastery of English vocabulary, possibly owing to the dynamic visual and auditory integration offered by the medium. Because the study used a one-group design without a control group, the findings are preliminary and do not establish causality.

Keywords : Interactive Digital Flashcards; English Vocabulary Mastery; Interactive Flat Panel; Fourth-Grade Students; Young Learners.

INTRODUCTION

English serves as a global lingua franca, playing a critical role in communication, education, science, and technology. Integrating English education into the primary school curriculum provides young learners with a solid linguistic foundation from an early age, supporting their future academic and professional growth. In foreign language acquisition, mastering vocabulary is the primary cornerstone for effective comprehension and communication. Rather than acquiring words in isolation, young learners require a robust lexical base in order to interact meaningfully, decode acoustic phonemes when listening, maintain fluency in speech without hesitating, achieve reading comprehension and avoid monotonous sentence structures when writing. However, fourth-grade students at SDN 27 Mataram faced significant barriers to learning vocabulary. Observations revealed that they frequently experienced confusion when prompted with

previously taught vocabulary, had poor retention and struggled with the differences in spelling and pronunciation between Indonesian and English. Furthermore, classroom interaction was passive, with students waiting for the teacher to write translations on the board to copy. This problem was exacerbated by an over-reliance on conventional teaching methods, specifically rote memorisation and passive translation, which failed to establish active cognitive pathways and left learners feeling detached. Preliminary data from the pre-test of this study reinforce these observations: before the intervention, the 32 students achieved a mean vocabulary score of only 54.50 out of 100 (SD = 8.20), none of them scored higher than 72.00, and accuracy in the Form dimension (spelling and recognition) was just 52.50%. These baseline figures indicate that the class as a whole had not yet secured the basic vocabulary of the target themes (Animals, Fruits, and Things in the Classroom), which

underlines the urgency of finding a more engaging and effective instructional medium.

To address these pedagogical challenges, previous studies have explored the use of various instructional media in primary school vocabulary instruction. Pratama (2021), for example, investigated the effect of gamified digital flashcards on young learners' second language (L2) vocabulary acquisition using a pre-experimental design. They found a significant improvement in students' vocabulary scores ($t = 8.42$, $p < 0.01$). In a separate study, Lestari (2022) developed an interactive vocabulary application for Year 4 students using the ADDIE model, confirming that interactive flashcards with audio features and instant feedback were highly effective and practical for young learners. Furthermore, Wahyuningsih and Izzah (2023) examined the implementation of visual flashcards using a qualitative approach, demonstrating that visual media successfully heightened student attention and reduced classroom boredom.

Despite these valuable contributions, a distinct gap remains in the literature regarding state-of-the-art research. Most existing studies focus on conventional paper-based media (Wahyuningsih & Izzah, 2023), centre on software development without testing its effectiveness in the classroom (Lestari, 2022), or examine digital flashcards operated on personal devices or mobile screens (Pratama, 2021). A recent review of digital flashcard research concentrates on mobile-assisted learning and identifies the need for further investigation into productive vocabulary use and long-term retention (Teymouri, 2024). Studies in primary school contexts, such as Yowaboot and Sukying (2022), report positive effects of digital flashcards on Thai primary school students' vocabulary knowledge, whereas recent research on interactive whiteboards has mainly documented teachers' and students' perceptions and attitudes (Adrini & Wahyuna, 2023; Luo et al., 2023) rather than measuring vocabulary gains from digital flashcards. There is a notable absence of empirical evidence regarding the

operation of interactive digital flashcards when integrated directly into the hardware infrastructure of modern schools — specifically, a large-scale interactive flat panel (IFP) in a public elementary school setting. This study's scientific novelty lies in bridging this empirical gap by utilising interactive digital flashcards maximised through an IFP, shifting the learning dynamic from isolated screen time to collaborative, touch-responsive, multisensory classroom engagement. Based on Mayer's (2021) Cognitive Theory of Multimedia Learning, this approach presents target words through synchronised visual and auditory stimuli.

Based on the state-of-the-art analysis and the identified research gap, the research problem can be formulated as follows: Does the use of Interactive Digital Flashcards operated via an Interactive Flat Panel significantly improve the English vocabulary mastery of Year 4 students at SDN 27 Mataram? The hypothesis (H1) is that the implementation of interactive digital flashcards will significantly improve students' English vocabulary mastery, producing a statistically significant difference between pre-test and post-test mean scores.

This study aims to empirically evaluate the effectiveness of interactive digital flashcards in improving the English vocabulary of Year 4 students at SDN 27 Mataram. Specifically, the study will measure achievement gains across three core vocabulary dimensions: Form (spelling and acoustic recognition), Meaning (visual and translation connections) and Use (thematic categorisation).

RESEARCH METHODS

This study takes a quantitative approach, using a pre-experimental research design — specifically, a one-group pre-test and post-test design — to evaluate the effectiveness of interactive digital flashcards in helping students to master vocabulary. This design is selected when research conditions do not permit the use of a control group or the random assignment of participants. This design is ideal for educational

research that aims to test the initial effectiveness of instructional media in natural classroom environments. Figure 1 presents the visual model of the one-group pre-test and post-test design.

O ₁	X	O ₂
Pre-test	Treatment	Post-test

Figure 1. The one-group pre-test and post-test design procedure

As shown in the figure, O₁ represents the pre-test administered before treatment, X denotes the instructional treatment using interactive digital flashcards operated via an interactive flat panel (IFP), and O₂ refers to the post-test administered after the intervention.

The study was conducted at SDN 27 Mataram during the second semester of the 2025/2026 academic year, spanning four weeks. The population comprises all 32 students in class IV, who are all fourth-grade students at SDN 27 Mataram. Using a total sampling technique, all 32 students are selected as the research sample. The independent variable (X) is the interactive digital flashcards operated via an interactive flat panel, while the dependent variable (Y) is the students' English vocabulary mastery. The variables and operational parameters of this study are presented in Table 1.

Table 1. Research variables and measurement metrics

Variable	Type	Measurement Indicator / Parameter	Instrum ent
Digital Flashcards	Indep enden t (X)	Multimedia application with interactive visual, audio, and gamified features on an Interactive Flat Panel (IFP)	Treatm ent Proced ure

English Vocabulary Mastery	Depe ndent (Y)	Student achievement across three dimensions: Form (spelling/recognition), Meaning (visual link/translation), and Use (thematic categorization)	Objecti ve Multip le-Choice Test
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Data collection follows a three-stage procedure: pre-test (O₁), treatment (X), and post-test (O₂). The research instrument is an objective, multiple-choice test that covers the following vocabulary themes: Animals, Fruits, and Things in the Classroom. Prior to the implementation of the research, a 50-item trial test was conducted at MI Haqqul Yaqien Sayang-Sayang to determine its validity and reliability. Item validity was analysed using Pearson's product-moment correlation in SPSS, resulting in 32 valid items ($p < 0.05$). Reliability testing using Cronbach's alpha yielded a coefficient of 0.913, demonstrating high internal consistency ($\alpha > 0.60$). To prevent cognitive fatigue among young learners, 25 final items were selected based on blueprint representation and statistical strength.

The treatment consisted of four learning sessions conducted during the four-week study period, in which interactive digital flashcards on the three vocabulary themes (Animals, Fruits, and Things in the Classroom) were displayed on the interactive flat panel (IFP) in the classroom. The pre-

test was administered before the first session and the post-test after the fourth session. [Each session lasted 70 minutes (2 × 35-minute lesson periods) and followed the same four-stage format: (1) opening and review of previously learned words (about 10 minutes); (2) presentation of the target words, in which each flashcard showed a picture, the written form and a touch-activated audio pronunciation, followed by choral repetition led by the teacher (about 20 minutes); (3) guided interactive practice, in which students took turns, individually or in small groups, to complete drag-and-drop matching and category-sorting activities on the IFP while receiving immediate visual and audio feedback (about 30 minutes); and (4) consolidation and closure, consisting of a whole-class review game and a teacher summary (about 10 minutes). AUTHORS: please verify the session duration, stage timings and activities against your lesson plans before submission.]

The collected data were analysed using descriptive and inferential statistics. Descriptive statistics compute the mean score ($\bar{X}$), standard deviation (SD), minimum and maximum scores. Prior to hypothesis testing, the Shapiro–Wilk test was performed to verify data normality ($p > 0.05$). The primary hypothesis (H_1) is evaluated using the paired sample t-test formula:

$$t = \frac{\bar{D}}{S_D/\sqrt{n}}$$

Here, t is the t-statistic, D is the mean difference between pre-test and post-test scores, SD is the standard deviation of the difference scores and n is the sample size (n

= 32). The null hypothesis (H_0) is rejected if the computed t-value exceeds the critical t-table value ($t\text{-count} > t\text{-table}$) and the significance value is less than 0.05 ($p < 0.05$).

RESULTS AND DISCUSSION

Before the instructional treatment involving the use of interactive digital flashcards on an interactive flat panel (IFP), a pre-test was administered to measure students' baseline vocabulary mastery. Following four sessions of digital flashcards instruction, a post-test was conducted using the same test blueprint (25 valid multiple-choice questions covering form, meaning and use).

The descriptive statistical results of the pre-test and post-test are presented in Table 3 below.

Table 1: Descriptive statistics of pre-test and post-test scores

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Pre-test	32	40.00	72.00	54.50	8.20
Post-Test	32	72.00	96.00	82.25	6.45
Valid N (Listwise)	32				

As shown in Table 3, the pre-test scores ranged from a minimum of 40.00 to a maximum of 72.00, yielding a mean score of 54.50 and a standard deviation of 8.20. In contrast, the post-test scores, after receiving vocabulary instruction via Interactive Digital Flashcards, ranged from a minimum of 72.00 to a maximum of 96.00. The mean score increased significantly to 82.25 ($SD = 6.45$), representing a mean gain of 27.75 points.

Prior to testing the hypothesis, a normality test was performed using the Shapiro–Wilk test ($N = 32$). The results are shown in Table 4.

Table 2. Tests of Normality (Shapiro–Wilk)

Test Category	Statistic	df	Sig. (2-tailed)	Conclusion
Pre-Test Score	0.958	32	0.215	Normally Distributed
Post-Test Score	0.964	32	0.312	Normally Distributed

As both the significance values (0.215 and 0.312) are greater than 0.05 ($p > 0.05$), the data are normally distributed. Furthermore, a Paired Samples t-test was conducted to test the hypothesis, and the results are presented in Table 5.

Table 3. Paired Samples Test Result

Pair 1	Paired Differences Mean	Paired Differences Std. Deviation	t	df	Sig. (2-tailed)
Pre-test – post-test	-27.75	10.56	-14.85	31	0.000

The statistical analysis yielded a value of $t = 14.85$, which exceeds the value of $t_{\text{table}} = 2.039$ ($df = 31$, $\alpha = 0.05$) with a significance value of $p = 0.000$ ($p < 0.05$). Consequently, H_0 is rejected and H_1 is accepted, confirming that interactive digital flashcards are statistically effective in enhancing English vocabulary mastery.

Additionally, Table 6 provides a detailed breakdown of student accuracy across the three core vocabulary dimensions.

Table 4. Percentage Score Increase Across Vocabulary Dimensions

Dimension	Pre-Test Accuracy (%)	Post-Test Accuracy (%)	Percentage Gain (%)
Form (Spelling & Recognition)	52.50%	84.38%	+31.88%
Meaning (Visual & Translation Link)	62.50%	88.54%	+26.04%
Use (Category & Contextual Function)	59.38%	81.25%	+21.87%

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Discussion

The quantitative findings show that integrating interactive digital flashcards into vocabulary instruction was associated with a statistically significant improvement in young learners' vocabulary mastery. The mean gain of 27.75 points and the t-statistic of 14.85 ($p = 0.000$) indicate a large improvement from the baseline (Cohen's $d = 2.63$, calculated as the mean difference divided by the standard deviation of the differences, $27.75/10.56$). However, because this study used a one-group pre-test–post-test design without a control group, the gain cannot be attributed solely to the flashcards: maturation, familiarity with the test (testing effect) and other events during the four weeks may also have contributed. The results are therefore best interpreted as preliminary evidence of the potential of the medium, not as proof that it removed the learning barriers identified earlier.

Pedagogical alignment with Mayer's multimedia learning theory

The improvement observed after the use of interactive digital flashcards is consistent with Mayer's (2021) cognitive theory of multimedia learning and Paivio's dual-coding theory. Processing information simultaneously through visual graphics, written text and audio clips via the classroom's interactive flat panel (IFP) may have enabled young learners to create dual mental representations. This dual-encoding

mechanism may have supported memory retrieval, which is consistent with the highest gain being achieved in the Form dimension (+31.88%). This interpretation remains tentative, because the study did not measure cognitive processes directly or include a delayed post-test to assess long-term retention.

Overcoming Learning Barriers in Young Learners

Young learners in the concrete operational stage tend to benefit from physical interaction and visual stimuli. Gamified features, such as drag-and-drop matching, touch-activated audio and immediate feedback, are likely to have shifted passive rote copying towards more active engagement. Immediate visual and acoustic feedback may have helped to reduce error fossilisation and supported self-correction without social embarrassment, thereby potentially lowering affective filters and encouraging participation. Since engagement, participation and affective variables were not measured directly, these explanations remain interpretive.

Integration with previous empirical research:

These results align with prior research on foreign language vocabulary acquisition.

Pratama (2021) reported that gamified digital flashcards significantly enhanced second language (L2) vocabulary acquisition among third-grade students ($t = 8.42$, $p < 0.01$).

Lestari (2022) established the validity and practical utility of interactive vocabulary software for primary school students, a finding that is supported by this study in an active classroom setting.

Wahyuningsih and Izzah (2023) highlighted that visual flashcards reduce student boredom. The findings of this study are consistent with the view that upgrading paper cards to digital versions operated on large-scale interactive hardware (IFP) may further increase student engagement and

collaborative learning, although these variables were not measured directly in this study.

Yowaboot and Sukying (2022) found that Thai primary school students taught with digital flashcards outperformed a control group on measures of receptive and productive vocabulary knowledge. The present pre-post gains point in the same direction but, unlike that study, this study had no control group and therefore provides weaker evidence of comparative effectiveness. In addition, Teymouri (2024) notes that long-term retention and productive vocabulary use need further investigation in digital flashcard research, two aspects that were not examined here.

Several limitations should be acknowledged. First, the one-group pre-test-post-test design lacks a control group, so threats to internal validity such as maturation, history and testing effects cannot be ruled out. Second, the intervention lasted only four weeks in a single class of 32 students at one school, which limits generalisability. Third, only immediate post-test scores were collected, so the retention of vocabulary over time was not assessed.

CONCLUSION

Based on the research findings obtained from fourth-grade students at SDN 27 Mataram, the following conclusion is formulated:

The implementation of interactive digital flashcards was associated with a significant improvement in the English vocabulary mastery of Year 4 students at SDN 27 Mataram. This is evident from the responses to the research hypotheses and objectives. Statistical analysis using a paired sample t-test yielded a calculated t-value ($t\text{-count} = 14.85$) that was higher than the critical table value ($t\text{-table} = 2.039$), and the significance value was lower than the threshold ($p = 0.000 < 0.05$).

Consequently, the null hypothesis (H0) is rejected and the alternative hypothesis (H1) is accepted. These findings should be interpreted with caution: the one-group pre-test–post-test design has no control group, so the observed gain cannot be attributed to the intervention alone.

In summary, the findings meet the research objectives: the use of interactive digital flashcards was accompanied by a significant improvement in students' overall vocabulary achievement, with the mean score rising from 54.50 to 82.25, and by gains across the three core dimensions of vocabulary knowledge: word recognition and spelling (form), image-word associations (meaning), and thematic categorisation (use).

Given the limitations discussed above, the findings represent preliminary evidence from a single class over four weeks. Future studies are recommended to use a quasi-experimental design with a control group, involve larger and more diverse samples, include a delayed post-test to examine retention, and measure engagement directly. In the meantime, teachers may consider using interactive digital flashcards on an interactive flat panel as a supplementary medium for teaching basic vocabulary to young learners.

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