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Using Lexilize digital flashcards to enhance academic vocabulary learning among Iranian EFL university students

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This study investigated the impact of mobile-assisted language learning (MALL) on Iranian university students' acquisition of academic vocabulary beyond classroom instruction. Forty-eight undergraduates participated, with 28 assigned to an experimental group and 20 to a control group. Over one academic semester, both groups received identical classroom instruction, but differed in their out-of-class learning approaches: the experimental group used Lexilize Digital Flashcards, whereas the control group used paper-based flashcards. Vocabulary proficiency was measured through three standardized tests assessing general, academic, and associative word knowledge, administered before and after the intervention. Reflective journals and semi-structured interviews complemented the quantitative data. Results from multivariate analyses revealed significant gains in both groups, with the experimental group showing superior improvement in vocabulary breadth and depth. Qualitative findings indicated that participants perceived mobile-assisted learning as flexible, engaging, and effective for systematic vocabulary expansion, though some expressed concerns about screen distraction and device limitations. Overall, the findings highlight the pedagogical value of integrating digital flashcards into out-of-class study routines to strengthen academic vocabulary learning in English for Academic Purposes (EAP) programs. Mobile-assisted tools can provide a scalable complement to traditional instruction, particularly in resource-limited or self-directed learning contexts.

Keywords: academic vocabulary, mobile-assisted language learning, digital flashcards, EFL learners, vocabulary learning

Introduction

Vocabulary learning is widely recognized as a cornerstone of second language (L2) proficiency, underpinning learners' abilities in both receptive and productive skills (Nation, 2022). A robust lexical repertoire is essential for academic communication, reading comprehension, and the development of disciplinary literacy (Clenton & Booth, 2020; Dodigovic & Agustín-Llach, 2020). Despite its central role, vocabulary instruction in English as a Foreign Language (EFL) contexts often receives limited attention due to constrained classroom time and curricular overload (Li & Hafner, 2022; Webb & Nation, 2017). Consequently, many EFL learners struggle to acquire a sufficient range of high-utility vocabulary items necessary for academic success (Rahmani et al., 2022; Webb & Chang, 2012; Zakian et al., 2022). Addressing this persistent gap, particularly in academic vocabulary acquisition, remains an urgent priority for language educators and researchers. In vocabulary research, it is important to distinguish between what learners know about words and how they come to know them. Vocabulary knowledge involves the breadth and depth of lexical mastery; the number of words known and the quality of that knowledge across form, meaning, and use (Nation, 2013; Read, 2019). Vocabulary learning, by contrast, concerns the cognitive and pedagogical conditions that promote such knowledge, including exposure, retrieval, and task engagement (Laufer & Hulstijn, 2001; Webb & Nation, 2017). Clarifying this distinction provides a more precise basis for examining how mobile-assisted environments support the development of academic vocabulary among EFL learners.

A widely adopted framework for categorizing English vocabulary distinguishes four types: general service (high-frequency), academic, technical, and low-frequency words (Coxhead & Nation, 2001; Nation, 2001, 2013). Academic vocabulary, positioned between high-frequency and discipline-specific terms, enables learners to express abstract ideas and engage with scholarly texts across fields (Coxhead, 2000; Evans & Morrison, 2011). Although it constitutes only about 10 percent of the words in academic writing, academic vocabulary presents a significant challenge to both native and non-native speakers due to its abstraction and cross-disciplinary nature (Coxhead, 2019; Green & Lambert, 2018). For EFL university students, particularly those preparing for high-stakes academic tasks in English-medium contexts, developing academic vocabulary is not only foundational to academic reading and writing but also integral to constructing a scholarly identity (Hyland, 2022).

In recent years, the integration of digital tools into vocabulary instruction has attracted growing interest, with meta-analyses confirming their potential to improve learning outcomes (Burston & Giannakou, 2021; Hao et al., 2021; Lin & Lin, 2019; Mahdi, 2017; Yu & Trainin, 2022). Of particular relevance is the rise of mobile-assisted language learning (MALL), which leverages smartphones and mobile applications to support language development outside the classroom (Stockwell, 2022). While numerous studies have examined digital tools for vocabulary learning broadly, fewer have focused specifically on how MALL can support academic vocabulary development (Jiang & Liou, 2022; Yüksel et al., 2022). Furthermore, existing research tends to prioritize vocabulary

breadth over depth and often lacks methodological rigor, such as standardized assessments or qualitative inquiry into learner experiences. To address these limitations, the present study explores the impact of a mobile-assisted vocabulary learning intervention on Iranian EFL university students' learning of academic vocabulary from the Academic Word List (AWL) (Coxhead, 2000). The intervention was intentionally designed rather than incidental, as students were guided to engage purposefully with mobile flashcards outside classroom time. The study therefore investigates how structured mobile-assisted practice, supported by brief instructor guidance, facilitates academic vocabulary learning beyond formal instruction. The focus on Iranian learners reflects both the widespread use of mobile devices among university students in the region and the acute academic demands they face in English for Academic Purposes (EAP) programs (Iranmehr et al., 2018; Tavakoli & Tavakol, 2018). Building on prior research, this study integrates both quantitative and qualitative approaches to examine how digital flashcards support vocabulary breadth and depth, and how learners engage with mobile tools in self-directed learning settings. The findings aim to inform language teachers and curriculum designers seeking to integrate scalable mobile technologies into academic English instruction and to advance understanding of mobile-assisted vocabulary learning in EFL contexts.

Literature review

Theoretical frameworks of vocabulary learning

The Involvement Load Hypothesis (ILH) serves as the theoretical foundation of this study. ILH conceptualizes vocabulary learning as a function of cognitive involvement, defined by three components: need, search, and evaluation. *Need* is a motivational element created by a task requirement; *search* involves the effort to find word meaning or form; and *evaluation* requires learners to decide how a word fits into a specific context. Tasks that demand more of these components impose a higher “involvement load” and are believed to produce stronger vocabulary retention (Laufer & Hulstijn, 2001). This framework has been empirically validated in second language learning contexts, with findings suggesting that tasks eliciting greater involvement result in more robust learning gains (Boers et al., 2017; Hulstijn & Laufer, 2021).

In mobile-assisted learning environments, ILH has particular relevance. Flashcard applications often engage learners in moderate involvement load tasks. These tools typically provide a sense of *need* (e.g., for test preparation), trigger *search* when learners recall meanings, and activate *evaluation* through feedback and repeated exposure. Digital platforms enhance these processes by incorporating spaced repetition and sample sentences, both of which promote efficient retrieval and long-term retention (Lei & Reynolds, 2022; Nakata, 2019). However, because flashcards focus heavily on form-meaning connections, they may better support vocabulary breadth than depth. Vocabulary depth requires richer semantic processing and higher cognitive effort, which is often more fully activated through tasks such as sentence creation or contextualized usage

(Liu & Reynolds, 2022; Webb et al., 2020). Recent research continues to affirm the predictive value of ILH in technology-enhanced vocabulary learning. Tasks designed with high involvement features such as active decision-making or contextual application tend to lead to greater vocabulary retention (Reynolds et al., 2020). In the present study, the digital flashcard application aligned with ILH principles by promoting repeated exposure, goal-directed learning, and metacognitive reflection. These features provide a plausible theoretical explanation for the experimental group's superior performance in both vocabulary breadth and depth.

The development of lexical competence in Second Language Acquisition (SLA) is a gradual and long-term process that involves both incidental and intentional learning mechanisms (Nation, 2013; Webb & Nation, 2017). Incidental learning occurs when learners acquire vocabulary indirectly through exposure to large amounts of comprehensible input and meaningful communicative interactions, where the emphasis is placed on conveying messages rather than on linguistic forms. Although this type of learning requires extensive and carefully adjusted input over an extended period, the vocabulary knowledge gained is typically robust and of high utility for learners (VanPatten & Smith, 2022). However, in many EFL contexts, the conditions necessary for effective incidental learning, particularly in terms of the quantity and quality of linguistic exposure, are often difficult to establish. As a result, vocabulary acquisition in such settings tends to rely more heavily on intentional learning, wherein learners deliberately focus on word acquisition through textbooks, flashcards, classroom activities, and teacher input, among other explicit instructional methods (Webb & Nation, 2017; Webb et al., 2020). Moreover, regardless of the mode of acquisition, vocabulary knowledge is inherently complex and encompasses multiple dimensions. These include the formal properties of words (both written and spoken forms), their meanings (i.e., the association between form and meaning), and their usage (such as grammatical behavior and collocational patterns), all of which influence both receptive and productive aspects of vocabulary acquisition (Nation, 2019). These theoretical insights also underpin the design of mobile-assisted vocabulary tasks, where the principles of cognitive involvement and retrieval practice are realized through digital flashcard technologies. This connection is further explored within the "Mobile-Assisted Vocabulary Instruction" section.

Vocabulary knowledge assessment

A fundamental distinction in L2 vocabulary assessment is the differentiation between breadth and depth of word knowledge (Nation, 2022). Vocabulary breadth refers to the number of words that a learner or language user recognizes or understands to some degree (Read, 2019). The critical role of vocabulary knowledge in reading comprehension has long been acknowledged in first language (L1) reading research, prompting extensive efforts to estimate the vocabulary size of native speakers across various age groups (Nation & Coxhead, 2021). In L2 research, the Vocabulary Levels Test (VLT), originally

developed by Nation (1983), became one of the first widely adopted instruments for assessing vocabulary breadth. Designed primarily as a diagnostic tool for teachers, the VLT measured learners' knowledge of words across different frequency bands, offering insight into vocabulary proficiency at varying levels of language learning. Building on this foundation, Beglar (2009) introduced the Vocabulary Size Test (VST), which improved upon earlier assessments by covering a wider range of word frequencies and incorporating a multiple-choice format, making it applicable to both L2 learners and native speakers. More recent developments include the New Vocabulary Levels Test (NVLT; McLean & Kramer, 2015) and the Updated Vocabulary Levels Test (UVLT; Webb et al., 2017), which assess knowledge of the 5,000 most frequent word families in English (Nation, 2012) as well as academic vocabulary (Coxhead, 2000).

Beyond vocabulary breadth, the notion of depth is crucial in understanding the richness and complexity of an individual's vocabulary knowledge. Nation (2013, 2022) provides a detailed framework for conceptualizing the different aspects of word knowledge. The first dimension pertains to word form, which includes spelling, pronunciation, and morphological structure. The second focuses on meaning, encompassing core definitions, semantic range, and associations with other lexical items. The final dimension concerns word use, which involves grammatical patterns, collocational tendencies, and contextually appropriate applications. Recognizing that vocabulary acquisition extends beyond simple form-meaning associations, researchers have developed a variety of approaches to assess vocabulary depth (Read, 2004). One such approach involves measuring learners' levels of understanding and confidence in the meanings of target words, as seen in instruments like the Vocabulary Knowledge Scale (VKS; Wesche & Paribakht, 1996). Another method investigates the mental connections between words in a learner's lexicon through word association tasks (Milton, 2009; Nation, 2022; Read, 2019). Additional research into multiple word meanings (Verhallen & Schoonen, 1993), morphological derivations and word components (Schmitt & Zimmerman, 2002), and collocational knowledge (Gyllstad, 2009) has further contributed to a more comprehensive understanding of vocabulary depth.

Mobile-assisted vocabulary instruction

Given the inherently multidimensional nature of vocabulary knowledge/acquisition, facilitating the learning of lexical competence among EFL learners remains a central concern in language education. From an ILH perspective, mobile applications such as digital flashcards operationalize need through goal-oriented tasks, search through active retrieval, and evaluation through self-checking and contextual review. Such design features explain why mobile-assisted tasks often lead to sustained vocabulary retention. Consequently, a substantial body of research has examined the affordances of digital technologies in supporting and scaffolding vocabulary learning (Burston & Giannakou, 2021; Hao et al., 2021; Hayati et al., 2013; Li & Hafner, 2022; Lin & Lin, 2019; Mahdi, 2017; Yang et al., 2021). Empirical findings generally suggest that

technology-assisted vocabulary learning yields superior learning outcomes compared to traditional instructional conditions that rely solely on print-based materials or lack technological integration (Yu & Trainin, 2022). Furthermore, studies on digital technology integration in vocabulary instruction have reported a range of positive effects, including heightened learner engagement, enhanced peer collaboration (Yang et al., 2021), and increased motivation and enjoyment in the learning process (Hao et al., 2021). As mobile devices, particularly smartphones, continue to gain widespread popularity and expand their functionalities, they offer increasing pedagogical potential for vocabulary learning, leading to a growing scholarly interest in mobile-assisted vocabulary learning (Burston & Giannakou, 2021; Lin & Lin, 2019). MALL is an instructional approach that capitalizes on the portability, connectivity, and multifunctionality of mobile technologies, such as smartphones and tablets, to support and enhance language acquisition (Stockwell, 2022). By leveraging these affordances, MALL enables the flexible delivery of educational content, promotes learner interaction and collaboration, and offers dynamic, interactive learning experiences (Burston & Giannakou, 2021; Chwo et al., 2018; Yang et al., 2021).

Mobile devices are particularly well-suited for vocabulary learning, as they allow learners to transcend the physical constraints of the classroom and engage in self-directed vocabulary learning at their convenience, irrespective of time or location (Hao et al., 2021; Lin & Lin, 2019). However, despite the promise of mobile-assisted vocabulary learning, findings regarding its overall effectiveness remain inconclusive. A recent systematic review highlighted mixed results, with some studies demonstrating significant learning gains while others found that traditional instructional methods outperformed mobile-assisted learning environments (Basöz & Can, 2021; Derakhshan & Kaivanpanah, 2011; Lin & Lin, 2019).

Although most research in this domain has focused on higher education contexts, particularly adult learners (Mahdi, 2017), fewer studies have explicitly examined the application of mobile technologies for academic and technical vocabulary learning (Jiang & Liou, 2022; Rafiq et al., 2021; Yüksel et al., 2022). Given the central role of academic and technical vocabulary in university students' academic success (Coxhead, 2019), further empirical research is needed to explore the potential benefits of mobile devices for facilitating the learning of these specialized lexical categories (Kohnke et al., 2020). Notably, recent findings suggest that mobile-assisted vocabulary instruction can be particularly effective for technical vocabulary learning. For instance, a study on undergraduate pharmacy students reported significant vocabulary gains and positive learner attitudes toward mobile-based learning tools (Yüksel et al., 2022). Similarly, in a Hong Kong higher education context, researchers evaluated the effectiveness of a locally developed mobile application for discipline-specific vocabulary learning, concluding that students benefited from mobile-assisted instruction (Kohnke et al., 2020). These findings collectively highlight the pedagogical potential of mobile technologies in supporting the learning of technical and domain-specific vocabulary (Rafiq et al., 2021).

The role of mobile-assisted learning in academic vocabulary development

has been explored across diverse educational contexts (Ashcroft et al., 2018; Dizon, 2016; Jiang & Liou, 2022). In one of the earliest studies on this topic, Dizon (2016) examined the effectiveness of a widely used online study tool for academic vocabulary learning among Japanese university EFL students. The results revealed substantial improvements in vocabulary knowledge from pre-test to post-test, and participants perceived the mobile application as both user-friendly and beneficial, expressing a willingness to continue using it for independent learning. Similarly, Ashcroft et al. (2018) investigated the comparative effectiveness of digital flashcards versus traditional paper-based flashcards in academic vocabulary learning among Japanese university students of varying English proficiency levels. Their findings indicated that while higher-proficiency students performed equally well with both modalities, lower-proficiency learners exhibited greater gains when utilizing digital flashcards. A similar study conducted in Iran which compared mobile-assisted vocabulary learning with digital flashcards and traditional paper-based materials among university students (Xodabande, Pourhassan, et al., 2022). The results of this study demonstrated that the mobile-assisted approach yielded significant improvements in both immediate post-treatment assessments and delayed post-tests, providing empirical evidence for the long-term efficacy of digital vocabulary instruction. More recently, Jiang and Liou (2022) examined the impact of mobile-assisted learning on academic vocabulary learning in writing tasks. Their findings indicated that mobile-based interventions scaffolded students' vocabulary learning, leading to increased academic vocabulary use in written compositions and overall improvements in writing quality.

Although this growing body of research underscores the potential benefits of mobile-assisted learning for academic vocabulary learning, the limited number of studies in this area makes it difficult to establish a comprehensive understanding of learning outcomes, as well as potential challenges and limitations. Further empirical investigations are necessary to provide a more nuanced account of how mobile-assisted vocabulary learning can be optimized, ensuring that both the advantages and constraints of this instructional approach are adequately addressed.

Research gaps

Despite the increasing scholarly interest in mobile-assisted learning for addressing the linguistic needs of EFL learners (Lin & Lin, 2019), several critical research gaps remain, necessitating further empirical investigation. First, while a limited number of longitudinal studies have been conducted, the majority of existing research on mobile-assisted vocabulary learning has been criticized for its reliance on short-term interventions (Chwo et al., 2018). The brevity of these studies has contributed to an incomplete understanding of the long-term learning outcomes associated with mobile-based vocabulary instruction (Lin & Lin, 2019). Second, a significant proportion of studies in this field have been conducted without the inclusion of a control group, and many have employed non-standardized vocabulary assessment instruments (Lin &

Lin, 2019; Xodabande, Pourhassan, et al., 2022). The inconsistent application of validated vocabulary assessment tools limits the generalizability of findings and underscores the need for greater methodological rigor in future research.

A third limitation concerns the predominant focus on vocabulary breadth, which measures learners' ability to establish form-meaning connections (i.e., receptive knowledge), while largely overlooking the depth of lexical learning and productive vocabulary use (Li & Hafner, 2022). Given that vocabulary knowledge encompasses multiple dimensions including collocational knowledge, grammatical integration, and lexical associations, further research is warranted to explore these qualitative aspects of vocabulary learning. Finally, as MALL continues to gain traction, there is an increasing need for studies that incorporate qualitative methodologies to examine learners' perceptions and experiences with mobile-based vocabulary instruction. While quantitative assessments provide valuable insights into learning outcomes, qualitative data can offer a deeper understanding of the cognitive and affective dimensions of mobile-assisted vocabulary learning.

The present study

This study was conducted in an Iranian EFL university context where academic vocabulary knowledge is essential for students' academic achievement and standardized test preparation. Despite widespread use of mobile technologies among university learners in Iran, empirical research on mobile-assisted academic vocabulary learning in this setting remains scarce and often limited to surface-level evaluations of vocabulary breadth. Furthermore, few studies have examined both receptive and productive aspects of word knowledge using validated measures that assess lexical depth. By combining a quasi-experimental design with qualitative exploration of learner experiences, this study provides a more comprehensive account of the effects and perceptions of mobile-assisted vocabulary instruction. Unlike previous research, which has tended to focus on short-term interventions, single dimensions of vocabulary knowledge, or self-report data alone, the present study integrates experimental data with learner reflections to offer a multidimensional understanding of vocabulary development through mobile learning. This study aims to address these research gaps by adopting a mixed-methods research design, integrating both quantitative and qualitative approaches (Creswell & Clark, 2017; Hashemi & Babaii, 2013). Specifically, the study investigates the role of smartphones in facilitating academic vocabulary learning among EFL university students. The research is guided by the following questions:

1. To what extent does mobile-assisted learning enhance different dimensions of academic vocabulary knowledge: lexical breadth (size) and lexical depth (quality)?
2. How do university students perceive the use of mobile devices for academic vocabulary learning?

Research design

This study employed an explanatory sequential mixed-methods design (Creswell & Clark, 2017), in which quantitative data collection and analysis were conducted in the first phase, followed by qualitative data collection and analysis to help explain and contextualize the quantitative results. Although the design followed a sequential structure, the interpretation stage adopted a convergent orientation, integrating both quantitative and qualitative findings to build a comprehensive explanation of how mobile-assisted learning influenced academic vocabulary development. The initial phase used a quasi-experimental approach to compare the effects of mobile-assisted vocabulary learning on lexical breadth and depth. The second phase involved the collection of qualitative data through reflective journals and semi-structured interviews, aiming to explore learners' experiences, emotional responses, and engagement with mobile learning tools. This design enabled a more comprehensive understanding of the instructional intervention by integrating measurable learning outcomes with participants' subjective perspectives.

Participants

The study sample consisted of 48 Iranian EFL university students (17 male, 31 female), with a mean age of 22 years. Participants were selected based on their availability within the research context, and practical considerations such as resource constraints and time limitations determined the sample size. No financial incentives were provided for participation. All participants were fully informed about the study's objectives, expectations, and vocabulary learning requirements before providing their informed consent. Additionally, strict confidentiality measures were implemented to protect their personal data throughout the research process. Participants' language proficiency was assessed using scores from the listening and reading sections of the International English Language Testing System (IELTS). The majority of them were classified as pre-intermediate (Council of Europe, 2001). Additionally, a diagnostic vocabulary knowledge test (McLean & Kramer, 2015) was administered to assess participants' lexical competence. The results confirmed that the sample was homogeneous in terms of receptive knowledge of general and academic vocabulary in English. Following the procedure outlined by Li and Hafner (2022), participants were assigned to either the experimental group ($n = 28$) or the control group ($n = 20$), based on their individual preferences regarding the learning materials used. This study adhered to ethical guidelines for research involving human subjects in educational settings. All participants provided informed consent, and they were given comprehensive details regarding the study's aims, methodology, and confidentiality measures. Participants retained the right to withdraw from the study at any stage without penalty.

The Academic Word List (AWL; Coxhead, 2000) was used as the primary lexical source for the selection of academic vocabulary. Given its strong empirical foundation and widespread use in EAP contexts, the AWL was appropriate for evaluating university learners’ knowledge of academic words. To enhance vocabulary learning beyond formal classroom instruction, two distinct types of learning materials based on the AWL were employed in this study. Specifically, vocabulary learning resources consisted of digital and paper-based flashcards that were systematically designed to target academic words. Both versions of the flashcards featured essential lexical information for each target word, including a simplified English definition, an equivalent translation in the learners’ first language (L1), and two example sentences demonstrating contextual usage (see Table 1).

Table 1. Sample information included in paper-based or digital flashcards

Side A	Side B
Assess (verb) /ə'ses/	Definition: To evaluate or analyze something systematically and make judgments Translation (Persian): ارزیابی کردن: بررسی کردن سیستماتیک و قضاوت کردن Sample Sentences: 1. The teacher will assess the students’ understanding of the material through a written exam. 2. It is important to assess the potential risks and benefits before implementing a new policy.
Concept (noun) /konsept/	Definition: An abstract or general idea representing the fundamental characteristics of something Translation: مفهوم: یک ایده یا مفهوم عمومی که ویژگی‌های اساسی یک چیز را نشان می دهد Sample Sentences: 1. The concept of sustainability is central to discussions on environmental protection. 2. The students struggled to grasp the concept of relativity in physics class.

With regard to the selection of the digital flashcard application, Lexilize Flashcards (Lexilize Flashcards, n.d.) was designated as the primary tool for the experimental group. Several key considerations informed this decision. Firstly, Lexilize Flashcards is freely accessible for Android smartphone users, ensuring broad availability and facilitating ease of access for participants. Secondly, the application features an intuitive user interface and straightforward functionalities, making it an appropriate choice for learners with varying levels of technological proficiency. Additionally, Lexilize Flashcards provides customization options, allowing for the integration of specific features necessary for this study, including word definitions, translations, and contextualized sample sentences. The selection of Lexilize Flashcards over alternative digital applications was primarily based on its alignment with the study’s objectives and the presence of essential functionalities that met the specific requirements of the research. In contrast, participants in the control group utilized traditional paper-based flashcards as a conventional method for vocabulary learning. While digital flashcards offer certain pedagogical advantages such as portability, interactive

features, and enhanced learner engagement, the incorporation of a paper-based alternative enabled a direct comparison between different vocabulary learning modalities. This comparative approach was essential for assessing the relative effectiveness of the digital flashcard application.

To evaluate various dimensions of participants' vocabulary knowledge and to enhance the reliability of findings through triangulation, multiple vocabulary assessments were administered. First, a standardized and validated vocabulary test (McLean & Kramer, 2015) was employed as a benchmark measure to assess participants' lexical proficiency in both general and academic vocabulary. This test consists of six sections and comprises a total of 150 multiple-choice items. The first five sections assess knowledge of the 5,000 most frequently occurring words in English (Nation, 2012), with each 1,000-word frequency level represented by 24 test items. The final section consists of 30 items specifically designed to evaluate participants' receptive knowledge of the Academic Word List (AWL). This structure aligns with the participants' proficiency levels as determined by their IELTS reading and listening scores.

In addition to this general vocabulary measure, two specialized tests developed specifically for assessing AWL knowledge were utilized (Flavell & Nation, n.d.; Read, n.d.). The first of these tests, available in two distinct versions (A and B), consists of 57 multiple-matching question types (see Figure 1). This test serves as an indicator of vocabulary size (breadth) by measuring the number of academic words known by the test taker. Each test item requires participants to match a set of academic words with corresponding short definitions. The total academic vocabulary size of a participant is estimated by multiplying the number of correct responses by 10, as each item represents knowledge of 10 academic words. Given that the AWL consists of 570 words, this scoring method provides an effective means of estimating a test taker's lexical breadth in academic vocabulary.

1. environment		
2. principle	_____	the close study of something
3. response	_____	money received
4. assumption	_____	the surrounding conditions and influences
5. analysis		
6. income		

Figure 1 . A sample item representing the multiple matching test format

In addition to the academic vocabulary size test, the study also employed a 50-item word association test (Read, n.d., 2000, 2019) to assess the depth (or quality) of academic vocabulary knowledge (Milton, 2009). As represented in Figure 2, each item in this test required the participants to select three out of six words that are closely related to a given target academic word. The test is different from the VST described above, as it taps into other aspects of vocabulary knowledge, such as related words, collocations, and different meanings.

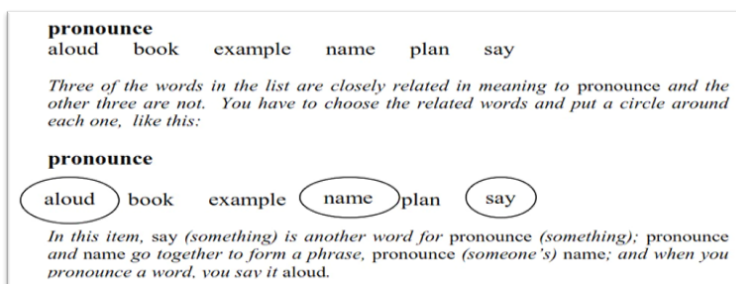


Figure 2. A sample item representing a word association test (Read, n.d.)

Procedures

Data collection began with the administration of the New Vocabulary Levels Test (NVLT) (McLean & Kramer, 2015) to all the participants. This was followed by assessments designed to evaluate both the breadth and depth of academic vocabulary knowledge, using tests specifically developed for the Academic Word List (AWL) (Flavell & Nation, n.d.; Read, n.d.). Upon completion of the pre-tests, participants were assigned to either the experimental or control condition. Both groups attended two online training sessions (each lasting 45 minutes) aimed at familiarizing them with flashcards as a vocabulary learning strategy (Nakata, 2019; Webb & Nation, 2017). The training provided explicit instruction on optimizing the use of flashcards, emphasizing techniques for systematic retrieval and reinforcement of lexical knowledge. Participants were guided on efficient engagement with word cards, focusing on structured exposure to the form and meaning of academic vocabulary items. Additionally, the experimental group received detailed step-by-step instructions on installing and utilizing the Lexilize Flashcards application, ensuring they could effectively navigate the digital learning environment. The mobile-assisted learning process was intentional rather than incidental. Students were explicitly guided to engage in purposeful study of the target academic words for approximately 15 minutes per day using the digital flashcards outside regular class time. The course instructor delivered an initial orientation session and brief weekly follow-ups to monitor progress and sustain engagement, while learners independently selected study pace and review cycles according to their individual needs.

Over the course of the 12-week academic semester, all participants attended regular classroom-based instruction, which was embedded within an English for Specific Purposes (ESP) framework and focused on reading discipline-specific texts. The classroom component of the instruction was situated within an ESP framework, focusing on discipline-specific academic texts relevant to the students' fields of study. This integration ensured that the academic vocabulary targeted through flashcards corresponded to the types of lexical items encountered in real academic reading tasks. However, while the experimental group engaged with digital flashcards, the control group used traditional paper-based flashcards for academic vocabulary learning outside the classroom.

In the final week of the semester, participants completed the post-tests, which included:

- The NVLT (McLean & Kramer, 2015)
- The academic vocabulary breadth test (Flavell & Nation, n.d.)
- The academic vocabulary depth test (i.e., word association test) (Read, n.d.)

To gain deeper insights into students' experiences, qualitative data were collected through reflective journals and semi-structured interviews. These two complementary sources of qualitative evidence enabled triangulation between participants' ongoing reflections during the intervention and their retrospective evaluations at its completion, ensuring that the qualitative findings captured both process-oriented and outcome-oriented dimensions of learner experience. Participants in the experimental group maintained reflective journals throughout the intervention (Ahmed, 2019; Alt et al., 2022; Denton, 2017), submitting one entry per week (approximately 200 words) based on predefined guidelines. Participants were asked to:

1. Indicate where they used mobile devices and digital flashcards for vocabulary learning.
2. Reflect on their learning experiences, including emotions, engagement levels, and overall satisfaction.
3. Discuss challenges and perceived affordances associated with mobile-assisted vocabulary learning.

At the end of the semester, semi-structured interviews were conducted with participants in the experimental group. The interview protocol was informed by recurring themes identified in the reflective journals, as well as insights from prior research on learners' perceptions of MALL (Dashtestani & Hojatpanah, 2021; Morgana & Shrestha, 2018). Each interview lasted approximately 30 minutes and was conducted in the participants' first language (L1) to ensure clarity and depth of responses. Translation into Persian was limited to interview questions, journal prompts, and procedural instructions to facilitate full comprehension and reduce participant anxiety. This practice is consistent with standard approaches in EFL research in non-English-speaking contexts, where using the L1 in qualitative elicitation enhances the quality of responses without affecting the validity of language learning outcomes (Hashemi & Babaii, 2013). All qualitative data were subsequently translated into English and cross-verified to ensure conceptual accuracy and consistency with the original responses.

Data analysis

Quantitative data from the vocabulary assessments were analyzed using IBM SPSS (Version 25). Descriptive and inferential statistical analyses were performed, with mean scores and standard deviations calculated for pre-test and post-test results. To assess whether the experimental and control groups differed significantly in their vocabulary performance, multivariate analysis of

variance (MANOVA) was employed. This method was appropriate given the presence of multiple dependent variables that were conceptually and statistically related: general vocabulary knowledge (NVLT 5K), academic vocabulary knowledge (NVLT AWL), AWL size test scores, and AWL word association test scores. MANOVA was used to examine the overall multivariate effect of group membership across these four vocabulary measures while controlling for Type I error inflation associated with multiple univariate tests.

For qualitative analysis, data from reflective journals and semi-structured interviews were examined using NVivo software. A thematic analysis approach was adopted, incorporating both deductive and inductive coding techniques (Braun & Clarke, 2006; Fereday & Muir-Cochrane, 2006). More specifically, NVivo software was used to organize, store, and retrieve coded data segments. Thematic analysis was conducted using a two-cycle coding process. In the first cycle, a set of deductive codes drawn from relevant literature was applied. In the second cycle, inductive codes were generated to identify emergent patterns. Coding decisions were iteratively refined, and peer debriefing was conducted to enhance analytical validity. Themes were finalized through cross-case analysis and verified against raw data to ensure conceptual alignment. The analytical process followed an iterative cycle of coding and recoding (Saldana, 2013):

- First Cycle Analysis (Deductive Coding): Predefined codes such as attitudes, learning experiences, and challenges were applied to systematically classify relevant segments in journal entries and interview transcripts. This ensured a structured and comprehensive categorization of participants' responses (Xu & Zammit, 2020).
- Second Cycle Analysis (Inductive Coding): Emerging themes were identified without predetermined categories, allowing for data-driven insights into students' experiences with mobile-assisted vocabulary learning.
- Final Phase (Pattern Categorization): Thematic patterns were systematically categorized, offering deeper insights into participants' perceptions, challenges, and engagement with mobile-assisted learning. This analytical framework enabled a holistic understanding of the cognitive, emotional, and motivational dimensions of mobile-assisted vocabulary learning, ensuring that findings were both statistically robust and qualitatively rich.

Findings

Quantitative Results

The descriptive statistical analysis of the pre-test scores is presented in Table 2. As shown, the results of the New Vocabulary Levels Test (NVLT), which assesses general vocabulary knowledge by covering the 5,000 most frequently occurring words in English as well as academic words (score range: 0–150), indicated that participants in the experimental group obtained slightly higher scores ($M = 66.14$, $SD = 6.46$) compared to those in the control group ($M = 65.50$,

$SD = 5.72$). An examination of the test's subsections revealed that while both groups performed similarly on the general vocabulary section (NVL T 5K, score range: 0–120), the experimental group achieved higher scores in the final section of the test, which specifically assessed academic vocabulary knowledge. The mean score for the experimental group in this section was 9.61 ($SD = 1.89$, score range: 0–30), whereas the control group obtained a mean score of 8.70 ($SD = 1.86$).

Similarly, performance on the AWL size test, which measures the breadth of knowledge regarding words included in the Academic Word List (score range: 0–57), showed a slight advantage for the experimental group ($M = 17.04$, $SD = 3.93$) in comparison to the control group ($M = 16.50$, $SD = 4.16$). Conversely, results from the Academic Word Association Test (WAT) (score range: 0–150) indicated that participants in the control group outperformed those in the experimental group. The mean score for the control group was 33.60 ($SD = 5.07$), which was marginally higher than the mean score of the experimental group ($M = 32.93$, $SD = 5.75$).

Table 2. Descriptive statistics for pre-test results

Group statistics

	Group	N	Mean	Std. deviation	Std. error mean
NVL T (5K)	Experimental	28	56.54	6.33	1.19
	Control	20	56.80	5.68	1.27
NVL T (AWL)	Experimental	28	9.61	1.89	.35
	Control	20	8.70	1.86	.41
NVL T (total)	Experimental	28	66.14	6.45	1.22
	Control	20	65.50	5.72	1.28
AWL (SIZE)	Experimental	28	17.04	3.93	.74
	Control	20	16.50	4.16	.93
AWL (WAT)	Experimental	28	32.93	5.75	1.08
	Control	20	33.60	5.07	1.13

Given the differences observed in pre-test scores, a multivariate analysis of variance (MANOVA) was performed to compare participants' performance on the NVLT, its subsections, and the two academic vocabulary tests. The results demonstrated that the overall differences between the two groups' test scores did not reach statistical significance, Wilks' Lambda = 0.943, $F(4, 43) = 0.644$, $p = .634$, multivariate partial eta squared = 0.057 (see Table 3).

Table 3. Multivariate tests for comparing the groups on pre-tests

		value	F	df1	df2	p
Group	Wilks' Lambda	0.943	0.644	4	43	0.634

Although the multivariate tests pointed to no overall significant difference in the scores obtained on vocabulary tests, to investigate possible differences in each of the individual vocabulary tests, a series of pairwise comparisons was conducted using Bonferroni adjustment (see Table 4). The results indicated that there were no statistically significant differences between the experimental and control groups in their general and academic vocabulary knowledge before the intervention. The results confirmed the homogeneity of the sample investigated in the study.

Table 4. Pairwise comparisons of scores obtained on pre-tests

Dependent variable	(I) Group	(J) Group	Mean difference (I-J)	Std. error	Sig. ^a	95% Confidence interval for difference ^a	
						Lower bound	Upper bound
NVLT (5K)	EXP	CONT	-.26	1.77	.88	-3.84	3.31
NVLT (AWL)	EXP	CONT	.90	.55	.10	-.20	2.01
NVLT (total)	EXP	CONT	.64	1.80	.72	-2.99	4.27
AWL (SIZE)	EXP	CONT	.53	1.18	.65	-1.84	2.91
AWL (WAT)	EXP	CONT	-.67	1.60	.67	-3.90	2.55

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

The descriptive statistics for the scores obtained on the post-tests are represented in Table 5. Similar to the pre-tests, both groups' performances were close on the general vocabulary test (NVLT 5K). However, the experimental group obtained considerably higher scores on the academic section of the NVLT ($M = 16.93$, $SD = 3.82$) compared to the control group ($M = 14.35$, $SD = 3.31$). Moreover, with respect to the AWL size test, the results revealed that the scores obtained by the participants in the experimental group ($M = 34.54$, $SD = 5.13$) were higher than the scores received by the control group ($M = 28.05$, $SD = 6.54$). Finally, the results indicated that for the academic word association test (WAT), the scores for the participants in the experimental group ($M = 38.46$, $SD = 6.23$) were higher compared to the scores obtained by the control group ($M = 35.00$, $SD = 4.56$).

Table 5. Descriptive statistics for results obtained on post-test

Group statistics

	Group	N	Mean	Std. deviation	Std. error mean
NVLT (5K)	Experimental	28	60.36	6.00	1.13
	Control	20	60.60	6.16	1.37
NVLT (AWL)	Experimental	28	16.93	3.82	.72
	Control	20	14.35	3.31	.74
NVLT	Experimental	28	77.28	7.33	1.38
	Control	20	74.95	6.17	1.38
AWL (SIZE)	Experimental	28	34.54	5.13	.97
	Control	20	28.05	6.54	1.46
AWL (WAT)	Experimental	28	38.46	6.23	1.17
	Control	20	35.00	4.56	1.02

The results of multivariate analysis of variance (MANOVA) for the scores obtained by the experimental and control groups on the post-tests indicated that the observed differences in the two groups' vocabulary knowledge were statistically significant, Wilks' Lambda = 0.644, $F(4, 43) = 5.942$, $p \leq .001$, multivariate partial eta squared = 0.356 (see Table 6). The magnitude of the differences (i.e., effect size as calculated by partial eta squared) was very large based on the criteria proposed by Cohen (1988). These findings indicate a statistically significant difference between the experimental and control groups, with the experimental group outperforming the control on combined vocabulary outcomes. The large effect size (partial eta squared = .356) suggests a substantial instructional impact.

Table 6. Multivariate tests for comparing the groups on the post-test

		value	F	df1	df2	p	Partial eta squared
Group	Wilks' Lambda	0.644	5.94	4	43	<.001	.356

As the final step in analyzing the quantitative data, using Bonferroni adjustment, a series of pairwise comparisons was conducted to find out about the differences in the scores in vocabulary tests. The results, as summarized in Table 7 indicated that the observed differences in the general vocabulary section of the NVLT were not statistically significant. However, the experimental group outperformed the control group in academic vocabulary section of the NVLT (mean difference = 2.58, $p = .019$, partial eta squared = 0.114), AWL size test (mean difference = 6.486, $p \leq .001$, partial eta squared = 0.243), and academic vocabulary association test (WAT) (mean difference = 3.464, $p = .040$, partial eta squared = 0.088). These results confirm that mobile-assisted learning led to significantly greater gains in academic vocabulary breadth and depth, while

no significant differences were found for general vocabulary. The effect sizes for AWL Size ($\eta^2 = .243$) and WAT ($\eta^2 = .088$) suggest that digital flashcards were especially effective in supporting vocabulary expansion and semantic associations.

Table 7. Pairwise comparisons of scores obtained on post-tests

Dependent variable	(I) Group	(J) Group	Mean difference (I-J)	Std. error	Sig. ^b	95% Confidence interval for difference ^b		Partial eta squared
						Lower bound	Upper bound	
NVLT (5K)	EXP	CONT	-.243	1.77	.892	-3.82	3.33	.000
NVLT (AWL)	EXP	CONT	2.579*	1.06	.019	.44	4.71	.114
NVLT	EXP	CONT	2.336	2.01	.252	-1.72	6.39	.028
AWL (SIZE)	EXP	CONT	6.486*	1.68	.000	3.08	9.88	.243
AWL (WAT)	EXP	CONT	3.464*	1.64	.040	.15	6.76	.088

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Qualitative results

The analysis of the qualitative data shed light on the participants' experiences in the learning process and revealed a number of perceived advantages and challenges associated with using smartphone devices for vocabulary learning outside the classroom. Overall, data collected from reflective journals indicated that the participants in the experimental group perceived mobile-assisted vocabulary learning positively and regarded smartphone devices as effective tools for vocabulary learning. With respect to the learning context, the majority of the participants conducted mobile-assisted vocabulary learning at home. Relatedly, most of the participants reported using digital flashcards for around 10 to 15 minutes just before going to bed and late at night. Several participants (i.e., 12) also reported using the materials in other places, such as public transport and parks. These aspects of learning experience were explored further in the interviews, and the obtained responses complemented insights gained from the reflective journal entries. In this regard, it was found that the preference for using mobile devices at home mainly stems from the perceived difficulties of using small screens for learning while someone is on the move, or the environmental conditions make it difficult to concentrate.

It is really difficult for me to use my smartphone for vocabulary learning when I am in a bus or a taxi. It is also difficult to use the device outside when the sun makes reading the screen difficult. To concentrate on learning, I need a quiet place. I take my smartphone with me, but I can't study outside the home. (P #5, interview)

Moreover, the participants' responses revealed a number of factors that influenced their habit of conducting learning activities late at night. Accordingly, although some participants reported using their devices for vocabulary learning before noon, a considerable number believed that distraction caused by social media negatively impacted their learning during the day, and the late-night learning strategy worked as they were receiving few notifications on their smartphones at this time:

During the day, as soon as I unlock my phone, I have a lot of notifications waiting for me. It takes a lot of time to see Instagram posts or respond to WhatsApp messages. While using the flashcards, these notifications keep coming. But it is not like that at night, and specifically around midnight. Just before going to bed, I activate the airplane [i.e., offline] mode on my phone, and I spend around 10 minutes studying academic words. (P #20, interview)

In relation to the participants' feelings and emotions, the data pointed to several positive emotions and high levels of satisfaction associated with mobile-assisted vocabulary learning. For example, some participants believed that using digital flashcards contributed significantly to their systematic focus on learning academic vocabulary, and their engagement with learning materials increased their motivation for language learning in general:

Learning academic words with digital flashcards seems to be fun and effective at the same time. I don't have to carry around my book as I can use my smartphone everywhere I go during the day, and the application helps me in learning and recycling difficult words. It seems that if I keep working with these flashcards, I might be able to learn a lot of words in just one year, and finally prepare myself for the IELTS exam. (P #6, reflective journal)

In addition to positive emotions and satisfaction resulting from using smartphone devices, the participants also mentioned several negative emotions they felt during mobile-assisted vocabulary learning. The negative emotion most felt was anger, resulting from (1) the participants' failure in recalling the meaning of words learned before, and (2) technical issues related to mobile devices, such as battery life. For some participants, learning some academic words was difficult, and this learning burden caused experiencing a range of negative emotions, and most notably anger:

No matter how many times I try, it seems that it is impossible to learn some words. After failing so many times, I wanted to delete the flashcards application and stay away from vocabulary learning for some time. (P #10, reflective journal)

Sometimes I wanted to practice vocabulary items, but to my disappointment, the battery was very low. This makes these devices really annoying and not appropriate for learning and serious academic activities. (P #21, interview)

Finally, the findings of the study pointed to three advantages and two challenges perceived by the participants for mobile-assisted vocabulary learning.

In this regard, ease of use, learning effectiveness, and increased motivation (and enjoyment) were the emerging themes from the data. For the majority of the participants, convenient use of digital flashcards compared to more traditional materials (such as paper flashcards) was a key factor in their learning experience. Both in reflective journals and interviews, the participants highlighted this issue and identified it as a key element contributing to their improved vocabulary knowledge. Another factor was related to the spaced repetition feature in the flashcards that facilitated learning academic words for the participants:

The app makes it easy to learn vocabulary. I remember using paper flashcards for university entrance exam preparation, where I had to place cards in different parts of the flashcards box manually. My learning is now much easier and effective as the app saves a lot of time, and the recycling of difficult words is more accurate. (P #13, interview)

Moreover, the participants in the experimental group made a lot of references to the impacts of mobile-assisted vocabulary learning on their increased motivation and enhanced learning enjoyment. One particular aspect in this regard was the participants' view on the utility of modern smartphone devices for conducting learning activities alongside being active in social media, listening to music, and watching videos:

We do a lot of things with these devices, as they are really mini-computers in our hands. The relatively large screen size of smartphones not only makes it easy for vocabulary learning, but also for reading books and watching movies. Since my phone is an essential part of my life, I think it is interesting to use it for language learning too. While using it in this way, I have good feelings as I am doing something valuable with my time, which is different from wandering on social media pages aimlessly or playing addictive games. (P #22, interview)

As for the challenges, the inherent distractions in the mobile environment and concerns related to the participants' health and digital well-being were identified as important and noteworthy aspects of their learning experiences. Notably, the participants in the experimental group were aware of possible negative effects of excessive use of mobile devices, and believed that since they are already using them for some hours every day, using mobile devices for vocabulary learning increases the health-related risks associated with too much screen time:

Sometimes I try to manage my screen time, and in most cases, I fail to do so, as it is becoming impossible to stay away from digital technologies. When I reach for my phone to use it for vocabulary learning, I can't help but check my messages on social media or go through some online shops. In this way, I believe mobile-assisted learning is not the best idea, and traditional books might be more appropriate. (P #19, interview)

Discussion

The first research question examined the effectiveness of mobile-assisted vocabulary learning beyond the classroom in comparison to traditional materials, specifically paper-based flashcards, in supporting university students' academic vocabulary learning. To address this, the study assessed learning outcomes in terms of vocabulary breadth (size) and depth (quality). The results indicated that prior to the intervention, participants' academic vocabulary knowledge, as measured by the three assessment tools (NVLT, AWL size test, and WAT), was comparable across both groups, confirming the homogeneity of the sample. However, following the treatment period, both groups demonstrated significant improvements in vocabulary knowledge, with participants in the experimental group acquiring a greater number of academic words than those in the control group. These findings provide empirical support for the efficacy of mobile-assisted vocabulary learning in enhancing academic word learning.

These results are consistent with previous studies that have examined digital versus traditional learning materials in academic and technical vocabulary learning among university students (Kohnke et al., 2020; Yüksel et al., 2022). However, they contrast with findings by Basöz and Can (2021), who reported superior learning outcomes for traditional methods. Several factors may explain the improvements observed in the experimental group. First, both groups engaged in intentional vocabulary learning, which has been widely recognized as an effective instructional approach (Nation, 2022; Webb & Nation, 2017). Second, the digital flashcard application used by the experimental group incorporated spaced repetition, an evidence-based learning strategy that enhances long-term vocabulary retention, which may have contributed to their higher post-test scores. Additionally, as noted in prior research, mobile-assisted vocabulary learning is closely linked to increased learner motivation (Rahmani et al., 2022; Xodabande, Asadi, et al., 2022; Xodabande & Atai, 2022; Zakian et al., 2022). Given the well-established relationship between motivation and learner engagement (Gardner & Yung, 2017; Murphy, 2011; Teimouri, 2017), this motivational advantage likely played a role in the superior performance of the experimental group.

The quantitative findings further demonstrated that the experimental group outperformed the control group in both academic vocabulary breadth and depth, as measured by the word association test (WAT). However, the magnitude of improvement varied between these two dimensions of vocabulary knowledge. The effect size for vocabulary breadth (partial eta squared = 0.243) was considerably larger than that for vocabulary depth (partial eta squared = 0.088), suggesting that mobile-assisted vocabulary learning with digital flashcards was more effective for expanding vocabulary size than for enhancing depth of word knowledge. Several factors may account for this disparity. The digital and paper-based flashcards used in the study primarily emphasized form-meaning connections, which aligns with vocabulary breadth assessments that rely on meaning recognition tasks. While the flashcards included sample sentences to illustrate usage, the exposure to contextualized input was likely

insufficient to foster deeper aspects of vocabulary knowledge, such as collocational understanding and the ability to recognize multiple word meanings. Additionally, participants' engagement with flashcards was largely passive, as the intervention required lower levels of cognitive involvement than tasks such as sentence writing or active form recall exercises. Although flashcards are widely recognized as effective vocabulary learning tools (Lei & Reynolds, 2022; Liu & Reynolds, 2022), the involvement load hypothesis posits that higher cognitive engagement leads to greater retention and recall of vocabulary (Laufer & Hulstijn, 2001). This suggests that increasing the cognitive demands of vocabulary learning tasks may lead to even greater gains in vocabulary depth. This finding also raises important pedagogical considerations for future implementations of mobile-assisted learning. While flashcards can effectively support the development of vocabulary breadth, additional activities such as sentence composition, semantic mapping, or collocation exercises may be necessary to foster deeper lexical processing. Designing hybrid interventions that combine mobile-based tools with higher involvement tasks may help bridge the gap between recognition and productive use, thereby addressing the multidimensional nature of academic vocabulary knowledge more comprehensively.

The second research question explored students' perceptions and attitudes toward mobile-assisted academic vocabulary learning. Qualitative findings revealed that participants generally held favorable attitudes, perceiving it as an effective and structured approach to systematic vocabulary expansion. This aligns with prior research examining learner perspectives on MALL (Dashtestani, 2016; Dashtestani & Hojatpanah, 2021). Participants also reported experiencing a range of positive and negative emotions while engaging with mobile devices for vocabulary learning, which may have influenced the observed learning outcomes. Regarding positive emotions, most participants described their experience as enjoyable and engaging, which likely contributed to greater motivation and sustained interaction with instructional content. This interpretation is supported by research emphasizing the motivational impact of emotions in language learning (MacIntyre & Vincze, 2017).

However, some participants reported negative emotions related to both the learning content and technological constraints. Several students found the small screen size of mobile devices inconvenient for reading and processing vocabulary materials, while others noted that battery limitations required frequent recharging, which they found disruptive. Additionally, frequent notifications from social media applications interrupted concentration and negatively impacted their learning experience. Prior studies indicate that frustration with mobile learning is associated with increased learning anxiety and negatively correlated with self-confidence, learning effort, and perceived competence (MacIntyre & Vincze, 2017). Given that the mobile-assisted intervention yielded more favorable learning outcomes than the traditional learning condition, these findings may be interpreted through the lens of positive emotion theories in language learning. Fredrickson's broaden-and-build theory (2004, 2013) suggests that positive emotions expand cognitive flexibility and enhance learning resilience, mitigating the effects of negative emotions such

as frustration. This theory helps explain why participants in the experimental group achieved superior learning outcomes despite encountering technological challenges. Another noteworthy behavioral pattern observed in the qualitative data was participants' preference for engaging in mobile-assisted vocabulary learning at night, particularly before sleep. Many reported deliberately activating airplane mode to avoid notifications, indicating a self-regulated strategy for minimizing digital distractions. This finding underscores learners' ability to adapt their technological environment in ways that support focus and emotional regulation. Such context-sensitive use of mobile devices highlights the importance of training learners not only in vocabulary strategies but also in managing their digital ecology for optimal learning.

Although mobile devices afford flexibility in learning time and location (Lin & Lin, 2019), most participants reported that they primarily used their mobile devices for vocabulary learning at home. Interview data further revealed that several factors negatively influenced the pedagogical effectiveness of mobile-assisted learning, including visual strain from reading on small screens, distractions from social media, and concerns about the potential health effects of prolonged screen exposure. These findings highlight the importance of optimizing mobile-assisted vocabulary learning environments to minimize distractions and reduce cognitive overload, ensuring that learners can fully capitalize on the affordances of digital technology for vocabulary learning.

Implications

The findings have important pedagogical implications for academic vocabulary instruction in higher education. First, as demonstrated in the study, flashcards and mobile-assisted learning beyond the classroom significantly facilitated the learning of academic vocabulary, offering students a structured and flexible approach to academic literacy development. Given the challenges university students face in acquiring and effectively using academic vocabulary, mobile-assisted vocabulary learning can serve as a valuable supplementary strategy to enhance their vocabulary development in a systematic and scalable manner. Second, since vocabulary acquisition is a long-term process, mobile-assisted learning has the potential to accelerate vocabulary growth, allowing students to expand their knowledge of academic words more efficiently. The findings of the current study showed that the experimental group improved by 30%, while the control group, using traditional materials, demonstrated a 22% vocabulary gains. Although both methods were effective, the additional 8% increase gained through digital flashcards underscores the added value of mobile-assisted vocabulary learning in facilitating comprehension of academic discourse.

While word cards have been widely recognized as effective tools for both receptive and productive vocabulary learning (Li & Hafner, 2022; Nakata, 2019), it is important to note that productive vocabulary development is often more limited than receptive vocabulary gains. Consequently, there is a need for additional pedagogical interventions to enhance productive vocabulary acquisition. Designing high-involvement learning tasks may be particularly

beneficial in this regard (Laufer & Girsai, 2008; Laufer & Hulstijn, 2001; Lei & Reynolds, 2022; Reynolds et al., 2020). Furthermore, although mobile devices provide accessible and flexible learning opportunities, this study also identified several challenges associated with mobile-assisted vocabulary learning. Participants reported experiencing distractions, technical and logistical issues, and concerns related to digital well-being and screen time. These findings highlight the importance of carefully integrating mobile technologies into vocabulary instruction, ensuring that potential challenges are addressed to maximize learning benefits.

Conclusion

This study examined the use of Lexilize flashcards for academic vocabulary learning beyond the classroom, comparing the learning outcomes of mobile-assisted vocabulary learning with those of traditional materials. The findings provide empirical support for the effectiveness of mobile-assisted learning in enhancing both receptive and productive vocabulary knowledge among university students. Additionally, qualitative data collected through reflective journals and semi-structured interviews revealed that participants generally held positive perceptions of mobile-assisted vocabulary learning and primarily engaged in this learning strategy at home. These findings contribute to a deeper understanding of the efficacy of mobile-assisted vocabulary learning while also highlighting some of the challenges and limitations associated with this emerging instructional approach in university settings. Despite its contributions, the study is not without limitations. The intervention was implemented within a single academic semester and focused on a specific population of Iranian EFL university students, which may limit the generalizability of the findings. Additionally, while the study assessed both vocabulary breadth and depth, it did not investigate long-term retention beyond the post-test phase. The qualitative component, although informative, was restricted to one group and may not capture the full range of learner experiences in other educational contexts. Future research should consider longitudinal designs to evaluate the sustained impact of mobile-assisted vocabulary learning, incorporate larger and more diverse samples, and explore the integration of higher involvement load tasks to enhance productive vocabulary development. Investigating the role of mobile-assisted instruction across different proficiency levels and academic disciplines would also provide a more comprehensive account of its pedagogical value.

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