

Two Vocabulary Learning Tools Used by Iranian EFL Learners: Physical Flashcards versus a Mobile App

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Abstract

With the help of technology and the Internet, foreign language students can learn vocabulary more conveniently than ever before. Meanwhile, increasing attention is being paid to mobile-assisted language learning (MALL). In this regard, the current study compared the effectiveness of digital flashcards in the form of an app and conventional paper flashcards. This study was based on a quasi-experimental design, and participants were recruited via convenience sampling. A total of 34 participants took part in the study. There were two groups of students, the experimental group that learned through mobile devices and the control group that learned through paper flashcards. There was a significant improvement in L2 vocabulary learning with digital and non-digital flashcards, but the Anki app was more effective. Moreover, ten students took part in the qualitative portion of the research to explore the merits and disadvantages of either types of vocabulary learning tools presented in this study through semi-structured interviews. This study implemented a mixed-method design. Based on the findings of the present study, paper flashcards shouldn't be dismissed altogether by learners and teachers. This is because they reduce screen time and distractions as well as stimulate muscle memory while learning. In addition, students can control their repetition cycles, physically manipulate them as they wish, and take control over how much information they repeat.

Keywords: Vocabulary Learning, Digital Flashcards, Paper Flashcards, Mobile Learning, Language Learning

Introduction

When learning a second language (L2), vocabulary knowledge is a critical component. Students and teachers also face many challenges when it comes to acquiring and teaching vocabulary (Kohnke et al., 2021; Hao et al., 2021). Wallace (1982) asserts that speaking another language is difficult when you can't find the words for what you

need to say. Moreover, Wilkins (1972) states that without grammar and vocabulary, one cannot convey anything at all. As Nam (2010) states, vocabulary boosts the main four language skills of writing, speaking, reading, and listening, and acts as a mediator between L2 learners and learning discussions in classrooms since a lack of vocabulary knowledge can often obstruct learning in classrooms.

Nowadays, we are witnessing a paradigm shift in our education system because of its integration with technology, primarily due to the influence of mobile phones (Rizwan, 2021). Today, teachers can use various strategies and techniques to teach vocabulary, including but not limited to Duolingo, game-based mobile apps, podcasts, Kahoot, and even social media applications such as Instagram and TikTok (Honarзад & Soyooof, 2020; Li & Hafner, 2022; Parsayi & Soyooof, 2018; Pratiwi et al., 2021; Putri, 2022; Soyooof et al., 2021; Soyooof, 2018; Soyooof, 2022). We are seeing the emergence of newer techniques such as Augmented Reality (AR) in this field as technology and education are implemented more than ever (Rapti et al., 2022; Yilmaz et al., 2022).

Despite the advent of newer technologies for vocabulary learning like mobile flashcard apps, the hidden value of paper flashcards should still not be ignored, just as we cannot consider paper books worthless compared to their electronic counterparts. Although a small number of research papers have examined the differences between paper and electronic flashcards so far (e.g., Ashcroft et al., 2016; Azabdaftari & Mozaheb, 2012; Basoglu & Akdemir, 2010), the present study attempts to reveal the hidden angles of these differences with a fresh look at this issue and with a higher degree of precision in quantitative and qualitative data analysis. This study is warranted since the majority of past studies were limited in their approach as they implemented either only quantitative or qualitative methods toward similar research questions and specifically failed to do an in-depth qualitative analysis of the issue to expose the minute details. In this study, conventional and mobile flashcards were compared in terms of their impact on learning vocabulary by Iranian L2 learners. Therefore, we developed two research questions in order to address the study's purpose:

1. What is the most effective method for Iranian EFL students to learn vocabulary, Anki, or paper flashcards?
2. From the learners' perspective, what are the benefits and drawbacks of the two vocabulary learning techniques used in the current study?

Theoretical Frameworks of the Study

This study was guided by the principles of the Cognitive Theory of Multimedia Learning (CTML) and Computer-Assisted Vocabulary Learning (CAVL) applications. CTML is a theoretical framework for learning through the utilization of multimedia, and it has three assumptions (Mayer, 2005). According to Mayer, first, the brain processes information according to two channels. In one channel, verbal information is processed; in the other, visual information. Second, each channel is limited by capacity, a concept derived from Cognitive Load Theory (CLT). Besides these two rather cognitivist principles, there is a third constructivist principle, namely, learning as a generative activity. According to the generative learning theory of Wittrock (1992), learning is an interplay between already stored information and new stimuli and is effective when

learners' active cognitive processing is stimulated. In the CTML, dynamic cognitive processing is stimulated through learners' engagement in selecting the relevant material, organizing it into a coherent structure, and integrating it with prior knowledge (Mayer, 2019). Learning with instructional media according to the principles stated in the CTML is what Mayer calls meaningful learning, where learners acquire knowledge and skills for effective problem-solving (Mayer, 2011).

Ma (2013) developed a framework that classifies CAVL applications. It categorizes applications into two general branches: lexical programs or tasks and lexical resources or aids. Four types of lexical programs or tasks can be distinguished: incidental learning with lexical glosses, computerized vocabulary lists, flashcards, and exercises. Such applications are essential tools and can be easily integrated into other tutorial applications. Learners only need to scroll up and down pages or click on buttons; the primary function of these types of applications is to execute the learner's command. There are three major lexical aids: open Google searches, electronic dictionaries, and lexical concordancers; they give learners access to meaning and other lexical information. In such a classification, vocabulary learning is ranked in terms of tools or tutors, implicit or explicit learning, and meaning or form emphasis. First, the electronic dictionary can respond to learners' input intelligently. Second, only necessary lexical information is displayed, and extra information can be displayed upon request. In addition, lexical information can be accessed in multiple channels simultaneously: textually, pictorially, and aurally.

Literature Review

Paper Flashcards vs. Mobile Applications

There have been a number of studies examining mobile applications as a way to learn new vocabulary. For example, Basoglu and Akdemir (2010) looked at the effects of a smartphone application on Turkish students' English vocabulary learning using a mixed-method research design with 60 undergraduate students. Results showed that using smartphones as a vocabulary learning tool was more effective than traditional paper flashcards. In a similar study, Azabdaftari and Mozaheb (2012) compared a mobile app and paper flashcards for teaching vocabulary to 80 undergraduate students at a non-profit, non-governmental university in Tehran. According to their findings, using the app was more effective for learning vocabulary. In another study, 139 Japanese university students with varying levels of English proficiency were assessed in a paper by Ashcroft et al. (2016) to determine how digital flashcards compared with paper flashcards for learning vocabulary. Results showed that Japanese university students with low levels of English proficiency learned vocabulary more efficiently with digital flashcards than with conventional flashcards. However, both study modes were equally effective for students at higher levels of proficiency. Further, Fathi et al. (2018) conducted a quasi-experimental study with 59 Iranian EFL learners to examine the effects of a mobile app (Memrise) on L2 vocabulary learning. The students were found to learn L2 vocabulary and self-regulation skills more efficiently using Memrise than in the control group.

Using the Rememba app, Kose and Mede (2018) examined the effects of the app on vocabulary growth and motivation among 38 EFL students enrolled in an academic

language preparatory program in Turkey. Researchers reported higher vocabulary knowledge levels and higher motivation among the group with access to the app. Furthermore, their study revealed that students and their teachers seemed to benefit from using mobile tools in the classroom when teaching and learning vocabulary. Additionally, 108 American college students were tested with conventional as well as digital flashcards by Sage et al. (2019). According to their results, paper and tablet-based flashcards worked equally, but computer flashcards performed less effectively. Also, computer-based flashcards felt less comfortable and less controlled, since a spaced-repetition system was used to manage the cards. Although students preferred paper over digital flashcard formats, their cognitive load was similar. Furthermore, the researchers noted that students might prefer different flashcard types depending on their perception of the subject's difficulty.

Students' perceptions about the use of digital flashcards were explored in a similar study by Yüksel et al. (2020), comparing the effect of digital flashcards and wordlists on learning technical vocabulary. Not only did the students learn more technical vocabulary through digital flashcards, but their perceptions about using digital flashcards were positive. Finally, they concluded that teacher-prepared digital flashcards could improve technical vocabulary learning. Furthermore, Xodabande et al. (2022) studied the impact of mobile application flashcards on vocabulary learning outcomes. A total of 55 Iranian high-school students were exposed to various learning conditions and tested at three different points throughout the year for their knowledge of receptive vocabulary in English. In the post-test, mobile applications outperformed paper flash cards in the experimental group. Furthermore, Halamish and Elias (2022) compared the effectiveness of digital and paper-based learning in foreign-language vocabulary acquisition. They conducted a controlled experiment on 79 young adults in Israel by implementing restudying or retrieval practice and then tested the learners' memory performance. Results showed that paper-based learning resulted in better test performance than digital learning when tested on paper. Still, this effect was eliminated when tested digitally, and concluded that using digital tools to study vocabulary for on-paper memory tests may challenge standard practices for vocabulary learning.

In another recently published article, Li and Hafner (2022) examined English vocabulary learning from engagement with mobile-based and paper-based word cards in a university classroom with 85 Chinese undergraduate students. The students were tested on two-word components: receptive knowledge of the form-meaning connection and productive knowledge of collocations. The results showed that while both the digital and non-digital word cards enhanced L2 vocabulary learning, the mobile app (Zhimi) promoted more significant gains than physical word cards. It is also worth noting that while language learners can retain vocabulary through mobile applications, they can also improve their self-regulation skills (Kondo et al., 2012) and self-awareness capacities (Liu et al., 2008). To examine how students use digital flashcards during self-regulated learning, Zung et al. (2022) surveyed 901 undergraduate students at a major U.S. university. According to their findings, college students preferred digital flashcards to paper flashcards due to their convenience, portability, ease of creating, storing and accessing them, and the fact that they could learn on autopilot.

Method

Research Design

Researchers used a mixed-method approach to collect the data in this quasi-experimental study, which included both qualitative and quantitative data sampling through pre-tests, post-tests and interviews. Two vocabulary learning strategies were examined in this study, namely m-learning through an app (for the experimental group) and physical flashcards (for the control group). The participants in this study were selected through convenience sampling. Cambridge Vocabulary for IELTS (Cullen, 2008) was chosen as the main teaching material for the course since the primary purpose was to reinforce the students' four language skills around vocabulary. The textbook is rich in context and revolves around various topics, including effective communication, student life, information technology, law, media, arts, and other similar topics. All of the vocabulary items were taught from this book. According to the wordlist provided at the end of the book, the list includes 1,211 new lexical items that boost learners' vocabulary to B2 or C1 levels. In total, 408 vocabulary flashcards were created in two forms by the researchers, selected from the less familiar verbs, nouns, adjectives, and adverbs included in the wordlist. A vocabulary assessment was administered before and at the end of the treatment to gather quantitative data to determine whether the groups were homogeneous and find out which study method was most effective. Subsequently, an independent samples t-test was performed. Then, qualitative data was collected through semi-structured interviews regarding the advantages and disadvantages of each type of flashcard with five students from the digital flashcard group in addition to five students from the paper flashcard group. Further information about the pre-test, post-test, interviews, and the mobile application used in the study are provided in the next section.

Participants

A total of 34 intermediate-level learners studying at a private language school in Shiraz, located in the southwest of Iran, took part in the study during the winter semester of 2021. The subjects were in the form of two intact and equal-sized groups. The age of participants varied from 23 to 36 (mean = 28). All participants owned at least one smart mobile device with the ability to connect to the Internet, which they used regularly, and stated that they had already experienced some type of mobile-assisted learning. All students had participated in the IELTS placement test prior to the onset of the course, and their scores ranged from a total band score of 4.0 to 5.0 which is correspondent to the B1 Intermediate level according to the IELTS in CEFR scale (British Council, n.d.). More importantly, A Quick Placement Test (UCLES, 2001) was used as a homogeneity test which showed that the language proficiency level of participants in this study was at the B1 level.

Data Collection and Analysis

Instruments

The instruments for the present study were the pre-test and the post-test, interviews, and the Anki application.

Pre-test and Post-test

A forty-item multiple choice test based on units 1 to 25 of the Cambridge Vocabulary for IELTS (Cullen, 2008) was prepared initially by the researcher. In collaboration with two experts with over eight years of teaching and testing experience in the field, the test was revised and 15 items were eliminated. Additionally, some items were revised as a result of participant familiarity with them and as some were deemed inappropriate after revision. Pilot tests were conducted with 16 L2 learners similar in age (22 to 34) and proficiency level to those participating in the study to ensure reliability. Using Cronbach's alpha analysis, a reliability coefficient of 0.81 was found for the test. Therefore, the revised version of the Cambridge Vocabulary for IELTS test was administered to both the experimental and control groups for both the pre-test and post-test and contained 25 items. Each correct response scored five points, leading to a maximum score of 100.

Interviews

Open coding and thematic analysis were used to analyze the qualitative data obtained from the interviews. According to Boyatzis (1998), thematic analysis allows researchers to explore themes in depth. Erlingsson and Brysiewicz (2017) developed a model which integrates meaning units, condensation, codes, categories, and themes. The advantages and disadvantages of conventional flashcards and their mobile counterparts were then analyzed using deductive and inductive methods. In the next step, the codes were categorized and treated as themes through phrases expressing the themes. Researchers read the data reiteratively during the process. After lengthy discussions, a few differences of opinion were resolved regarding the themes. As a precaution to avoid COVID-19 and the associated health risks, interviews were conducted in written form. Even so, whenever the researchers felt a point was vague, they would use WhatsApp to communicate with the participants to remedy the issue. A total of 4276 words were collected during the interviews and a total of 682 words came from WhatsApp. As a result, a total of 4958 words were collected from the two data sources. Representative samples of the interview questions include: What do you think about your experience learning with Anki or conventional flashcards? What were the advantages of using Anki or physical flashcards? What difficulties did you encounter while using Anki or paper flashcards? In what capacity do you believe Anki or paper flashcards could be superior?

Anki App

Anki is an open-source, spaced-repetition flashcard program that offers numerous advantages and is free to download on various platforms, including Windows, Mac, Linux, and Android (Ankitects Pty Ltd, 2021). Anki uses the Spaced Repetition System (SRS) in order to spread out students' learning intervals so that they remember information more effectively. The basic idea behind this technique is that one needs to review new or difficult flashcards more frequently than familiar or easy ones.

The researchers chose Anki for this study since it has a built-in spaced-repetition engine, is widely and freely available across all platforms and operating systems, and can be used both online and offline with all devices; this feature is specifically of significance

since the internet connection can be at times unstable in Iran in an educational context (Honarзад, 2022). Still, Quizlet, for example, cannot be accessed offline in Windows and does not implement spaced-repetition. Furthermore, Anki can only be used as a flashcard app, while other apps, such as Quizlet, may have additional learning modes such as test mode, match mode, and gamification capabilities which makes them more than a flashcard app and thus could have affected the current study's reliability (Waluyo & Bucol, 2021). Another factor was that other apps, in this case, Quizlet, may have additional features that cannot be accessed until the user upgrades the account to a paid version; an instance of this would be that one cannot import images while making flashcards in the free mode (Pechenkin et al., 2018). Purchasing software globally is also not an option for Iranian students (Butler, 2019).

Procedure

Each individual was randomly assigned to one of two groups, the experimental group ($n = 17$) or the control group ($n = 17$). Students in both the experimental and control groups learned new vocabulary items within the study's 6-week period. The students in the experimental group used the mobile app Anki while those in the control group only used conventional flashcards. Before the treatment began, learners in both groups received training on how to use the flashcards. Each flashcard included the target vocabulary word, its pronunciation, and its definition in both the L1 and L2 languages. While the paper flashcard group used the phonetic alphabet for pronunciation, for the digital group, a sound recording of the word was played automatically as the word emerged on the screen. Students were given 15 minutes to review new flashcards each week during class. The learners only had the opportunity to review all the target vocabulary words in the last week. Studying outside of class was encouraged, but the researchers did not track it.

Results

Results of the Pre-test

To determine the impact of using either digital or conventional flashcards, (the independent variables), on Iranian EFL learners' IELTS vocabulary learning, (the dependent variable), all participants needed to complete a pre-test to ensure they were in the same level in terms of their vocabulary knowledge. Digital flashcard and paper flashcard users were compared via an independent-samples t-test. There were no significant difference ($t(32) = -0.13, p = 0.892$) in scores for the digital flashcard group ($M = 44.70, SD = 8.02$) and the paper flashcard group ($M = 44.35, SD = 6.93$). The magnitude of the differences in the means (mean difference = -0.35 , $CI: -5.59$ to 4.88) was not significant. Hence, the groups were found to be homogeneous. The pre-test results are shown in Table 1 below.

Table 1
Independent Samples T-test for the Pre-test

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | 95% Confidence Interval of the Difference | | |
|--------------|-----------------------------------|---|-------|------------------------------|----|---------------------|--------------------|---|---------|--------|
| | | F | Sig. | t | df | Sig. (2- tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| Pre- test | Equal variances assumed | 1.398 | 0.246 | -0.137 | 32 | 0.892 | -0.35294 | 2.57349 | -5.595 | 4.8891 |
| | Equal variances not assumed | | | -0.137 | 31 | 0.892 | -0.35294 | 2.57349 | -5.5993 | 4.8934 |

Results of the Post-test

After the teaching session, students took the post-test to examine whether the treatment changed participants' vocabulary knowledge. In order to compare the two groups in terms of their IELTS vocabulary gain, an independent samples t-test was deployed after the treatment period (see Table 2). There was a significant difference ($t(25.81) = -2.381, p = 0.025$) in scores for the digital flashcard group ($M = 67.76, SD = 14.59$) and the paper flashcard group ($M = 58, SD = 8.54$). The magnitude of the differences in the means (mean difference = $-9.76, CI: -18.19$ to -1.33) was significant. Cohen's d effect size ($d = 0.75$) demonstrated moderate effectiveness (Plonsky & Oswald, 2014). Hence, the difference between the two groups was statistically significant. The post-test results are shown in Table 2 below.

Table 2
Independent Samples T-test for the Post-test

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | 95% Confidence Interval of the Difference | | |
|---------------|--------------------------------------|---|------|------------------------------|----|---------------------|--------------------|---|---------|---------|
| | | F | Sig. | t | df | Sig. (2- tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| Post- test | Equal variances assumed | 7.534 | 0.01 | -2.381 | 32 | 0.023 | -9.76471 | 4.10123 | -18.119 | -1.4108 |
| | Equal variances not assumed | | | -2.381 | 25 | 0.025 | -9.76471 | 4.10123 | -18.198 | -1.3316 |

Interview Results

Based on the data analysis, two major themes emerged: a) Technological Aspects (Table 3) and b) Flashcard Management (Table 4). These themes were discovered by grouping subcategories into categories. Themes are then derived from similar categories.

Theme 1: Technical Aspects

The first theme and its relevant categories are shown in Table 3 below. Anki is viewed positively by the majority of students. This is why we will begin with its positive aspects, including technology-based self-regulation and memory boost. Based on comments from participants 8, 9, and 10:

Participant 10: "My favorite thing about Anki is that it automatically tells me which cards to study and review daily."

Participant 9: "Anki helps me remember IELTS vocabulary for much longer. with much less effort, making it more reliable and convenient."

Participant 9: "I can also check my learning and progress via the statistics section of the app."

Participant 8: "I'm no longer bogged down by cramming vocabulary because I feel more confident in my learning abilities now. Honestly, I consider Anki valuable; I can't recommend it enough."

Furthermore, they mentioned the possibility of incorporating multimedia into the flashcards and said:

Participant 6: "I got surprised when I found out that adding images, audio, vocabulary pronunciations, GIF files, and videos to any of the flashcards is possible with Anki."

Participant 10: "..., you can also pack a lot of information in one digital flashcard if needs be."

Another participant explained how they could find a flashcard by using the search function. They said:

Participant 9: "The "Card browser" shortcut in the app allowed me to locate any flashcard and edit it if I wanted; I can also find if there are any duplicates."

According to one student, it is easy to share different flashcards through the Internet, and the following is what they said:

Participant 7: "I recently discovered that I can also download and import flashcards shared by other people into my Anki app quite easily."

Aside from the positive aspects of the Anki app, a student complained,

Participant 6: “If I had to make flashcards myself, I feel I would not be able to add handwriting, sketches, or drawings as quickly as I can with paper flashcards.”

There was also positive feedback about the paper flashcards from two learners concerning how the activation of muscle memory can facilitate learning and concreteness of physical flashcards as follows:

Participant 2: “When I rewrite the words by hand, I feel I am better able to remember their dictation. I also learn faster and retain information when I write something down.”

Participant 1: “The way I see it when it comes to paper flashcards, they are more tangible and real-life than their digital counterparts.”

A learner mentioned a drawback of paper flashcards regarding the lack of SRS, per below:

Participant 5: “I dislike paper flashcards because they require me to follow a review plan, which I hate doing, but Anki does that automatically.”

Other participants talked about the limited capacities of conventional flashcards, as follows:

Participant 5: “Not being able to include long texts or multiple examples on a paper flashcard is a major drawback, in my opinion.”

Participant 4: “You can write phonetic pronunciation on flashcards, but it’s not the same as actual voice pronouncing it.”

Participant 4: “In order to remember things better, you need to draw something on each paper card, and you have to be skillful in drawing relatable items.”

Participant 3: “If you have a lot of paper flashcards, it may be challenging to find and update a card.”

Participant 3: “..., you may end up with duplicates since you don’t remember which cards you made.”

Table 3*Theme 1: Technical Aspects*

| Theme 1 | Categories | Sub-categories |
|-------------------|------------------------------------|--|
| Technical aspects | Advantages of the Anki application | <ol style="list-style-type: none"> 1. SRS makes learning more convenient, self-regulated, and long-lasting. 2. Adding multimedia is as simple as a few clicks or taps. 3. To edit or add additional information, you can simply search by keywords. 4. It is possible to download other people's flashcard decks and customize them. |
| | Disadvantages of Anki application | <ol style="list-style-type: none"> 1. Adding handwriting or hand drawings is not easy. |
| | Advantages of paper flashcards | <ol style="list-style-type: none"> 1. It can activate muscle memory. 2. It is more concrete. |
| | Disadvantages of paper flashcards | <ol style="list-style-type: none"> 1. The lack of SRS increases difficulty of use, especially for students with lower self-regulation. 2. You cannot add multimedia to paper flashcards. 3. Searching through the cards and finding duplicates is not easy. |

Theme 2: Flashcard Management

Table 4 shows the categories and subcategories associated with the second theme, Flashcard Management. The key aspect of this theme is how learners organize their flashcards and their data as well as how they manage their time and environment. Some learners believe that one of the major benefits of digital flashcards is that they do not have to deal with paper at all. As an example:

Participant 9: "I cannot imagine having to go through hundreds of physical pieces of paper every day."

Participant 8: "If I had to study a greater number of paper flashcards, I do not know what I would do. I felt like I was losing motivation to learn."

Participant 10: "In my opinion, it is not logical to carry paper flashcards around anymore when you can easily have all of them at your fingertips through your phone."

Moreover, they contend that Anki holds a great advantage over paper flashcards since a person's entire collection of flashcards can be used across a wide range of devices and operating systems. For instance:

Participant 10: "I believe I can create the flashcards only once and then use them across multiple platforms with Anki."

Participant 8: "..., I'm planning on making Anki flashcards for my other classes because my digital flashcards are accessible wherever I am."

Participant 9: "There have been many times when I have flipped through flashcards on the bus, at my bedside, in the dentist's office, and more."

Digital flashcards have a positive environmental impact, according to one learner.

Participant 10: "The fact that I do not need to use paper while using Anki means that fewer trees are cut down, and additionally, no paper is wasted."

Meanwhile, other participants discussed the disadvantages of Anki with regard to managing their Anki accounts for example:

Participant 7: "I didn't like being forced to make an account just to be able to sync my flashcards automatically, but I was also afraid that I'd lose the changes I had made to the flashcards."

Participant 6: "It automatically syncs every time I want to open or close the application on my PC, which is sometimes annoying and takes too much time."

Another issue raised by a student is the time it takes Anki to synchronize a flashcard after adding a video file to an edited flashcard as follows:

Participant 7: "I added a video to one of my flashcards using my laptop, but then realized that it took much longer than expected to sync it with AnkiWeb."

A few students mentioned that Anki was not appropriate for cramming or short-term learning. As they added:

Participant 3: "Unfortunately, with Anki, it is not possible to simply repeat the same few cards that I reviewed last time, over and over again."

Participant 5: "..., I simply think Anki is not a suitable tool if you want to cram the night before your exam."

There was also a complaint regarding the increased screen time while using the Anki app. As one participant put it:

Participant 4: "I get migraines and blurry vision after reading a screen for too long due to digital eye strain."

Two learners felt they had firmer control over how they wanted to review the paper flashcards. For example:

Participant 2: "I like to choose when to review which cards; for instance, I can study the same card 15 times in a row if I want."

Participant 1: "As I review some cards, I like to fold the paper with my hand to cover some parts I do not want to see yet and gradually review each portion."

Other participants said they preferred paper flashcards because they could study without any distractions associated with smartphones and became less attached to their phones. For instance:

Participant 1: "Not getting distracted with sudden notifications and messages is an added bonus of using paper flashcards in my opinion."

Participant 2: "I could reduce my on-screen time and take a break from being too attached to my smartphone for doing everything."

A number of participants argued that conventional flashcards are prone to becoming lost and can get out of hand as their number increases. For example:

Participant 5: "I once lost all of my paper flashcards on the way while visiting relatives; I left them in the taxi as I was reviewing them."

Participant 3: "It is not easy to travel around with paper flashcards; I constantly worry about losing them."

Participant 4: "As paper flashcards increase in number, I find that they become unmanageable; there may be so many that I cannot keep track of what I need to review."

A student talked about how they felt while studying outside with their paper flashcards. For instance:

Participant 5: "I don't particularly appreciate how people look at me while I'm studying with a pile of papers outside."

A participant raised concern over the environmental impact of using paper for creating flashcards and added that it also requires more effort. They said:

Participant 2: "Making physical flashcards requires a lot of paper and patience; if you write something wrong, you'll need to replace it with a new piece of paper, and I'm worried about the impact it could have on the environment."

Table 4
Theme 2: Flashcard Management

| Theme 2 | Categories | Sub-categories |
|-----------------------|-----------------------------------|---|
| Flashcards Management | Advantages of Anki application | <ol style="list-style-type: none"> 1. Handling an app is much easier than being forced to deal with large quantities of small papers. 2. It has higher mobility. 3. It is more environmentally friendly. |
| | Disadvantages of Anki application | <ol style="list-style-type: none"> 1. You must provide an AnkiWeb ID and password to sync the flashcards automatically. 2. Data and changes could get lost if you fail to sync and backup the flashcards. 3. Sometimes, it takes a long time to sync the app. 4. Less control over reviewing procedures (how and when). 5. It increases screen time. |
| | Advantages of paper flashcards | <ol style="list-style-type: none"> 1. It allows total control over reviewing procedures. 2. It permits less distractions from notifications. 3. It results in less screen time. |
| | Disadvantages of paper flashcards | <ol style="list-style-type: none"> 1. The flashcards can get lost relatively easily. 2. If the number of flashcards grows too large, they become difficult to organize. 3. Paper flashcards are not environmentally friendly. |

Discussion

The purpose of this study was to compare the effectiveness of a mobile flashcard application (Anki) and conventional paper flashcards on students' vocabulary learning. According to Table 2, both paper-based and mobile application flashcards significantly developed the learners' vocabulary knowledge; however, the mobile app had a more significant effect. The findings agreed with the earlier studies that reported similar results (e.g., Ashcroft et al., 2016; Azabdaftari & Mozaheb, 2012; Basoglu & Akdemir, 2010; Fathi et al., 2018; Kose & Mede, 2018; Li & Hafner, 2022; Sage et al., 2019; Xodabande et al., 2022; Zung et al., 2022). The results contrast with those found in previous studies (Burgess & Murray, 2014; Sage et al., 2019) in which mobile apps and paper flashcards were not significantly different.

The researchers also looked into the advantages and disadvantages of both the mobile app and paper flashcards from the participants' point of view. The findings revealed that while digital flashcards and, in particular, the Anki application are not flawless, they provide a few key advantages including the convenience of learning with the SRS in extended study periods and the power of multimedia integration, higher mobility, availability over various platforms and being more environmentally friendly than paper. Nevertheless, as Sage et al. (2019) put it, "Paper is often the "tried-and true" method for learning, and, though digital means can potentially be just as viable, platform matters as well as perceptions" (p. 476) and called for further investigation into the matter.

According to the current study's participants, paper flashcards have several benefits, which were acknowledged in previous studies. Especially, paper flashcards have more concrete properties, which might accelerate learning for a group of students. Further, paper flashcards can instantly make any changes to the flashcards using a pen or pencil.

For instance, students can draw a mnemonic on them or write a few more example sentences on the back of the flashcards to accelerate their learning via the activation of muscle memory. Paper flashcards are also great for avoiding the distractions caused by mobile devices, such as notifications that pop up on the screen or the urge to do other activities other than studying. With conventional flashcards, students also feel they are in total control of how many times they want to repeat a card, which is ideal for cramming and short-term learning.

Finally, it is worth mentioning that smartphones have developed since their appearance, and some of the relevant issues such as small battery and memory capacity and tiny screens in addition to slow processors (Azabdaftari & Mozaheb, 2012; Burgess & Murray, 2014; Houser et al., 2002; Traxler & Kukulska-Hulme, 2005) have been largely resolved by the current generations of mobile phones, and it is even claimed that some of the latest smartphones are more powerful than personal computers (Samsung for Business, 2021). Hence, English language teaching stakeholders need to inform material developers and mobile developers about how smartphones can address their potential concerns. For example, how application designers can develop more educational-friendly mobile applications that not only would facilitate vocabulary learning in language learners but would be applicable in classroom contexts.

Conclusion

According to Naciri et al. (2020), phones have developed tremendously in the last two decades, so the purpose of mobile from making calls and sending short text messages has extended to many more important daily chores in human life. Especially after being adversely affected by the COVID-19 pandemic, mobile learning became one of the most pervasive alternatives to physical classrooms. Learning through mobile allows students to study anytime, anyplace, and anywhere. Although m-learning, coupled with the power of the Internet, provides an array of unique opportunities that were not available before the dawn of the 21st century, we cannot completely dismiss traditional learning methods. After all, traditional methods have their advantages which allow many students to achieve their academic or non-academic goals. It seems that mobile phones play a crucial role in facilitating the learning of the English language in particular as it offers more innovative language learning opportunities. For example, students are increasingly using mobile phones as an instructional tool for language learning, particularly vocabulary learning, as vocabulary apps become more diverse and more appealing with higher functionality. However, it is important to keep in mind that the data was collected from learners preparing for and passing the IELTS exam. Thus, the main purpose of participating students was to learn vocabulary to pass the exam may have affected the effectiveness of interventions used by the control and experimental groups. In addition to this limitation, it should be considered that the study had a relatively small sample size, which must be considered before generalizing its findings. Since this study relied on small sample size, it may be necessary to replicate it with a larger population in future studies. Even though the group who used digital flashcards outperformed the group who used paper flashcards, this does not mean that traditional flashcards should be discarded because they can provide several benefits that are less investigated by researchers.

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