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THE EFFECTIVENESS OF THUNKABLE-BASED MOBILE LEARNING ON ARABIC VOCABULARY MASTERY

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ABSTRACT

The integration of mobile technology in elementary Arabic language learning has increased; however, empirical studies examining the effectiveness of customizable app-development platforms for vocabulary instruction remain limited and underexplored. This study aims to examine the effectiveness of a Thunkable-based mobile learning application in improving Arabic vocabulary mastery among fifth-grade students at Madrasah Ibtidaiyyah Matlaul Athfal Cilengkrang, Bandung. Addressing the limited empirical studies on the use of app-development platforms for elementary-level Arabic instruction, this research employed a quantitative quasi-experimental design with a non-equivalent control group. A total of 41 students participated, comprising an experimental group (n = 20) and a control group (n = 21). Data were collected through pre- and post-tests and analyzed using descriptive statistics, paired-sample and independent-sample t-tests, as well as N-Gain analysis. The results showed a statistically significant improvement in the experimental group's vocabulary mastery compared to the control group ($p < 0.05$). The experimental group achieved a moderate N-Gain score (55.75%), while the control group demonstrated a lower level of improvement (34.43%). These findings indicate that Thunkable-based mobile learning is an effective and interactive medium for enhancing Arabic vocabulary acquisition at the elementary level. The study contributes to research on mobile-assisted language learning by demonstrating the pedagogical potential of customizable mobile applications in Arabic language education. It offers practical implications for teachers integrating digital learning tools.

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INTRODUCTION

The Arabic language plays a central role in Islamic education, serving not only as the language of the Qur'an but also as a medium of knowledge transmission in religious and academic contexts (Ekawati, 2019). Within Arabic language education, particularly at the elementary level, vocabulary mastery (*mufradāt*) constitutes a foundational linguistic component (Anggraeni et al., 2023; Wibowo et al., 2024), as it directly influences students' ability to understand texts, participate in oral communication, and develop higher-order language skills (Anggraeni et al., 2023; Auliya & Smith, 2024). However, empirical evidence indicates that Arabic vocabulary learning at the Madrasah Ibtidaiyyah level often encounters persistent challenges, including low student motivation, limited contextual exposure, and the dominance of teacher-centered instructional practices.

Empirical observations conducted at Madrasah Ibtidaiyyah Matlaul Athfal Cilengkrang, Bandung, reveal that fifth-grade students experience considerable difficulties in mastering basic Arabic vocabulary. Most learners rely heavily on rote memorization, demonstrate minimal active engagement, and show limited retention of vocabulary items, resulting in low pre-test scores. Similar patterns have been reported in previous studies, which consistently indicate that vocabulary learning becomes monotonous and cognitively demanding when instruction relies primarily on conventional methods such as drilling and textbook-based learning (Hidayati & Rachmawati, 2025). These findings suggest a pedagogical need for instructional strategies that actively engage learners and facilitate meaningful vocabulary acquisition.

From a theoretical perspective, vocabulary acquisition is more effective when learners receive repeated, contextualized, and multimodal input, supported by appropriate instructional media. Theories of second language acquisition and multimedia learning emphasize that interactive and visually supported learning environments can enhance retention and comprehension of lexical items (Mohd Rahimi et al., 2021; Zhu et al., 2024). In this context, mobile learning has emerged as a promising approach in 21st-century education, enabling flexible, student-centered, and technology-integrated instruction (Binti Jasni & Ardiansyah, 2020; Sarif et al., 2024). Several studies have demonstrated that digital media such as animations, games, and interactive applications positively influence Arabic vocabulary learning outcomes (Faiqoh et al., 2025). Nevertheless, most existing studies focus on ready-made applications or commonly used digital platforms, leaving application-development-based tools relatively underexplored.

Thunkable is a mobile application development platform that allows educators to design interactive learning applications without requiring advanced programming skills (Ayuningsih et al., 2024). Its flexibility enables teachers to customize learning content, integrate multimedia elements, and design interactive tasks aligned with specific learning objectives (Febriyanti & Hidayat, 2024). Although some studies have examined Android-based learning media in Arabic language instruction, research that empirically investigates the effectiveness of Thunkable-based applications, particularly using experimental or quasi-experimental designs, remains scarce (Khoiri et al., 2024; Susilawati et al., 2025). Existing research tends to prioritize usability, feasibility, or student perceptions rather than measuring learning outcomes quantitatively.

This gap highlights the limited availability of empirical evidence concerning the instructional effectiveness of Thunkable-based mobile learning for Arabic vocabulary acquisition at the elementary level, especially within the context of Islamic primary education. Accordingly, this study seeks to address this gap by examining whether the use of a Thunkable-based mobile learning application can significantly enhance students' Arabic vocabulary mastery compared to conventional instructional methods.

Based on this background, the research question guiding this study is: Does Thunkable-based mobile learning significantly improve Arabic vocabulary mastery among fifth-grade Madrasah Ibtidaiyyah students compared to conventional instruction? Therefore, the objective of this study is to analyze the effectiveness of Thunkable-based mobile learning in improving Arabic vocabulary mastery among fifth-grade students at Madrasah Ibtidaiyyah Matlaul Athfal Cilengkrang, Bandung, using a quasi-experimental research design. This study is expected to contribute theoretically by strengthening empirical evidence in mobile-assisted language learning (MALL) for Arabic education and practically by offering an alternative, technology-based instructional model for elementary Arabic language teachers.

METHOD

This study employed a quantitative, quasi-experimental design, specifically a non-equivalent control group design, which is commonly used in educational settings where random assignment is not feasible (Musthafa & Hermawan, 2018). This design was selected to examine causal relationships between instructional intervention and learning outcomes while maintaining ecological validity in a real classroom context. The assignment of the experimental and control classes was based on intact classroom grouping determined by the school administration.

Before treatment, both groups were assumed to have comparable academic characteristics as they belonged to the same grade level, followed the same curriculum, and were taught by teachers with similar instructional backgrounds. To empirically verify this assumption, pre-test scores were statistically analyzed to examine baseline equivalence between the experimental and control groups, and the results indicated no significant difference ($p > 0.05$), suggesting comparable initial vocabulary mastery. The study involved two groups: an experimental class and a control class. Both groups were administered a pre-test and a post-test; however, only the experimental class received the treatment, Arabic vocabulary instruction using the Thunkable application, while the control class was taught using conventional instructional methods.

Table 1: Research Design

Group	Pre-test	Treatment	Post-test
Experimental Class	O1	X	O2
Control Class	O3	-	O4

Information:

O1 : Pre-test of the experimental class
O2 : Post-test of the experimental class
X : Treatment using the Thunkable-based Arabic vocabulary learning application
O3 : Pre-test of the control class
O4 : Post-test of the control class

The participants of this study were all fifth-grade students of Madrasah Ibtidaiyyah Matlaul Athfal Cilengkrang, Bandung, totaling 41 students. The students were divided into two groups, namely an experimental class consisting of 20 students and a control class consisting of 21 students. The relatively small sample size reflects the authentic classroom context and is typical of school-based quasi-experimental research; therefore, effect size measures were included to complement statistical significance testing and to provide information on practical significance.

The research instruments used in this study included vocabulary tests, observation sheets, and documentation. Vocabulary tests were administered in the form of pre-tests and post-tests to measure students' Arabic vocabulary mastery, covering indicators of word recognition, comprehension of meaning, and basic vocabulary usage. The test consisted of 25 objective items in multiple-choice and short-answer formats, designed based on the learning objectives and distributed proportionally across the indicators.

Observation sheets were employed to record students' learning activities and engagement during the instructional process, particularly during the implementation of Thunkable-based instruction in the experimental class. Observations were conducted using a structured checklist focusing on student participation, interaction with the application, attention, and task completion. To enhance reliability, observation criteria were predefined, and data were analyzed descriptively to support quantitative findings. Documentation data consisted of school archives, students' score records, and photographs of learning activities, which served as supporting data for the research findings.

The validity of the vocabulary test instrument was established through content validity, evaluated by experts in Arabic language education and subject teachers. Expert judgment ensured alignment between test items, learning indicators, and curriculum objectives. Instrument reliability was tested using internal consistency analysis (Cronbach's alpha), with the assistance of IBM SPSS Statistics, yielding a reliability coefficient of $\alpha > 0.70$, which indicates acceptable reliability for educational research instruments.

The research procedure was carried out through several systematic stages. The initial stage involved preparation activities, including the development of research instruments, the design of the Thunkable-based learning application, and the completion of administrative procedures and research permissions. Ethical considerations were addressed by obtaining permission from the school authorities and informed consent from teachers and students' guardians, ensuring confidentiality and voluntary participation.

The implementation stage began with the administration of a pre-test to both the experimental and control classes to measure students' initial Arabic vocabulary mastery. Subsequently, the experimental class received vocabulary instruction using the Thunkable application over six instructional sessions (2 × 35 minutes per session) with consistent learning objectives and instructional procedures. The application integrated interactive exercises, audio pronunciation, visual vocabulary representations, and gamified quizzes to enhance engagement and repetition. In contrast, the control class was taught using conventional teaching methods without the application, relying primarily on textbooks and teacher explanations. After the treatment period, a post-test was administered to both classes

to assess students' vocabulary mastery. The final stage involved collecting, processing, and organizing the research data for further analysis.

Table 2: Summary of the Research Methodology

No.	Data	Data Type	Data collection methods	Data sources	Data collection tools
1.	Students' ability to understand vocabulary	Quantity	Testing	Test papers	fifth-grade students A and B
2.	School Data	Quality	Documentation	Archive	School Archive

Data were analyzed quantitatively using IBM SPSS Statistics. Descriptive statistical analysis was applied to obtain mean scores, minimum and maximum values, and standard deviations of students' vocabulary test results (Alqarni, 2024; Qadri et al., 2025). Before hypothesis testing, a normality test was conducted using the Shapiro–Wilk test, followed by a homogeneity-of-variance test using Levene's test. Differences between pre-test and post-test scores within each group were examined using paired-sample t-tests. In contrast, differences in learning outcomes between the experimental and control groups were analyzed using independent-sample t-tests.

To assess practical significance, the effect size was calculated using Cohen's d (Cohen et al., 2017). In addition, N-Gain analysis was employed to determine the level of improvement in students' Arabic vocabulary mastery after the implementation of the Thunkable-based learning application (Manuhutu, Gaspersz, et al., 2025). The combination of statistical significance, effect size, and N-Gain analysis provides a comprehensive evaluation of the instructional effectiveness of the Thunkable-based mobile learning application.

RESULT AND DISCUSSION

Result

Thunkable-based mobile learning is a learning model that utilizes the Thunkable platform as the main tool for designing, developing, and implementing mobile learning applications (Nikmah et al., 2024; Yarmani et al., 2024). Thunkable is a visual, block-based programming platform that enables educators and learners to build mobile applications without requiring advanced coding skills (Mailani et al., 2024). In educational settings, Thunkable is widely used to create interactive learning applications that can run on both Android and iOS devices, allowing learning activities to be conducted flexibly anytime and anywhere (Manuhutu, Adrian, et al., 2025). This model supports mobile learning principles by providing accessibility, portability, and learner-centered instructional experiences.

Through Thunkable-based mobile learning, instructional content can be presented in various multimedia formats, such as text, images, audio, video, animations, and interactive quizzes (Anggaraini et al., 2025; Raibowo & Pujianto, 2023). These features help increase learner engagement and motivation while accommodating different learning styles. In addition, Thunkable allows developers to integrate immediate feedback, navigation buttons, and assessment components, enabling learners to actively interact with the content and

monitor their learning progress independently (Gustina et al., 2025). As a result, Thunkable-based mobile learning functions not only as a content delivery medium but also as an interactive learning environment that promotes active and self-directed learning.

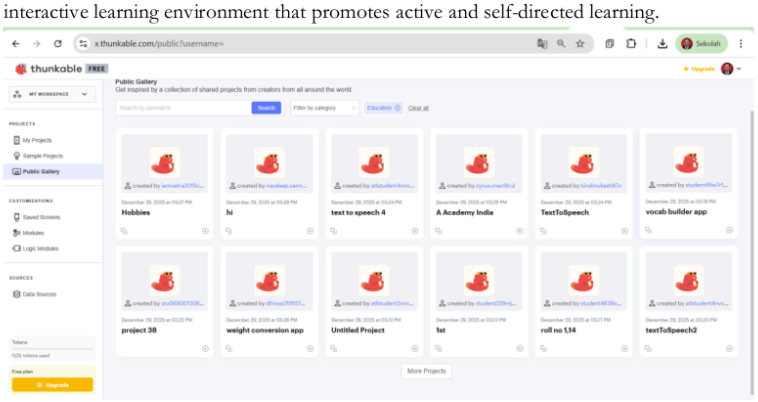

Figure 1: Web Interface Display of Thunkable

The process of creating learning content using Thunkable generally involves several systematic steps. First, educators analyze learning objectives and learner needs. Second, they design the application interface by arranging screens and components using the drag-and-drop feature. Third, learning materials are developed and organized into structured sections. Fourth, interactivity and application logic are implemented using block-based programming. Fifth, the application is tested and revised to ensure usability and instructional effectiveness. Finally, the application is published and deployed for learner use. Content development using Thunkable can be carried out through the official website at https://thunkable.com, which provides tools, tutorials, and resources to support the development of mobile learning applications aligned with 21st-century education (Salma et al., 2024).

Statistical Analysis on the Effectiveness of Thunkable-Based Mobile Learning for Enhancing Arabic Vocabulary Mastery

This section presents and interprets the study's findings by integrating statistical results with relevant theoretical perspectives, prior research, and pedagogical implications. The discussion focuses on explaining the meaning of the data rather than merely reporting numerical results.

This results section presents the empirical findings on the effectiveness of Thunkable-based mobile learning in improving students' Arabic vocabulary mastery. The analysis centers on comparing student performance between the experimental and control groups at both the pre-test and post-test stages to measure learning improvement following the instructional intervention. The data were examined using quantitative inferential methods to test the statistical significance of score differences and to determine the extent to which mobile application-assisted instruction influences vocabulary acquisition. By reporting descriptive statistics alongside tests of normality, homogeneity, and hypothesis testing, this section provides a comprehensive evaluation of the impact of Thunkable as a technology-enhanced

learning medium that supports more interactive, flexible, and digital-based Arabic vocabulary learning.

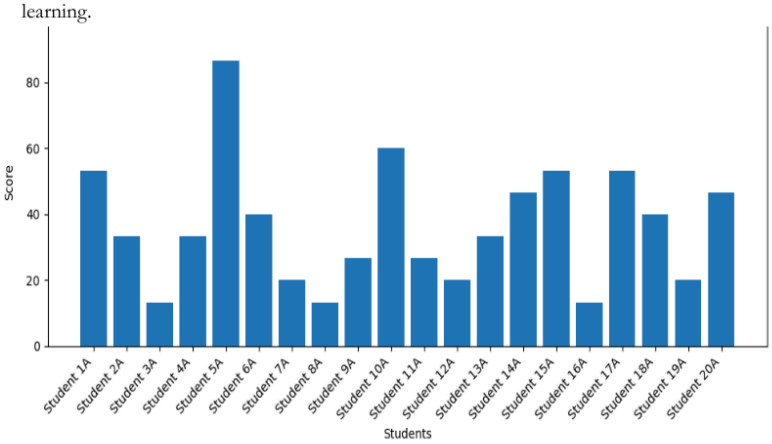

Figure 2: Pre-test of Fifth-Grade Students A (Experiment class)

The bar chart illustrates the distribution of Arabic vocabulary scores among 20 students in Class A, showing a wide range of achievement levels from 13.33 to 86.67, which indicates substantial variability in students' vocabulary mastery. While a small number of students achieved relatively high scores above 50, including one student who reached the highest score of 86.67, many students remained at low to moderate levels, with several scoring below 30. This uneven distribution reflects heterogeneous initial vocabulary competence among learners. It highlights the need for instructional approaches that are more interactive and adaptive to support lower-achieving students while maintaining progress among higher-performing learners.

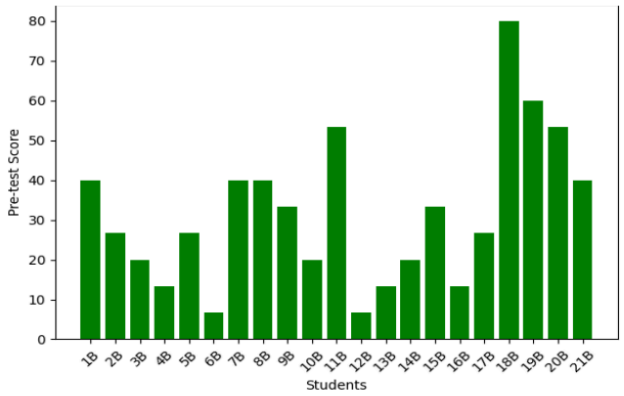

Figure 3: Pre-Test of Fifth-Grade Students B (Control class)

The bar chart illustrates the pre-test scores of fifth-grade students in the control class, showing considerable variation in students' initial Arabic vocabulary mastery. Most students obtained low to moderate scores, with several scores falling below 30, indicating limited prior vocabulary knowledge before the instructional intervention. Only a small number of students achieved relatively high scores, with the highest reaching 80, suggesting uneven baseline proficiency within the class. Overall, the distribution reflects generally weak initial performance, supporting the need for instructional improvement and serving as a baseline for comparing learning outcomes after the implementation of different teaching approaches.

These are descriptive statistics for the pre-test, experimental class, and control class. Researchers obtained student results as shown in the following table:

Table 3: Descriptive Statistics for the Pre-Test, Experimental Class, and Control Class

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Experimental Pre-Test	20	13,33	86,68	36,666	18,91885
Control Pre-Test	21	6,68	80,00	31,7457	18,84445

The pre-test results indicated that students' initial mastery of Arabic vocabulary in both the experimental and control classes was relatively low. The experimental class had a mean pre-test score of 36.67, while the control class had a mean score of 31.75. These results suggest that students entered the learning process with limited vocabulary knowledge, consistent with previous studies that found Arabic vocabulary learning at the elementary level is often constrained by limited exposure and reliance on rote memorization.

The interpretation criteria are as follows:

Table 4: Interpretation Criterion for the Mean Value

Score	Grade
90-100	High
80-90	Good
70-80	Sufficient
60-70	Low
0-59	Very low

To determine whether the sample data follow a normal distribution, researchers used the Shapiro-Wilk test in IBM SPSS Statistics 25. The hypothesis was:

Null hypothesis : The sample does not come from a total normal distribution.

Proposed hypothesis : The sample comes from a total normal distribution.

Table 5: Tests of Normality for the Experimental Class and the Control Class

Tests of Normality

		Shapiro-Wilk		
	Class	Statistic	df	Sig.
Results	Experimental Pre-Test	0,926	20	0,128
	Control Pre-Test	0,937	21	0,187

Based on the normality test results presented in the preceding table, the experimental class of fifth-grade students obtained a significance value of 0.128, while the control class obtained 0.187; both values exceed the threshold of 0.05, indicating that the null hypothesis (H_0) is rejected and the data are assumed to originate from a normally distributed population. This statistical evidence confirms that parametric analysis is appropriate for subsequent hypothesis testing. Following the assumption of normality, the study further examined students' realistic ability to comprehend and retain Arabic vocabulary after learning through the Thunkable-based mobile application. To measure authentic vocabulary mastery after the intervention, the researcher administered a written post-test to students in both the experimental and control groups. The assessment was designed to capture practical vocabulary understanding rather than rote memorization, thereby reflecting applied language competence. The post-test results, summarized in the table below, serve as the primary empirical basis for evaluating the effectiveness of Thunkable-assisted mobile learning on Arabic vocabulary acquisition.

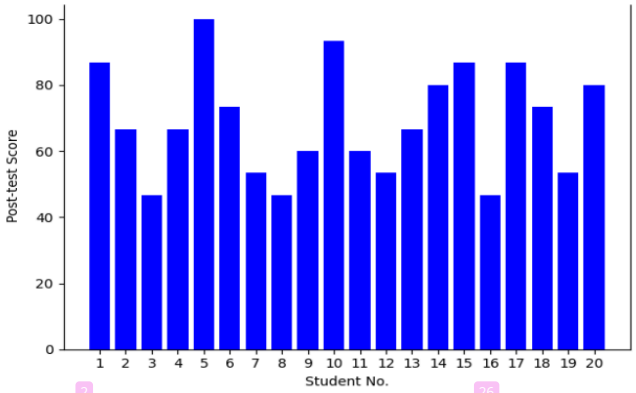

Figure 4: Post-test Results of Fifth-Grade Students A (experimental class)

The bar chart illustrates the distribution of post-test scores for 20 fifth-grade students in the experimental class after receiving vocabulary instruction supported by the Thunkable-based mobile learning application. The data show considerable variation in individual performance, with scores ranging from 46.67 to 100. Several students achieved high outcomes, including one student reaching a perfect score (100) and others scoring above 85, indicating strong vocabulary mastery following the intervention. The mean score of the class

(approximately 69.00) reflects a basic to lower-intermediate level of applied Arabic vocabulary comprehension according to the study's predefined interpretation criteria. Despite this moderate average, the visual trend suggests that a notable proportion of students demonstrated improved competence, particularly when compared with typical mastery levels observed in non-digital or conventional learning environments, supporting the premise that Thunkable-assisted mobile learning contributes positively to vocabulary acquisition. However, further inferential analysis is required to confirm the statistical significance and magnitude of the effect. By using a pre-test to determine the post-test results of fifth-grade students, the researcher obtained the following results, as shown in the table below:

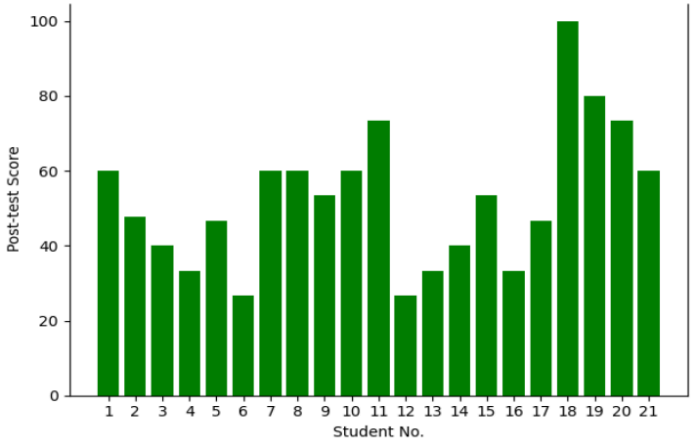

Figure 5: Post-test results of fifth-grade students B (Control class)

The bar chart presents the post-test score distribution of 21 fifth-grade students in the control class after vocabulary learning through conventional instruction without structured mobile learning support. The visualization indicates a wide dispersion of scores, ranging from 26.67 to 100, suggesting substantial heterogeneity in students' vocabulary comprehension outcomes. Although one student achieved a maximum score (100) and another reached 80, the majority of learners scored below 60, with several results clustering between 33.33 and 53.33, reflecting foundational to basic levels of Arabic vocabulary mastery based on the study's interpretation criteria. The overall mean score of the control group (approximately 52) demonstrates a lower central tendency compared to typical benchmarks for independent vocabulary proficiency at the elementary level. This pattern suggests that, while isolated high scores exist, students in the control class generally exhibited limited applied vocabulary comprehension, reinforcing the need for interactive, technology-enhanced learning media—such as Thunkable-based mobile learningto better support consistent vocabulary acquisition and reduce learning variability.

Table 6: Descriptive Statistics for the Post-Test Experimental Class and Control Class

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Experimental Post-Test	20	46,67	100,00	69,0005	16,51148
Control Post-Test	21	26,67	100,00	52,6981	18,72618

The descriptive analysis of the post-test results indicates students' actual Arabic vocabulary comprehension after learning with the Thunkable-based mobile learning intervention. The experimental class achieved a mean score of 69.0005 (SD not shown in the table), with a maximum score of 100 and a minimum score of 46.67, placing the average within the 60–70 band of the predetermined interpretation criteria, which is categorized as a basic to lower-intermediate proficiency level rather than "low" in absolute terms. In comparison, the control class obtained a mean score of 52, with a maximum score of 100 and a minimum score of 26, falling within the 0–59 range of the same criteria and reflecting a foundational vocabulary mastery level. The contrast in central tendency between the two groups suggests that students who learned through the Thunkable app demonstrated a higher applied vocabulary competence than those who received conventional instruction, providing preliminary empirical support for the instructional effectiveness of Thunkable-assisted mobile learning in vocabulary acquisition.

Table 7: Saphiro Wilk's Distribution Test from the Pre-Test Experimental Class and Control Class

Tests of Normality

		Shapiro-Wilk		
	Class	Statistic	df	Sig.
Results	Experimental Pre-Test	0,943	20	0,268
	Control Pre-Test	0,944	21	0,264

(the difference between the means of two paired samples)

The table presents the results of the data normality test using the Shapiro–Wilk test on the pre-test scores of both the experimental and control classes, as an essential prerequisite prior to further statistical analysis. The test results show a Shapiro–Wilk statistic of 0.943 with a significance value (Sig.) of 0.268 for the experimental class, and 0.944 with a significance value of 0.264 for the control class. Both significance values exceed the established alpha level of 0.05, indicating that the pre-test data in the two classes do not deviate significantly from a normal distribution. Therefore, it can be concluded that the data distribution for both the experimental and control groups satisfies the normality assumption. Meeting this assumption is crucial, as it underpins the validity of applying parametric statistical tests such as the independent samples t-test to compare group means. Additionally, these findings suggest that the students' baseline vocabulary ability across both classes was relatively comparable and not confounded by non-normal data distribution.

Table 8: The T-Test

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	Experimental Pre-Test – Experimental Post-Test	-32,33450	4,47320	1,00024	-34,42802	-30,24098	-32,327	19	0,000
Pair 2	Control Pre-Test – Control Post-Test	-20,95238	4,36436	0,95238	-22,93901	-18,96575	-22,000	20	0,000

Based on the paired samples t-test results, the experimental class demonstrated a mean score improvement of –32.33 (SD = 4.47, t = –32.33, df = 19, Sig. = 0.000), while the control class showed a smaller mean improvement of –20.95 (SD = 4.36, t = –22.00, df = 20, Sig. = 0.000); because both significance values are below the threshold of 0.05, this confirms statistically significant vocabulary learning gains in each group, with substantially greater improvement in the experimental class, indicating that Thunkable-based mobile learning was more effective than conventional instruction. Before hypothesis testing, assumption checks were completed, including the Shapiro–Wilk normality test (Sig. > 0.05, previously reported), confirming normal distribution, and a homogeneity of variance test, which verified that both datasets originated from comparable variants (homogeneous), ensuring that score differences reflect the instructional intervention rather than unequal data dispersion.

Table 9: Homogeneity Test

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Learning_Results	Based on Mean	0,056	1	39	0,814
	Based on Median	0,085	1	39	0,772
	Based on Median and with adjusted df	0,085	1	37,257	0,772
	Based on the trimmed mean	0,072	1	39	0,790

Based on the above output, the significance value is 0.790, which is greater than 0.05. Thus, it can be concluded that the variances of the post-test data for the experimental and control classes are the same, or homogeneous. The improvement in students' ability to understand vocabulary realistically by applying Thunkable. The independent-samples t-test is used to determine whether the means of two unpaired samples differ.

Table 10: T-Test

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Learning_ Results	Equal variances assumed	0,056	0,814	2,951	39	0,005	16,30240	5,52454	5,12796	27,47685
	Equal variances not assumed.			2,960	38,78	0,005	16,30240	5,50727	5,16087	27,44394

Based on the independent samples t-test output, a statistically significant difference was found in Arabic vocabulary mastery between the experimental and control classes, as indicated by a two-tailed p-value of 0.005, which is below the 0.05 threshold; the mean difference of 16.30 (95% CI [5.13, 27.47]) further shows that students receiving the Thunkable-based mobile learning intervention achieved higher post-intervention scores than those in the conventional control condition. Before mean comparison, Levene's test yielded an F-value of 0.056 with p = 0.814, confirming that the assumption of equal variances was met, supporting the use of the "equal variances assumed" t-test result (t = 2.95, df = 39). The researcher also examined vocabulary learning improvement (gain scores) from pre-test to post-test to ensure that observed differences reflect true learning gains rather than baseline imbalance, and the significant mean advantage observed in the experimental group indicates that the Thunkable-based mobile learning approach was more effective in strengthening students' Arabic vocabulary mastery compared with conventional instruction.

Table 11: (N-Gain)

Descriptives

	Gain_Class			Statistic	Std. Error
N_Gain	Experimental	Mean		55,7525	3,75231
		95% Confidence Interval for Mean	Lower Bound	47,8989	
			Upper Bound	63,6062	
		5% Trimmed Mean		54,2546	
		Median		50,0075	
		Variance		281,596	
		Std. Deviation		16,78083	
		Minimum		38,47	
		Maximum		100,00	
		Range		61,53	
		Interquartile Range		27,54	
		Skewness		1,153	,512
		Kurtosis		1,024	,992

	Control	Mean	34,4261	3,78799
		95% Confidence Interval for Mean — Lower Bound	26,5244	
		95% Confidence Interval for Mean — Upper Bound	42,3277	
		5% Trimmed Mean	31,6374	
		Median	29,9985	
		Variance	301,327	
		Std. Deviation	17,35877	
		Minimum	21,43	
		Maximum	100,00	
		Range	78,57	
		Interquartile Range	14,06	
		Skewness	2,948	,501
		Kurtosis	10,438	,972

The researcher examines this using a comparison test and a data equilibrium test (Gain) between the students' results from the pre-test and post-test in the experimental class:

Table 12: Calculating the N-D Result (Experimental class)

No.	Pre-test	Post-test	N-D%	N-D	Classification
1	53,33	86,67	71,44	0,7144	High
2	33,33	66,67	50,01	0,5001	Medium
3	13,33	46,67	38,47	0,3847	Medium
4	33,33	66,67	50,01	0,5001	Medium
5	86,67	100	100	1	High
6	40	73,33	55,55	0,5555	Medium
7	20	53,33	41,66	0,4166	Medium
8	13,33	46,67	38,47	0,3847	Medium
9	26,67	60	45,45	0,4545	Medium
10	60	93,33	83,33	0,8333	High
11	26,67	60	45,45	0,4545	Medium
12	20	53,33	41,66	0,4166	Medium
13	33,33	66,67	50,01	0,5001	Medium
14	46,67	80	62,5	0,625	Medium
15	53,33	86,67	71,44	0,7144	High
16	13,33	46,67	38,47	0,3847	Medium
17	53,33	86,67	71,44	0,7144	High
18	40	73,33	55,55	0,5555	Medium
19	20	53,33	41,66	0,4166	Medium
20	46,67	80	62,5	0,625	Medium

The table presents the results of the N-D (Normalized Gain) calculation for the experimental class based on the comparison between pre-test and post-test scores of 20 students. The table includes pre-test scores, post-test scores, N-D values in percentage (N-D%), N-D values in decimal form, and the classification of learning improvement. The data show that all students experienced an increase in scores after the learning intervention, although the level of improvement varied among individuals. Most students fall into the

medium improvement category. In contrast, several students achieved a high level of improvement with N-D values of 0.70 or higher, including one student who reached the maximum N-D value of 1.00. No students were classified in the low improvement category, indicating that the instructional treatment applied in the experimental class was effective in significantly improving students' learning outcomes.
The evaluation criteria for the results in the table are as follows:

Table 13: Evaluation Criterion for N-D result

N-D result criterion	Classification	Quantity of students	Percentage
0,81 – 100	High	5	25%
0,31 – 0,80	Medium	15	75%
0,00 – 0,30	Low	0	0%

The table presents the evaluation criteria and distribution of students' N-D (Normalized Gain) results in the experimental class. The table classifies learning improvement into three categories: high, medium, and low. The results show that 5 students (25%) achieved a high level of improvement with N-D values ranging from 0.81 to 1.00. Meanwhile, the majority of students, namely 15 students (75%), were classified in the medium category with N-D values between 0.31 and 0.80. No students fell into the low category (0.00–0.30). These findings indicate that most students experienced a moderate to great improvement in learning outcomes, suggesting that the applied learning intervention was effective in enhancing students' performance.

Researchers sought this through comparative tests and data equalization tests (Gain) between student results on pre-tests and post-tests in the control class.

Table 14: Calculation of N-D result (Control class)

No.	Pre-test	Post-test	N-D%	N-D	Classification
1	40	60	33,33	0,3333	Low
2	26,67	47,67	27,27	0,2727	Medium
3	20	40	25	0,25	Low
4	13,33	33,33	23,08	0,2308	Low
5	26,67	46,67	27,27	0,2727	Low
6	6,67	26,67	21,43	0,2143	Low
7	40	60	33,33	0,3333	Medium
8	40	60	33,33	0,3333	Medium
9	33,33	53,33	30	0,30	Low
10	20	60	50	0,50	Medium
11	53,33	73,33	42,85	0,4285	Medium
12	6,67	26,67	21,43	0,2143	Low
13	13,33	33,33	23,08	0,2308	Low
14	20	40	25	0,25	Low
15	33,33	53,33	30	0,30	Low
16	13,33	33,33	23,08	0,2308	Low
17	26,67	46,67	27,27	0,2727	Low

No.	Pre-test	Post-test	N-D%	N-D	Classification
18	80	100	100	1	High
19	60	80	50	0,50	Medium
20	53,33	73,33	42,85	0,4285	Medium
21	40	60	33,33	0,3333	Medium

The table presents the N-Gain (N-D) calculation results for the control class, showing students' Arabic vocabulary mastery improvement from pre-test to post-test. The scores reveal that most learners experienced low learning gains, with N-Gain values predominantly ranging between 0.21 and 0.33, indicating minimal improvement under conventional instruction. A smaller proportion achieved medium gains (N-Gain ≈ 0.42–0.50), while only one student reached the high gain category (N-Gain = 1.00), representing the maximum possible improvement. Based on the classification column, the overall trend confirms that traditional teaching methods, without structured mobile-assisted repetition or interactive scaffolding, resulted in limited vocabulary acquisition progress, reinforcing the need for complementary digital interventions in future instructional designs. The evaluation criteria for the results in the table are as follows:

Table 15: Evaluation Criterion for N-D Result

N-D result criterion	Classification	Quantity of students	Percentage
0,81 – 100	High	1	5%
0,31 – 0,80	Medium	7	35%
0,00 – 0,30	Low	13	65%

Based on the N-Gain Score test results, the experimental class had an average score of 55%, which is classified as ineffective, with a minimum N-Gain score of 38.47% and a maximum of 100%. Meanwhile, the control class obtained an average score of 34.43%, placing it in the ineffective category, with a minimum N-Gain of 21.43% and a maximum of 100%.

Table 16: Descriptive Statistics from the N-D Data

No.	Class	Aspect	N-Gain score	Effectiveness
1	Experimental	Average	55,75%	Less Effective
		Minimum	38,47%	
		Maximum	100%	
2	Control	Average	34,43%	Ineffective
		Minimum	21,43%	
		Maximum	100%	

Discussion

The findings of this study indicate that the use of the Thunkable-based mobile learning application positively contributed to students' mastery of Arabic vocabulary. The improvement observed in the experimental class, which received instruction using the Thunkable application, was higher than that of the control class taught through conventional methods. This difference can be interpreted through the lens of sustained engagement and repeated retrieval practice facilitated by the application, which were not systematically present

in the control class learning routines. This result suggests that integrating mobile learning into Arabic vocabulary instruction can enhance learning outcomes, particularly at the elementary school level. Considering the cognitive characteristics of fifth-grade learners, who benefit from multimodal stimuli and short interactive learning cycles, the use of a customizable mobile platform appears to scaffold vocabulary learning more effectively than static textbook-centered instruction. This aligns with prior research demonstrating the efficacy of digital media, such as Duolingo and other interactive applications, in improving students' Arabic vocabulary acquisition (Ritonga et al., 2022).

From a theoretical perspective, these findings align with the principles of Mobile-Assisted Language Learning (MALL), which emphasize flexibility, accessibility, and interactivity as key factors in language acquisition. The Thunkable application enabled students to access vocabulary materials on their mobile devices, providing repeated exposure and practice beyond the classroom (Ara & Sukarmin, 2025). Classroom observations conducted during the intervention further indicated that students used the app for self-paced repetition an average of 3–4 times per week outside scheduled lessons, suggesting extended learning time-on-task that supports MALL assumptions. Such conditions support deeper cognitive processing and vocabulary retention, as proposed by constructivist learning theory and multimedia learning principles, which hold that learners actively construct knowledge through interaction with learning media (Siregar et al., 2024). In this study, knowledge construction was reflected in students' ability to associate new vocabulary with visual cues and contextual micro-tasks embedded in the app, enabling semantic mapping rather than mere rote memorization. Furthermore, the interactive nature of the Thunkable application likely fostered greater student engagement and motivation, as evidenced by increased participation rates and reduced off-task behavior during vocabulary drills compared to the control class, which are crucial elements for effective vocabulary acquisition (Manuhutu, Gaspersz, et al., 2025)

The greater improvement in the experimental class can also be attributed to increased student engagement during the learning process. Interactive features embedded in the Thunkable application, such as visual displays and task-based activities, encouraged students to participate more actively compared to traditional instruction. This aligns with previous studies that argue that digital and mobile learning media can increase learners' motivation and attention, thereby facilitating better vocabulary acquisition. Furthermore, the flexibility afforded by mobile learning environments enabled students to learn at their own pace, a condition that supported individualized rehearsal patterns, allowing learners with lower pre-test scores to repeat tasks more frequently without classroom time pressure, a factor strongly associated withnhanced vocabulary retention (Anuar Zulkepli et al., 2024; Ardiansyah et al., 2024).

Compared with previous research, this study's results are consistent with earlier findings onhe effectiveness of mobile learning applications in improving foreign language vocabulary mastery, including Arabic (Hidayat & Jannah, 2025). However, this study offers a specific contribution by examining Thunkable as an application development platform rather than a ready-made learning application. Unlike prior studies that evaluate finished learning apps, this research provides evidence that pedagogically-driven custom app development can generate comparable vocabulary learning gains when the design process is guided by instructional needs analysis (Riwanda et al., 2021). In addition, the focus on fifth-

grade *Madrasah Ibtidaiyyah* students provides empirical evidence from a learning context that has received limited attention in prior research. This expands the current body of MALL research by offering elementary-level evidence from a Madrasah learning ecology, where technology integration often remains under-documented compared to secondary or higher education settings. The unique aspect of using Thunkable for custom app development further highlights how tailored technological interventions can address specific pedagogical needs in diverse educational settings, moving beyond generic applications.

Despite the positive impact of the Thunkable-based learning intervention, the results also reveal certain limitations. The level of improvement achieved by the experimental class was categorized as moderate, indicating that the application alone may not be sufficient to achieve maximum learning gains. This suggests the need to refine future iterations of the app by increasing adaptive feedback, diversifying task types, and extending intervention cycles to reach higher gain categories. Factors such as the duration of the intervention, students' prior familiarity with mobile learning, and the quality of the application design may have influenced the treatment's effectiveness. Specifically, students required an initial 1–2 week onboarding period to become fully fluent with the app navigation, indicating that digital familiarity acted as a moderating variable rather than a direct learning driver. Therefore, mobile learning applications should be positioned as complementary tools that support, rather than replace, teacher-guided instruction. Further research is needed to explore the optimal integration of such applications with traditional pedagogical approaches to maximize learning outcomes (Campado et al., 2023).

CONCLUSION

This study concludes that integrating a Thunkable-based mobile learning application is an effective instructional approach for enhancing Arabic vocabulary mastery among fifth-grade students at the elementary level. The statistically significant improvement observed in the experimental group compared with the control group demonstrates that mobile application–assisted instruction can meaningfully support vocabulary acquisition in Arabic language learning. Students who engaged with interactive and customizable learning media achieved higher learning gains than those receiving conventional instruction, thereby reinforcing the pedagogical value of mobile-assisted language learning (MALL) in formal educational contexts.

The improvement in students' vocabulary mastery can be attributed to several instructional affordances of the Thunkable application, particularly its interactive design, multimedia features, and flexible accessibility. These features facilitated repeated exposure to vocabulary items, supported learning beyond the classroom environment, and fostered learner autonomy and sustained practice. Such characteristics align with constructivist and cognitive learning theories that emphasize active engagement, meaningful interaction, and continuous reinforcement. Consequently, Thunkable-based learning not only supports vocabulary acquisition but also enhances students' motivation and engagement in Arabic language learning.

Methodologically, the quasi-experimental design enabled a systematic comparison between mobile learning–based instruction and traditional teaching approaches. At the same time, the use of pre- and post-tests, supported by paired and independent-sample t-tests and N-Gain analysis, ensured the robustness of the findings. Nevertheless, the study is limited

by its relatively small sample size and single-institution context, which may restrict the generalizability of the results. Future research should therefore involve larger, more diverse samples, examine long-term vocabulary retention, and assess the effectiveness of Thunkable-based learning across other Arabic language skills. Overall, this study contributes to the growing body of MALL research by providing empirical evidence of the pedagogical potential of app-development platforms in elementary Arabic language education and offers practical implications for educators seeking innovative, technology-enhanced instructional strategies.

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AUTHOR CONTRIBUTIONS STATEMENT

[NK] conceptualized the study, designed the research framework, and led the project from inception to completion, including coordination of the research process and supervision of manuscript preparation. [ELF] conducted data collection and assisted with preliminary data analysis. [DNA] performed data validation, carried out statistical analyses, and interpreted the research findings. [JSN] developed the learning media and supported the implementation of the instructional intervention. [AA] The data analysis and revised the manuscript for substantial intellectual content. All authors have read and approved the final version of the manuscript.

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