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Investigating the Impact of Mobile Vocabulary Application on Vocabulary Learning Among Saudi ESL Learners With Different Learning Styles

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Abstract

This study explores the impact of the mobile vocabulary application Kahoot on vocabulary learning among Saudi ESL learners, Kahoot has the advantage of addressing individual learning styles (visual, auditory, kinesthetic, read/write). Using a quasi-experimental design, 20 female students were divided into an experimental group that received Kahoot-based instruction and a control group that followed traditional methods. Pre- and post-test vocabulary scores were analyzed to assess learning gains, and the VARK questionnaire determined learning style preferences.

The results revealed that the experimental group significantly outperformed the control group in post-test vocabulary scores, with a large effect size (Cohen's d = 0.96), demonstrating the effectiveness of Kahoot in enhancing vocabulary learning. Although learning styles were not significant moderators of app effectiveness, correlations suggested varied benefits across styles.

The findings suggest that mobile applications like Kahoot can serve as practical tools for vocabulary instruction in ESL contexts, benefiting learners regardless of their learning style. The study concludes with recommendations for integrating mobile-assisted learning into classroom practices to enhance vocabulary learning.

Keywords: Mobile-Assisted Language Learning, Vocabulary Learning, Learning Styles, Kahoot, Saudi ESL Learners, Quasi-Experimental Design

1. Introduction

1.1 Problem Statement

Vocabulary learning plays a vital role in developing proficiency in English as a second language (Schmitt, 2008; Nation, 2001). However, Saudi ESL learners face difficulties building an extensive vocabulary due to limited opportunities for natural exposure and practice of English outside the classroom (Alhuqbani, 2019; Aldersi, 2017; Aldosari, 2021). Researchers have attributed this challenge to heavy reliance on formal instruction with minimal authentic language use, lack of English-speaking communities or media, and limited engagement in vocabulary reinforcement activities beyond lessons (Alhuqbani, 2019; Aleassa, 2014).

While some studies have started exploring mobile technologies as a potential means to address this input gap and enhance vocabulary learning outcomes, research specifically assessing their effectiveness among Saudi students is still limited (Aldosari, 2021). Furthermore, existing work has not adequately considered how individual variables like learning styles influence the benefits students gain from assistive tools despite evidence that learning preferences impact strategies and needs (Felder & Silverman, 1988; Reid, 1987). Additional investigation is needed to provide more conclusive insights into the optimal implementation of mobile applications according to Saudi ESL learners' differentiated characteristics.

This study aims to address these knowledge gaps by evaluating the impact of mobile vocabulary applications on Saudi students' vocabulary learning development and examining how effectiveness varies according to predominant learning styles. Findings could help address barriers faced by this learner population and inform more tailored integration of technologies to maximize support. The above issues constitute the problem motivating the present research.

1.2 Significance of the Study

This study holds practical and theoretical significance for enhancing vocabulary learning among Saudi ESL students through the mobile game application Kahoot. From a practical standpoint, incorporating Kahoot aims to increase learner motivation and engagement with vocabulary (Burston, 2014; Soto, 2017). This may improve retention, especially for different learning styles supported through the app's interactive features.

Theoretically, integrating Kahoot following tailored recommendations based on established learning style models could help reduce working memory loads associated with vocabulary acquisition (Pashler et al., 2008). Acquiring new words through enjoyable mobile games actively contributes to productive vocabulary development in ways traditional methods alone may not (Nation, 2001; Schmitt, 2008).

Few studies have comprehensively examined the relationship between mobile vocabulary app effectiveness and individual learning styles, but not in Saudi contexts (Aldosari, 2021). This research addresses this gap to provide valid recommendations for optimizing Kahoot implementation according to students' diverse preferences and needs.

Findings from investigating the research questions could guide the appropriate integration of Kahoot to maximize outcomes. This has implications for enhancing vocabulary instruction delivery and supporting differentiated learners. More broadly, insights from understanding the best mobile pedagogical practices may help strengthen English education in Saudi Arabia

(Hamdan, 2005).

Therefore, theoretically and practically, this study contributes meaningful knowledge to facilitate vocabulary learning through a customized approach based on learners' differentiated characteristics.

1.3 Literature Review

1.3.1 Definitions of Vocabulary and Vocabulary Learning

Vocabulary has been defined in various ways by applied linguists. Nation (2001, p. 26) describes vocabulary as "all the words in a language." However, this definition fails to recognize that words consist of form, meaning, and use. Hence, Lewis (1993, p. 87) provides a more comprehensive definition, describing vocabulary as "the body of words used in a language, language, or branch of knowledge, including single words, compound words, idioms or set expressions."

More recently, Gardner (2013, p. 3) defines vocabulary as "the total number of words in a language collectively, their meanings, and how they combine into meaningful phrases and sentences." Mecartty (2000) also refers to vocabulary as multi-dimensional, involving associations between form and meaning across a range of contexts. Vocabulary learning refers to gaining familiarity with new words and deepening understanding of known words. According to the Education Endowment Foundation, vocabulary learning involves "actively engaging with words to consolidate understanding, develop associations between words, and integrating new meanings into existing knowledge. Effective strategies involve multiple exposures to vocabulary items and active retrieval practice" (EEF, 2018). Oxford Learning also describes it as "the continuous process of learning new words and enhancing our knowledge of words we already know. It involves learning word meanings, pronunciation, grammatical use, relationships with other words, and increased fluency." (Oxford Learning, 2022). It occurs gradually through repeated exposure in natural contexts and through focused study and practice over an extended period (Nation, 2013; Ellis, 1997). Vocabulary can be acquired incidentally during general reading, listening, and conversations aimed at communication, as well as intentionally, through direct instruction and exercises designed to reinforce words (Schmitt, 2008).

Many researchers have identified levels of vocabulary knowledge, ranging from a basic familiarity with recognition of a word's form and meaning to complete assimilation, where words can be spontaneously and accurately integrated into one's active use of the language (Nation, 2013; Wesche & Paribakht, 1996). Vocabulary learning aims to develop an active command of terms, allowing productive use in all modalities appropriate to the context (Nation, 2001). Achieving fluency involves strengthening word associations and consolidating multi-dimensional semantic representations over numerous encounters (Schmitt, 2014).

1.3.2 Mobile-Assisted Language Learning (MALL)

MALL has emerged as an innovative pedagogical approach utilizing portable technologies (Stockwell, 2010). Mobile phones are a useful learning resource which need to be tapped. Several apps such as Duolingo provide practice in language skills, quickly and efficiently. Al-

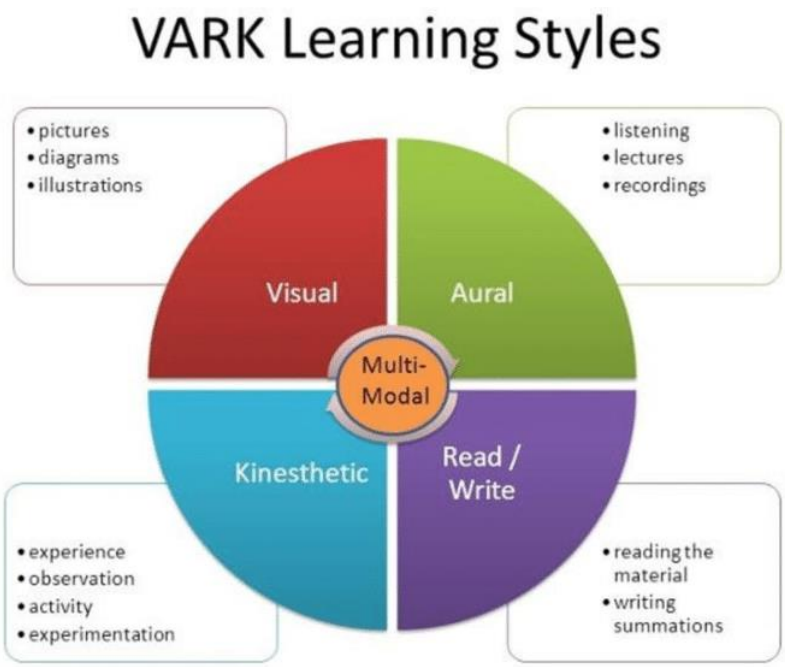
Shehri (2011) notes that the rapid proliferation of mobile devices in Saudi Arabia provides opportunities to integrate language learning seamlessly into daily life. According to Aljohani (2017), the ubiquity of smartphones supports "just-in-time" vocabulary practice to complement formal classroom instruction. MALL refers to using portable electronic devices like smartphones, tablets, and MP3 players to study languages outside the classroom (Chinnery, 2006; Kukulska-Hulme & Shield, 2008). It builds upon the principles of CALL by extending learning beyond stationary computer labs into informal contexts (Stockwell, 2010). MALL allows learners to practice languages ubiquitously at their convenience rather than confined to fixed schedules.

Vibrant multimedia features also augment MALL's effectiveness. Combining text, audio, video, and graphics optimizes language uptake according to Dual Coding Theory, as working memories are not overloaded (Mayer, 2009; Sampson et al., 2013). Integrated tools like interactive dictionaries and flashcards further support need-based, personalized language exposure (Wang & Smith, 2013). As a result, MALL can increase motivation and autonomous learning, which is critical for mastery of vocabulary depth and breadth.

1.3.3 Learning Styles

Individual differences in how people perceive and process information, known as learning styles, have been shown to impact second language learning (Oxford, 2017). Learning styles refer to the various ways in which individuals perceive and process new information. Pashler et al. (2009) categorized styles into visual, auditory, verbal, physical, logical, social, and solitary dimensions. However, one of the most widely used frameworks is the VARK model, which describes four significant styles - visual, auditory, reading/writing, and kinesthetic (Fleming & Mills, 1992). For example, visual learners prefer seeing information displayed spatially through images, diagrams, and flow charts.

Auditory learners learn best through verbal lectures, discussions, and audio material. Reading/writing learners absorb new ideas most successfully through textual resources like books and manuals. Finally, kinesthetic learners thrive on physical experience involving touch, movement, simulations, and tactile activities (Kihlstedt, 2022). While learning style models provide helpful insight, there is an ongoing debate around their methodological rigor and impact on instructional design (Coffield et al., 2004; Pashler et al., 2009; Dekker et al., 2012). However, assessing individual preference profiles remains a common practice to help shape appropriate pedagogies (Rayner & Riding, 1997). Further research investigates relationships between styles and specific learning outcomes like vocabulary learning (Jafari & Hashim, 2012; Lee & Huang, 2018).



VARK Learning Styles (Alshamsi, Aysha, 2021).

1.3.4 The Relationship between Learning Styles and Vocabulary Learning

Some research has suggested that learners learn vocabulary more effectively when instructional methods match their individual sensory preferences, with visual, auditory or tactile approaches potentially facilitating vocabulary learning. However, much of the existing evidence is mixed, with numerous studies failing to consistently demonstrate strong connections between style profiles and assessment vocabulary outcomes. While stylistic preferences may provide insights, there are indications that variability in instructional techniques, including technology integration, can positively impact vocabulary growth across diverse learners regardless of their most dominant learning modalities.

Some studies have found a positive correlation between certain learning styles and vocabulary outcomes, suggesting that Individual learning styles significantly impact how students acquire and retain new vocabulary. It is important to understand how an ESL learner's preferred perceptual strengths or channels for receiving information, such as visual, auditory, kinesthetic or read/write preferences, may support or hinder their vocabulary development process (Pashler et al., 2009). For example, one study found that visual and kinesthetic learners performed better on vocabulary post-tests when word drills incorporated graphics, movement and gamification (Miller, 2015).

Research indicates that an individual's preferred learning style can affect various vocabulary processes. Lin and Zhao (2007) conducted a quantitative study with 120 Chinese EFL undergraduates, who were classified into visual, auditory, and kinesthetic styles using the VAK questionnaire. When exposed to 30 new English words through differing style-based activities, results found visual participants recalled more words accurately than those in other groups.

They relearnt words most effectively using graphic organizers, outperforming peers who used audio recordings or role plays. In another mixed-methods study, Madhumathi and Ghosh (2012) administered the Index of Learning Styles questionnaire to 80 Indian undergraduate EFL learners before teaching 30 vocabulary items through diverse methods aligned with sensory preferences. Verbal-style students who practiced oral definition recitation demonstrated more muscular long-term retention than visual peers who used flashcards. Verbal preference learners also self-reported deeper processing of word meanings through speaking.

In the Saudi context, research to date also questions relationships between styles and outcomes while demonstrating that digital supplementation can elevate achievement across preferences when integrated strategically. Alhujayyyan and Shachlouf (2019) administered learning-style questionnaires to 465 Saudi university students studying English as a foreign language. They found no significant correlations between styles and exam scores, supporting the insignificance of style-matching on outcomes. Alotaibi and Hail (2019) reviewed 57 studies on the learning styles and strategies of Saudi EFL learners. They concluded that while Styles provide insight, but there is insufficient evidence that direct matching enhances learning and that various approaches benefit diverse learners regardless of preferences. Contradictory findings could stem from variability in how styles are defined and assessed across studies. Overall, more conclusive data is still needed to determine the precise role of students' learning style on vocabulary learning.

1.3.5 Theoretical Framework

This research draws upon three influential theoretical frameworks related to vocabulary learning, learning styles and technology-enhanced language learning. First, Paivio's (1986) Dual Coding Theory provides a cognitive foundation for understanding how new lexical items are encoded verbally and visually in long-term memory. Next, the Learning Styles Theory conceptualized through the VARK model (Fleming & Mills, 1992) informs individual differences in visual, auditory and kinesthetic modalities that influence encoding. Finally, Technology-Enhanced Language Learning (TELL) theory refers to the application of technology in language education to enhance the teaching and learning process (Chen et al., 2020). TELL theory recognizes the potential of technology to support and facilitate language learning by providing learners with additional resources, tools, and opportunities for practice (Hubbard & Levy, 2006). It encompasses various approaches, strategies, and principles for integrating technology into language learning environments (Egbert, 2005). By integrating these three approaches, this study examines how Saudi EFL learners' diverse learning styles impact their mobile-assisted vocabulary learning process as depicted by the TELL model, with dual coding cognition as the underlying psychological mechanism.

1.3.5 Research Questions

This study aims to address its objectives by seeking to answer the following research questions:

1. How does regular mobile vocabulary application (Kahoot) usage affect vocabulary learning among Saudi ESL students?

This question aims to assess the use of a supplemental app significantly affects the development

of students' vocabulary learning, as measured by vocabulary assessment results.

2. How could the benefits of vocabulary apps differ based on students' visual, auditory, kinesthetic or read/write learning styles?

This question examines whether vocabulary gains differ depending on whether students preferred Visual auditory, kinesthetic, or read/write modalities are well-supported by app features and activities.

Answering these questions will provide valuable insights into the potential role of mobile technologies in addressing the vocabulary challenges Saudi learners face. It will also offer guidance for optimizing apps within instruction informed by learners' characteristics and needs. The findings intend to fill existing research gaps while advancing knowledge on effective implementation approaches.

This study hypothesizes that Saudi ESL learners who receive Kahoot-based vocabulary instruction will achieve significantly higher vocabulary acquisition than those using traditional methods. Additionally, individual learning styles (visual, auditory, kinesthetic, read/write) may or may not influence the effectiveness of Kahoot in vocabulary learning.

2. Method

2.1 research Design

This quantitative study follows the postpositivist assumptions that realities exist but are imperfectly interpreted, and data can be used to determine causes of underlying trends and group differences observed among variables. As Creswell and Creswell (2018) note, within the postpositivist worldview, the research aims not to prove hypotheses but to use deductive logic and gathered data to test hypotheses and objectively evaluate outcomes. This study employed a quantitative research design to investigate relationships between variables. Muijs (2010) notes that quantitative research methods are effective for examining relationships between variables and the impact of educational interventions. Therefore, the current study seeks a quantitative approach aligned well with these objectives to investigate the relationships between vocabulary learning outcomes, use of mobile technology, and learning style preferences while also evaluating the effect of the mobile app.

2.2 Participant and Setting

Twenty female students from Saudi Arabia enrolled in their A1 Beginner English Course at a language institute in Makkah City, Saudi Arabia participated in the study. These students were Arabic native speakers of about 14-30 years of age. They were randomly put into two groups of ten students each. Their course book was Direct English level one. All teaching was done in a normal classroom in the language institution.

2.3 Sampling

The target population was defined as Saudi female English language learners enrolled in a

Saudi institution in Makkah, Saudi Arabia. The study employed a non-probability convenience sampling method. All ESL students comprised the accessible population. As is common in educational research (Young, 2015), convenience sampling was utilized due to constraints on random selection (Dörnyei, 2007). Specifically, two intact English classes were selected based on their availability to participate, which were then randomly assigned to the experimental and control groups of 10 students each. This sampling approach offers feasibility but limits generalizability.

2.4 Instruments

The study utilized three main instruments: the Learning Style Questionnaire, a Vocabulary Test (pre and post), and the Kahoot application. The Learning Style Questionnaire, adapted from Fleming and Mills (1992), assessed participants' learning preferences across visual, auditory, kinesthetic/tactile, and reading/writing modalities using a 13-item scale with a 5-point Likert response format. The Vocabulary Test, designed by the researcher, measured participants' knowledge of 30 key terms through multiple-choice questions, evaluating word meaning and usage, with scores reflecting changes in lexical knowledge over an 8-week intervention. The Kahoot application, a game-based learning platform, facilitated interactive quizzes that engaged students through various formats appealing to different learning styles, incorporating visual, auditory, and kinesthetic elements. This combination aimed to enhance motivation and vocabulary recall, aligning with research on the effectiveness of technology-enhanced learning environments.

2.5 Procedure

After obtaining ethical permission, the study followed a detailed procedure involving several key steps. First, a non-probability convenience sampling method was employed to select 20 Saudi female English language learners from two intact classes, randomly assigning them to experimental (10 students) and control (10 students) groups. The Learning Style Questionnaire was translated into Arabic, proofread, and administered digitally at the study's outset, allowing for tailored vocabulary activities. A vocabulary pre-test was then given to both groups via Google Forms to establish a baseline of lexical knowledge. Over eight weeks, the experimental group engaged with the Kahoot app for vocabulary quizzes and games, while the control group received traditional instruction. At the end of the intervention, both groups completed a post-test to assess changes in vocabulary knowledge. A pilot study ensured the clarity and effectiveness of the instruments used, and expert reviews confirmed the validity and reliability of the Learning Styles Questionnaire and Vocabulary Test, solidifying the study's methodological integrity. The study also considered several ethical concerns. The participants' anonymity was ensured as no personal information was required. In addition, all participants were informed about their right to withdraw at any stage without any consequences. Finally, the data was only accessible to the researchers and was used for research purposes only to maintain confidentiality.

2.6 Data Analysis

Quantitative analytic methods were employed and the IBM SPSS software was used to analyze the data collected throughout the study Means and standard deviations were calculated for the pre-test and post-test scores of the experimental and control groups to summarize the vocabulary knowledge before and after the intervention as the pre-test and post-test contained identical question items. A paired samples t-test was conducted to determine whether there were significant differences between participants' scores before and after the intervention period within each group. This test examined whether the Kahoot application led to a significant increase in vocabulary learning.

Additionally, an independent sample A t-test was run to compare the average score gains achieved by the two different instructional approaches, testing whether the experimental group showed a significantly higher vocabulary gain than the control group. Responses to the learning styles questionnaire were coded, and frequencies were obtained for each style profile. The two-way analysis of variance (ANOVA) was used to analyze whether there was an interaction between learning style and group (experimental vs. control) on vocabulary learning. Correlations were explored between these profiles and vocabulary test performance. The quantitative analysis of pre-test, post-test and questionnaire data provided insights into the impact of supplementing lessons with mobile vocabulary practices compared to traditional methods alone.

3. Results

3.1 Participant Characteristics and Learning Styles

Table 1 presents the distribution of learning style preferences among the study participants.

Table 1. Participants Learning Style

		Groups		Total
		Control group	Experimental group	
Learning Styles	Visual	5	4	9
	Auditory	1	2	3
	Kinesthetic	3	3	6
	Read/Write	1	1	2
Total		10	10	20

The sample consisted of 9 visual, 3 auditory, 6 kinesthetic, and 2 read/write learners, evenly divided between the control and experimental groups.

3.2 Descriptive Statistics

Here are the statistical analyses of all data collected in the experimental and control groups. The results are about central tendencies and variations across the groups. The scores from the

pretest and post-test are presented, as well as patterns between the two groups according to different learning styles. It also discusses the effect of intervention through the Kahoot application against its relevance to dependent learners among Saudi ESL learners. Below are the specifics of each part.

3.2.1 Equivalence of Groups on Vocabulary Pre-Test

An independent sample t-test was conducted to examine any significant differences between the control and experimental groups' vocabulary pre-test scores.

Table 2. Descriptive Statistics of Pre-Test and Post-Test Vocabulary Scores

Group	Pre-Test Mean	(SD)	Post-Test Mean	(SD)
Control	7.50	(1.71)	13.80	(2.04)
Experimental	8.00	(1.41)	22.40	(4.38)

As seen in Table 2, the experimental group had a slightly higher pre-test mean score (8.00) than the control group (7.50). However, both groups showed improved vocabulary learning, with the experimental group showing a substantial increase in their post-test scores (22.40), in contrast to the control group's more modest increase (13.80).

3.2.2 Equivalence of Groups on Learning Styles

Similarly, an independent samples t-test was performed to assess whether the control and experimental groups differed in their learning style preferences as measured by the pre-assessment.

Table 3. Independent Samples Test

Items	Group	N	Mean	Std. Deviation	t	df	Sig.
Visual Items	control grub	10	3.57	1.491	0.306	18	0.763
	experimental	10	3.37	1.426			
Auditory Items	control grub	10	3.47	0.688	0.391	18	0.700
	experimental	10	3.60	0.829			
Kinesthetic Items	control grub	10	3.70	0.948	0.000	18	1.000
	experimental	10	3.70	0.935			
Read/Write Items	control grub	10	3.58	0.612	0.281	18	0.782
	experimental	10	3.65	0.579			
All Items	control grub	10	3.57	0.199	0.105	18	0.917
	experimental	10	3.58	0.115			

The results in Table 3 revealed no statistically significant differences across the visual, auditory, kinesthetic, and read/write modalities, again confirming that the groups were equivalent.

3.3 Statistical Tests

Here, we present the complete statistical analysis done for the efficacy of Kahoot in vocabulary learning and its influence across various learning styles. Various statistical test methods were used to test the hypotheses: independent and paired samples t-tests, two-way ANOVA, and correlation analyses. These were mainly used to determine population differences, measure learning gains, and correspondingly relate learning styles and vocabulary acquisition. Such robust result analyses were aimed at generalizing evidence of the influence of this mobile application intervention when considering the many learning preferences of Saudi ESL learners. The following subsections provide detailed information on the various statistical procedures and their results:

3.3.1 Independent Samples T-Test: Pre-Test Scores

An independent sample t-test was conducted to compare the pre-test vocabulary scores between the experimental group (M = 8.00, SD = 1.41) and the control group (M = 7.50, SD = 1.71). The test results are shown in Table 4.

Table 4. Independent Samples T-Test for Pre-Test Scores

Group	Mean	SD	t	df	Sig. (2-tailed)
Control	7.50	1.71	0.711	18	0.486
Experimental	8.00	1.41			

The t-test result (t (18) = 0.711, p = 0.486) reveals that there is no statistically significant difference between the two groups in their pretest scores. This means the two groups had similar levels of vocabulary knowledge at the beginning of the study, establishing baseline equivalency.

3.3.2 Paired Samples T-Test: Pre-Test and Post-Test Scores for the Experimental Group

A paired samples t-test was conducted to compare the vocabulary scores of the experimental group before and after the intervention. The test results are shown in Table 5.

Table 5. Paired Samples T-Test for Experimental Group Pre-Test and Post-Test Scores

Group	Pre-test		Post-test		t	df	Sig.	Effect size
	Mean	Std. Deviation	Mean	Std. Deviation				
Experi-mental	8.00	1.414	22.40	4.377	14.060	9	0.000	0.96

The paired samples t-test showed a significant improvement in the post-test scores (M = 22.40, SD = 4.38) compared to the pre-test scores (M = 8.00, SD = 1.41) with a t-value of 14.06 ($p < 0.001$). The effect size (Cohen's d = 0.96) indicates a significant effect of the mobile vocabulary app on vocabulary learning in the experimental group.

3.3.2 Independent Samples T-Test: Post-Test Scores

An independent sample T-test was conducted to compare the post-test scores between the experimental and control groups. The results are presented in Table 6.

Table 6. Independent Samples T-Test for Post-Test Scores

Group	Mean (SD)	t	df	Sig. (2-tailed)	Effect Size (Cohen's d)
Control	13.80 (2.04)	5.630	18	0.000	0.64
Experimental	22.40 (4.38)				

The results indicate that the experimental group scored significantly higher (M = 22.40, SD = 4.38) than the control group (M = 13.80, SD = 2.04), with a t-value of 5.63 ($p < 0.001$). The3.2effect size of 0.64 suggests a sizeable practical significance, confirming that the Kahoot app is an effective tool for vocabulary learning compared to traditional methods.

3.4 Two-Way ANOVA: Effects of Group and Learning Styles

A two-way ANOVA was conducted to examine the main and interaction effects of group (control vs. experimental) and learning styles on students' vocabulary post-test scores.

Table 7. Effects of group and learning style

Tests of Between-Subjects Effects						
Dependent Variable: pre-test						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	423.467a	7	60.495	4.644	0.010	0.730
Intercept	4398.466	1	4398.466	337.622	0.000	0.966
group	219.501	1	219.501	16.849	0.001	0.584
Learning Styles	21.661	3	7.220	0.554	0.655	0.122
group * Learning Styles	31.479	3	10.493	0.805	0.515	0.168
Error	156.333	12	13.028			
Total	7132.000	20				
Corrected Total	579.800	19				
a. R Squared =0 .730 (Adjusted R Squared = 0.573)						

As displayed in Table 7, the analysis revealed a significant main effect for the group, $F (1, 12) = 16.849$, $p = .001$, partial $\eta 2 = .584$. This indicates that the experimental group that used the

Kahoot mobile application demonstrated significantly higher vocabulary gains than the control group receiving only traditional instruction. However, the analysis did not yield significant main effects for learning styles, F (3, 12) = 0.554, p = .655, partial η2 = .122, or a significant group*learning styles interaction, F (3, 12) = 0.805, p = .515, partial η2 = .168. These findings suggest that students' visual, auditory, kinesthetic, or read/write learning style preferences did not differentially impact the effectiveness of the Kahoot-based vocabulary intervention. The mobile application's features appeared to benefit learners across diverse sensory modalities similarly.

3.5 Normality of Data Distribution

Before the primary statistical analyses, Kolmogorov-Smirnov and Shapiro-Wilk normality tests were conducted on pre-and post-test scores. As presented in Table 8, the significance values exceeded 0.05, indicating the data was normally distributed and appropriate for parametric analyses. This justifies the use of parametric tests for the analysis.

Table 8. Tests of Normality

Test	Group	Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistic	Df	Sig.	Statistic	df	Sig.
Pre-test	control	0.215	10	0.200*	.925	10	0.398
	experimental	0.200	10	0.200*	.924	10	0.391
Post-test	control	0.221	10	0.180	.910	10	0.282
	experimental	0.224	10	0.169	.933	10	0.480

3.6 Post-Hoc Analysis

A Bonferroni post-hoc test was conducted to investigate further the source of the significant difference between the experimental and control groups.

Table 9. A Bonferroni post-hoc analysis result

(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.b
control	experimental	-7.958-*	1.939	0.001
experimental	control	7.958*	1.939	0.001

As shown in Table 9, The mean difference of -7.96 between the groups (p = 0.001) confirmed that the experimental group showed significantly better vocabulary learning after the intervention than the control group.

3.7 Confidence Intervals (CIs)

Confidence intervals (CIs) were calculated for the mean differences between the experimental and control groups to provide a range for the proper population parameters. Table 10 provides

confidence intervals for mean differences between groups.

Table 10. Confidence Intervals for Mean Differences

Comparison	Mean Difference	95% CI Lower	95% CI Upper
Control vs. Experimental	7.96	5.34	10.58

As shown in Table 10, the mean difference for the post-test scores between the experimental and control groups was 7.96 (95% CI [5.34, 10.58]), indicating the mobile app's strong and meaningful effect on vocabulary learning and providing robust support for the findings.

3.8 Correlation Analysis

Pearson correlation analysis examined the relationships between learning styles and post-test vocabulary scores. The following Table 11 presents the results of the correlations between each learning style (visual, auditory, kinesthetic, read/write) and the vocabulary post-test scores.

Table 11. Pearson Correlations Between Learning Styles and Post-Test Vocabulary Scores

Correlations								
		Mean Visual Items	Mean Auditory Items	mean Kinesthetic Items	mean Read/Write Items	mean All Items	Learning Styles	Post-test
mean Visual Items	Pearson Correlation	1	-.447-	-.362-	-.499-	.662*	-.804-**	-.174-
	Sig. (2-tailed)		.195	.305	.142	.037	.005	.630
	N	10	10	10	10	10	10	10
mean Auditory Items	Pearson Correlation	-.447-	1	-.315-	-.189-	-.499-	-.114-	.029
	Sig. (2-tailed)	.195		.375	.601	.142	.754	.937
	N	10	10	10	10	10	10	10
mean Kinesthetic Items	Pearson Correlation	-.362-	-.315-	1	-.061-	.221	.428	.467
	Sig. (2-tailed)	.305	.375		.866	.540	.217	.174
	N	10	10	10	10	10	10	10
mean Read/Write Items	Pearson Correlation	-.499-	-.189-	-.061-	1	-.306-	.758*	-.322-
	Sig. (2-tailed)	.142	.601	.866		.391	.011	.364
	N	10	10	10	10	10	10	10
mean All Item	Pearson Correlation	.662*	-.499-	.221	-.306-	1	-.510-	-.074-

	Sig. (2-tailed)	.037	.142	.540	.391		.132	.839
	N	10	10	10	10	10	10	10
Learning Styles	Pearson Correlation	-.804 -**	-.114 -	.428	.758*	-.510 -	1	.152
	Sig. (2-tailed)	.005	.754	.217	.011	.132		.675
	N	10	10	10	10	10	10	10
Post test	Pearson Correlation	-.174 -	.029	.467	-.322 -	-.074 -	.152	1
	Sig. (2-tailed)	.630	.937	.174	.364	.839	.675	
	N	10	10	10	10	10	10	10
*. Correlation is significant at the 0.05 level (2-tailed).								
**. Correlation is significant at the 0.01 level (2-tailed).								
a. group = experimental								

The analysis revealed a significant positive correlation between read/write learning styles and performance on related vocabulary items ($r = 0.758$, $p = 0.011$) and a significant negative correlation between visual learning styles and performance on visual items ($r = -0.804$, $p = 0.005$). However, no significant correlation was found between overall learning styles and total post-test scores ($p > 0.05$), suggesting that while learning styles influenced performance on specific vocabulary items, they did not significantly impact overall vocabulary learning.

4. Discussion

4.1 Research Question 1: How do mobile apps (Kahoot application) impact vocabulary learning among Saudi ESL learners?

4.1.1 Interpretation of Findings

The experimental group, which used the Kahoot app, showed a significant improvement in vocabulary acquisition, as indicated by the marked differences in post-test scores compared to the control group. The significant effect sizes further demonstrate the strong impact of the mobile app on vocabulary learning.

The results of this study indicate that the Kahoot application significantly enhances vocabulary learning among Saudi ESL learners. The experimental group, which used Kahoot, demonstrated a substantial improvement in post-test vocabulary scores compared to the control group, with a large effect size (Cohen's $d = 0.96$). The mean post-test score for the experimental group was 22.40 ($SD = 4.38$), compared to 13.80 ($SD = 2.04$) for the control group. The t-test analysis confirmed the statistical significance of this difference ($t(18) = 5.63$, $p < 0.001$), showcasing the app's efficacy as a supplementary tool for vocabulary instruction.

These results suggest that Kahoot's gamified features, such as interactive quizzes, real-time feedback, and competitive elements, contribute to its success in engaging learners and enhancing their vocabulary retention. The competitive nature of Kahoot may have fostered intrinsic motivation and encouraged active participation, leading to improved learning outcomes.

4.1.2 Theoretical Connections

The findings align with dual coding theory (Paivio, 1986), emphasizing using verbal and visual representations to enhance memory retention. Kahoot incorporates visual aids such as colorful graphics and animations alongside verbal components like vocabulary questions and audio cues, enabling learners to encode information through dual channels. This multimodal approach likely facilitated deeper cognitive processing and improved recall of vocabulary items (Clark & Paivio, 1991). The results also support the Technology-Enhanced Language Learning (TELL) Framework, highlighting the importance of interactivity and learner engagement in technology-mediated learning environments (Kozma, 1994). Kahoot aligns with TELL principles of learner autonomy and engagement by integrating quizzes and activities that require active participation. Additionally, the app's immediate feedback and adaptive learning opportunities reflect TELL's emphasis on personalized and meaningful language learning experiences.

4.1.3 Comparison with Previous Studies

The findings of this study align with prior research highlighting the effectiveness of gamified learning tools like Kahoot in improving vocabulary and language learning outcomes. Iglesias et al. (2019) demonstrated that Kahoot significantly enhanced vocabulary test scores among Spanish high school students compared to traditional methods. This aligns closely with the current study's results, which show that the experimental group outperformed the control group in post-test vocabulary scores, further supporting Kahoot's utility in vocabulary instruction. Similarly, Burrows et al. (2020) reported that Kahoot-based quizzes improved performance in linguistics exams among Australian undergraduates, emphasizing the app's versatility across different educational contexts and learner levels.

Prior studies have highlighted the motivational benefits of gamification in the context of language learning. For example, Al-Furaih and Al-Awidi (2020) found that the interactive and competitive nature of Kahoot increased student engagement and motivation in Saudi higher education. This observation is consistent with the present study, where the gamified features of Kahoot, such as real-time feedback and leaderboards, likely contributed to the significant improvement in vocabulary scores.

Additionally, Alresheed et al. (2015) explored the role of mobile-assisted language learning (MALL) tools in Saudi classrooms, noting that students expressed positive attitudes toward the flexibility and autonomy offered by such applications. These findings align with the results of this study, where Kahoot's accessibility and ease of use supported students in engaging with vocabulary content outside traditional instructional boundaries. While many previous studies have focused on the motivational and engagement aspects of Kahoot (Plump & LaRosa, 2017; Wang, 2019), the present study adds to the literature by providing robust quantitative evidence of its direct impact on measurable learning outcomes. By focusing specifically on vocabulary acquisition among Saudi ESL learners, this research extends the applicability of gamified tools to second language learning in non-Western contexts, addressing a gap in existing studies.

Understanding how learning modalities amplify facets of schooling technology in accordance

with language learning rate provides knowledge on many prior pieces of research and can be carried out. Studies like those performed by Iglesias et al. (2019) and Burrows et al. (2020) have already investigated the effectiveness of Kahoot, particularly in the vocabulary acquisition area in various settings. The effectiveness of Supplementary Technology On-Demand Learning Tools, or STODLT, using Kahoot for vocabulary acquisition in different contexts emerged from the study, suggesting a whopping upsurge in the vocabulary score ($M = 22.40$, $SD = 4.38$). In Saudi Arabia, research further corroborated the acceptance of mobile learning tools by teachers and students as a massive jump in student performance due to the Kahoot tool, which has been widely evidenced.

Learning behaviors prompt a more intricate picture concerning educational technology. Nonetheless, the insistence of Alotaibi and Hail (2019) on a predilection of culture for visual instruction and the taking of the negative side of visual learners in the current study are interestingly placed in contrast to each other ($r = -0.804$, $p < 0.01$). This apparent conflict can be explained very well in line with the literature in the form of meta-analysis by Pashler et al. (2008), with some evidence that supports the lack of substantial benefits of matching style delivery in learning regarding what they found. This report casts doubt on the view of Brown et al. (2014), judging them against the backdrop that no significant differences can be tracked between the congruent and dissonant teaching methods. Overall, these conclusions seem to suggest that regardless of how effective technologies like Kahoot can be in supporting vocabulary acquisition, their relative efficacy will likely depend more on the overall pedagogical design and, therefore, be less likely on alignment with specific learning styles than usually thought.

4.2 Research Question 2: Does learning style moderate the effectiveness of the mobile app (Kahoot application) on vocabulary learning?

4.2.1 Interpretation of Findings

Although learning styles did not significantly moderate the effectiveness of the Kahoot app on vocabulary acquisition, specific learning styles (visual and read/write) correlated with performance on related vocabulary items, indicating that the app's diverse features may cater to multiple learning styles simultaneously. The findings of this study suggest that learning styles (visual, auditory, kinesthetic, read/write) influenced the effectiveness of the Kahoot application to varying degrees. However, they did not significantly moderate its overall impact on vocabulary acquisition. Correlation analysis revealed a positive association between the read/write learning style and post-test vocabulary scores ($r = 0.758$, $p < 0.05$) and a negative association for the visual learning style ($r = -0.804$, $p < 0.01$). These results indicate that students who preferred read/write learning modes benefited more from Kahoot's features, while visual learners experienced less pronounced gains.

The Kahoot application incorporates text-based questions, which may have supported read/write learners by aligning with their preference for engaging with written materials. Kahoot offers various text-based quizzes. Such kinds of quizzes may have attracted students with learning preferences, according to (Alresheed et al., 2015), because they like interaction with written materials. His study supports his premise that, Saudi students preferred text-based

interaction with mobile-assisted language learning devices, suggesting that one could satisfy them with such programs, particularly by using Kahoot. Kahoot has shown that the features of text-based interactivity in this application improved student engagement in Saudi higher education contexts (Al-Furaih & Al-Awidi, 2020). However, visually oriented learners might shun this learning app because it is heavy on text and focuses more on interactive, textual questions with prompt feedback instead of rich visual stimuli. The findings are congruent with Alotaibi and Hail's study from 2019, where they documented the literature highlighting that most of the Saudi students, they analyzed were still learning themselves and attributed a preference among the majority for very clearly visualized lessons. The present study corroborates this by substantiating the claim with quantitative evidence that the two variables are significantly negatively related ($r=-0.804$, $p<0.01$). It proves that those students preferring a visual learning style do less well on performance (test scores). Enhanced visual stimuli would be needed to infuse gamification into these tools, which would be most helpful to these students.

4.2.2. Theoretical Connections

The findings align with aspects of the VARK learning style model (Fleming, 2001), categorizing learners into four primary modalities: visual, auditory, kinesthetic, and read/write. Kahoot's design caters to read/write learners more effectively through its text-based features and timed responses. However, the negative correlation for visual learners may reflect a mismatch between Kahoot's features and their preferred reliance on non-verbal visual aids like images and charts. The Dual Coding Theory (Paivio, 1986) emphasizes integrating visual and verbal elements to enhance memory and learning. While Kahoot incorporates verbal and some visual elements (e.g., coloured buttons, animations), the dominance of textual content may not have fully engaged visual learners. This could explain why their performance was negatively correlated with post-test scores. The app may need richer visual stimuli to accommodate this learner group more effectively.

4.2.3 Comparison with Previous Studies

The findings of this study align with existing research on the relationship between learning styles and the effectiveness of technology-assisted vocabulary learning tools. Alresheed et al. (2015) highlighted the motivational benefits of mobile-assisted language learning (MALL), where Saudi learners valued the autonomy and flexibility of these tools. Similarly, this study found that Kahoot effectively engaged learners across various learning styles, particularly those with a read/write preference, who benefitted from its text-based quizzes and real-time feedback.

Studies such as Iglesias et al. (2019) and Burrows et al. (2020) demonstrated the positive impact of Kahoot on vocabulary retention in Western educational contexts, attributing its success to features like interactivity, gamification, and immediate feedback. The current study corroborates these findings, as evidenced by the significant gains in post-test scores for the experimental group. However, while prior studies primarily emphasized Kahoot's broad effectiveness, this study provides new insights into how learning styles, particularly visual learners, may affect outcomes. The negative correlation observed for visual learners ($r = -0.804$, $p < 0.01$) suggests that Kahoot's limited use of rich visual aids may have reduced its effectiveness for this group.

This divergence in findings could also be attributed to contextual differences. For instance, Al-Furaih and Al-Awidi (2020) found that Saudi students are often motivated by competitive elements in gamified tools, which is consistent with this study's observations of improved engagement in Kahoot's interactive environment. However, cultural preferences for explicit visual instruction in the Saudi context, as suggested by Alotaibi and Hail (2019), may explain the challenges visual learners face in fully leveraging Kahoot's potential.

While learning styles did not significantly moderate Kahoot's overall effectiveness, this study aligns with Alotaibi and Hail's (2019) conclusion that learning styles alone may not predict success in vocabulary acquisition. Instead, the intrinsic features of gamified tools, such as interactivity and engagement, likely play a more substantial role in driving learning gains.

This study contributes to the literature by offering quantitative evidence of Kahoot's effectiveness in a Saudi ESL context and expanding on the specific role of learning styles. The findings suggest that while gamified tools like Kahoot are broadly effective, future designs should consider richer visual elements to support learners with visual preferences better. This highlights the need for adaptive and versatile tools that cater to diverse learner needs across various cultural and educational contexts.

4.3 Limitations of the Study

Several limitations were identified to have influenced the study results. The first limitation that might constrain the findings' ability for generalizability concerns the tiny sample size and its nature, that is, females only. Little may also be said of the actual long-term effects of Kahoot on vocabulary retention after a brief eight-week intervention. Another area for possible bias or inaccuracy in identifying the actual preference of the learner is that self-reporting may not provide accurate information regarding learning styles, as scored by VARK. Technologies may have limited access to devices plus stable internet access, which makes the experimental group's experience different from the performance. This limitation signals that future research might attend to a more thorough understanding of the impact of Kahoot across the diversified space of contexts and learner groups

4.4 Pedagogical Implications and Recommendations for Practice

The findings of this study emphasize the effective integration of mobile-assisted learning tools like Kahoot in ESL classrooms, highlighting several key pedagogical implications and practical recommendations for educators. First, the significant improvements in vocabulary scores among the experimental group suggest that gamified tools can enhance student engagement and motivation. Teachers are encouraged to use Kahoot for formative assessments and review activities, leveraging its interactive features to create enjoyable learning experiences. Additionally, the study underscores the importance of catering to diverse learning styles; educators should customize quizzes to include visual elements for visual learners, audio cues for auditory learners, and active participation for kinesthetic learners.

4.5 Recommendations for Further Research

The study discovers and clarifies several areas that require more analyses. Future research

should include longitudinal studies to examine the long-term effects of Kahoot on vocabulary retention and other key language skills, such as grammar, reading, and listening. Additionally, expanding the study to a more diverse group of participants—varying in proficiency levels, genders, and ethnic backgrounds—would enhance the generalizability of the findings.

Further recommendations include improving Kahoot's adaptability for visual learners by developing and testing enhanced visual features. Moreover, future research could compare Kahoot's effectiveness with other mobile-assisted learning tools in promoting vocabulary acquisition. Lastly, studies could explore strategic ways to integrate Kahoot into blended learning environments that combine traditional and technology-enhanced instructional methods for optimal learning outcomes

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Appendix A

Learning Styles Questionnaire

Please indicate your preference for each of the following items using this scale:

1 = Strongly Disagree
2 = Disagree
3 = Neutral
4 = Agree
5 = Strongly Agree

NO.	Item	1	2	3	4	5
1.	I prefer images like diagrams, charts, maps to understand information.					
2.	In my mind, Visualizing helps me making sense of new ideas.					
3.	I often picture information in my mind to remember it.					
5.	Listening to audio recordings helps me to learn.					
6.	I learn better in lectures where I can hear information.					
7.	I prefer learning that involves practical exercises and hands-on experience.					
8.	Physical demonstrations help explaining concepts to me.					
9.	Opportunities to practice speaking explanations builds my learning.					
10.	I prefer print materials like books and written notes to					

	learn.					
11.	Taking notes helps to reinforce my learning.					
12.	Summarizing information helps me to remember.					
13.	Marking and highlighting texts aids my understanding of core ideas.					

14. Please indicate your strongest learning preference:

____ Visual ____ Auditory ____ Kinesthetic ____Read/Write

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The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.