

A Review of Empirical Studies of Effectiveness of Mobile Apps on EFL Vocabulary Learning

Zeng Hongjin

Department of Foreign Language, Tianjin Normal University, Binshuixi Street, Tianjin, China

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Abstract: Although mobile apps have been used for many educational purposes, little is known about how effective these apps are in EFL (English as a Foreign Language) vocabulary learning. To fill this gap, this study centered on the effectiveness of mobile apps on EFL vocabulary learning. A total of 18 articles were collected from 3 selected databases—Web of Science, Eric, and Academic Search Complete. The findings were analyzed through content analysis. The results provide a profile of using contexts of mobile applications for EFL vocabulary learning and the impacts of using mobile apps on EFL vocabulary learning outcomes. Mobile applications are mostly used in informal learning contexts and adopted in higher education for EFL vocabulary learning. The studies also identified 8 categories of impacts, including vocabulary acquisition and retention, administration for learning, pronunciation feature, usage frequency, learners' perceptions and attitudes, motivation and interest, feedback and evaluation, and learning environments. Implications are discussed, and suggestions for future research are provided.

1 INTRODUCTION

In recent years, the rapid development in communications and wireless technologies has resulted in mobile devices (e.g., PDAs, cell phones) becoming widely available, more convenient, and less expensive. More importantly, each successive generation of devices has added new features and applications, such as Wi-Fi, e-mail, productivity software, music player, and audio/video recording. Mobile devices could open new doors with their unique qualities such as “accessibility, individualization, and portability”(Saran & Seferoglu, 2010, p.253). One of the main current trends of educational applications for new technologies is mobile learning. O'Malley et al. (2003, p.6) have defined mobile learning as taking place when the learner is not at a fixed, predetermined location or when the learner takes advantage of learning opportunities offered by mobile technologies. Kukulska-Hulme (2005) defined mobile learning as being concerned with learner mobility in the sense that learners should be able to engage in educational activities without being tied to a tightly-delimited physical location. Thus, mobile learning features engage learners in educational activities, using

technology as a mediating tool for learning via mobile devices accessing data and communicating with others through wireless technology.

The new generation, as digital natives (Prensky, 2001) or the Net generation (Tapscott, 1998), enjoy using the latest technology such as online resources, cell phones, and applications. Prensky (2001, p. 1) conceptualizes digital natives as a young generation of learners who have grown up engrossed in recent digital technological gadgets. The young generation is “surrounded by and using computers, videogames, digital music players, video cams, cell phones, and all the other toys and tools of the digital age”(Andarab, 2019). The advocates of digital natives believe that educational communities must quickly respond to the surge of the technology of the new generation of students (Frاند, 2000). Along with the surge of the device, ownership is a growing obsession with smartphone applications (apps). As a result, most young adults have an access to smartphone applications. Meanwhile, 90% of users' mobile time has been spent on using apps (Chaffey, 2016) that encompass all aspects of our lives, such as books, business, education, entertainment, and finance. The ownership and use of mobile devices generate and facilitate more non-formal language learning opportunities for learners (Kukulska-Hulme, 2009).

Mobile technologies allow students to access learning content of all types anywhere and at any time (Kukulka-Hulme & Shield, 2008; Kukulka-Hulme, Lee, & Norris, 2017; Pachler, Bachmair, Cook, & Kress, 2010). Likewise, most university students are equipped with touchscreen smartphones (Yu et al., 2018).

However, offering students mobile devices does not guarantee their effective use to acquire language knowledge (Chen, 2013; Stockwell, 2008). As Conole and Perez-Paredes (2017) argue, students' learning outcomes are not merely determined by the technology itself. Learners use the same technology differently to achieve their learning aims (Lai, Hu, & Lyu, 2018), but many may fail to effectively use the resources available due to a lack of digital literacy skills (Conole & Perez-Paredes, 2017). To address this issue, a study on the effectiveness of mobile apps is of great importance.

With the increasing popularity of mobile learning, language learning assisted with mobile technologies is becoming a new focus of educational research. This phenomenon has prompted educators and researchers to take a pedagogical view toward developing educational applications for mobile devices to promote teaching and learning. As a result, research on mobile learning has expanded significantly (Kukulka-Hulme & Traxler, 2007). However, this growing body of literature has focused on several broad areas of inquiry, such as the development of mobile learning systems and how mobile technologies assist learning a language (e.g., exploring the widely-used commercial L2 learning apps like Duolingo) (Loewen et al., 2019), paying less attention to the effectiveness of mobile-assisted EFL vocabulary learning. It is identified that among those students who use mobile apps to learn a language, most of them use mobile apps for vocabulary learning. Although statistics suggest that the number of students learning vocabulary through mobile apps is increasing (Makoe & Shandu, 2018), little is known about how effective these apps are in EFL vocabulary learning. To fill this gap, this study focused on the effectiveness of mobile apps on EFL vocabulary learning.

It is unreasonable to expect any single study to tell us to what extent mobile applications assisted EFL vocabulary learning is effective in improving language learning. However, a comprehensive review of the existing studies can get us closer to an answer (Cavanaugh, 2001).

To this end, this study centers around EFL vocabulary learning assisted with mobile applications.

The specific research questions that this study aims to address are as follows:

- RQ1: In what contexts have mobile apps been used for EFL vocabulary learning?
- RQ2: What are the impacts (if any) of using mobile apps on EFL vocabulary learning outcomes?

This study is significant in several aspects. It was determined that research on vocabulary learning strategies is related to the indirect vocabulary learning strategy (Bauman & Kameenui, 2004; Stahl & Nagy, 2006). When, why, and how mobile apps are used by EFL learners to learn vocabulary has been researched. However, there is a lack of empirical review of the effectiveness of mobile apps assisted EFL vocabulary learning. Furthermore, the acquisition of mobile apps is of great importance for students with limited vocabulary and language skills in academic and professional lives. In the teaching and learning processes, mobile devices could create new models with their unique qualities, and the physical characteristics (e.g., size and weight), input capabilities (e.g., keypad or touchpad), output capabilities (e.g., screen size and audio functions), file storage and retrieval, processor speed, and the low error rates" (Alzu'bi & Sabha, 2013, p.179). EFL learners, one of the leading mobile user groups, are facing a "transitional period" from formal teacher-led English learning to non-formal self-directed English learning (Mellati, Khademi, & Abolhassani, 2018). Against such a background, this study aims to figure out the practicability of mobile apps to assist vocabulary learning, which helps to enlarge EFL learners' English vocabulary and diverse cultural knowledge in helping them to acquire a high level of English and culture understanding. Moreover, vocabulary teaching is at the heart of developing proficiency and achieving competence in the target language. This study evaluated the impact of using mobile apps on EFL vocabulary learning outcomes, which affords teachers an overall dialectical view to improve their teaching methods. Also, there is a need to determine exactly what strategies are employed by mobile developers on apps and their effects on vocabulary learning. In this sense, this study can offer apps developers a fundamental review of learners' needs of vocabulary learning.

2 METHODS

2.1 Data Sources and Search Process

Data were collected from three databases, including the Web of Science, Academic Search Complete, and Eric. The reason for selecting these three databases

was that they were the most commonly cited databases for educational research. Particularly, the Web of Science is generally deemed to be one of the most reliable databases for scholars in social science research (Bergman 2012). Common search key words “apps(applications) vocabulary learning” was applied in the databases for search any publication which contains “apps (applications) vocabulary learning” in its content.

After the initial literature search, a total of 88 results were produced in the 3 databases, including 30 duplicates that were deleted. The author read through the abstracts of the remaining 58 articles and determined whether they were appropriate to be included in the review by inspecting carefully to find whether it met the inclusion criteria. A total of 31 articles were determined consequently. Then the author further examined these articles by full-text scrutinizing and excluded 13 articles. Finally, a total of 18 papers were reviewed and analyzed for this study. Figure 1 demonstrates the search process of the literature.

2.2 Inclusion and Exclusion Criteria

Guided by the research questions, the following inclusion criteria were applied:

(1) The empirical research must be conducted with mobile apps(applications). Studies that deal with other kinds of apps, such as computer apps, were excluded.

(2) The empirical research must be conducted with vocabulary learning. Using the word like the level of vocabulary or vocabulary acquisitions is also acceptable. Articles that deal with other educational purposes such as grammar, writing, or listening were excluded.

(3) The empirical research must deal with learning English as the second language. Articles that stress learning English as mother language or learning other languages such as Chinese, Korean, Japanese were excluded.

(4) The empirical research must include empirical findings with actual data. Articles that present personal opinions and theoretical argumentations were excluded.

(5) The empirical research must be published in a peer-reviewed journal. Books, book chapters, and conference proceedings were excluded. However, review articles on mobile apps assisted vocabulary learning were read. The information from these reviewed articles was used as background information.

(6) The empirical research must be written in English. All other languages were excluded.

2.3 Data Coding and Analysis

To address the first research question concerning in what contexts mobile apps have been used for EFL vocabulary learning, data were coded in an inductive way using content analysis (Cho & Lee, 2014). Contexts in this study were defined from different dimensions, including geographical information, grades of students, learning contexts (Eaton, Ph, & Eaton, 2010). Moreover, research methods used in the articles reviewed were also analyzed.

To explore the impacts of using mobile applications on EFL vocabulary learning outcomes, content analysis (Cho & Lee, 2014) was employed again. First, units of analysis such as “peer pressure could encourage Chinese EFL learners’ interests and motivation in language learning” were identified by scrutinizing the results of the section of each study for open coding. To complete open coding, preliminary codes appearing from the articles (such as “motivation” or “interests”) were decided, and then all the results were coded with these codes. When data did not adapt to an existing code, new codes were added. Next, similar codes were grouped and placed into categories that were revised, refined, and checked until they were mutually exclusive to form the final categories (such as “motivation and interests”). Impacts of using mobile applications to learn vocabulary were recorded and numbered in notes first after each article had been read and then were compared cross articles to find common patterns for theme generation (Cho & Lee, 2014). Themes from the categories were developed through a qualitative design through a grounded theory (Glaser & Stauss, 1967).

All papers were scrutinized gingerly and completely by the author. In order to intensify the validity of the results, two stages were adopted. First, the literature on the impacts of mobile applications assisted EFL learning was reviewed thoroughly for theoretical validity. Moreover, an expert was invited to examine the categories of impacts of mobile applications assisted

EFL vocabulary learning that emerged from the data analysis by the author and to confirm the results by reviewing the main findings of the 18 studies identified. The inclusion criteria for the expert reviewer were based on his academic impact, including publications, citations, H-index, and i10-Index. An agreement rate of 62% was yielded in that the author and the expert agreed on eight categories

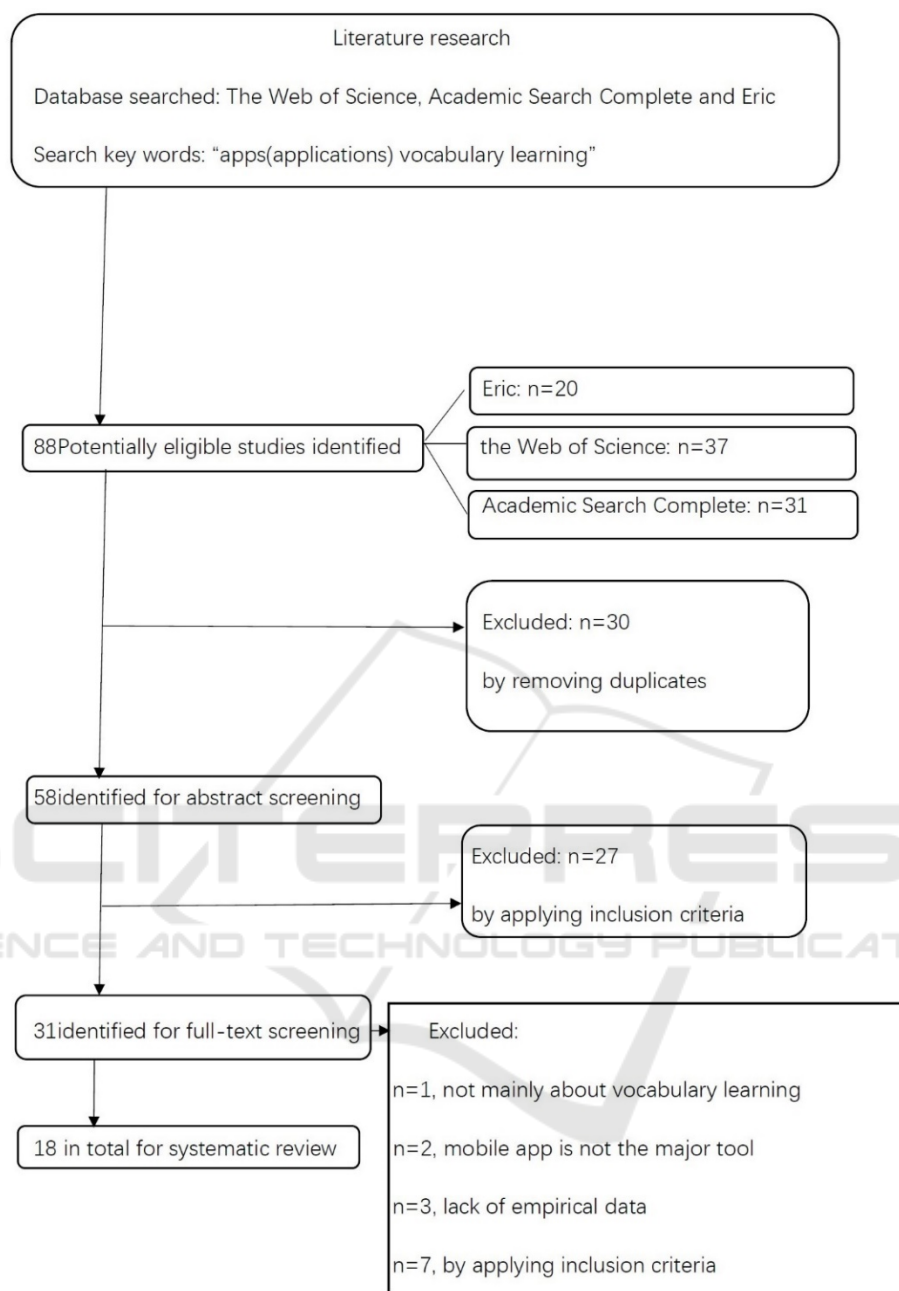


Figure 1: The search process of the literature.

of the impacts out of thirteen. Distinctions were resolved through discussion until consent was reached. At last, eight categories of the impacts of using mobile apps in EFL vocabulary learning were explicated. No prior assumptions were generated before the analysis. The results emerged inductively from inspecting and interacting with real data.

3 RESULTS

3.1 RQ1: In What Contexts Have Mobile Apps Been Used for EFL Vocabulary Learning?

The geographical distribution of relevant studies was examined (Figure 2). The results indicated that the

majority of the studies were conducted in Asia (10), which includes Turkey (1), China (5), and Japan (4) respectively; four studies conducted in Middle East countries with three in Iran and one in Arab countries; two studies conducted in Europe included Spain (1) and Czech (1); one conducted in South Africa and one study did not indicate country and region.

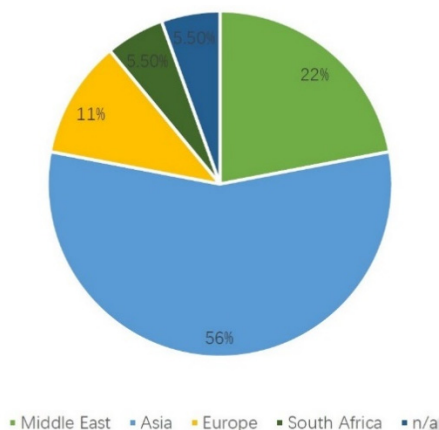


Figure 2: Numbers of studies distributed based on geographical information. *n/a=not applicable.

The studies were conducted in different grades (Figure 3). The studies covered ranges from primary school to college and university. The results concluded that most studies were conducted in colleges and universities (12), two conducted in primary school and one in senior high school. There is one study that did not indicate the research context.

While most studies were conducted in the setting of higher education, the learning contexts were different (Figure 4). The systematic review of Eaton (2010) suggested that formal learning is a type of learning arranged by institutes and guided by a curriculum that is organized and structured, in contrast with informal learning that is spontaneous, experiential, not arranged by institutes, and not guided by a curriculum. Non-formal learning means organized learning but granted no credits and not evaluated. Based on the data, over half of the studies were conducted in either non-formal (3) or informal (11) contexts. Only four studies were conducted in a formal learning context, in which the use of mobile applications was well organized and structured, also arranged by institutes, and guided by a curriculum.

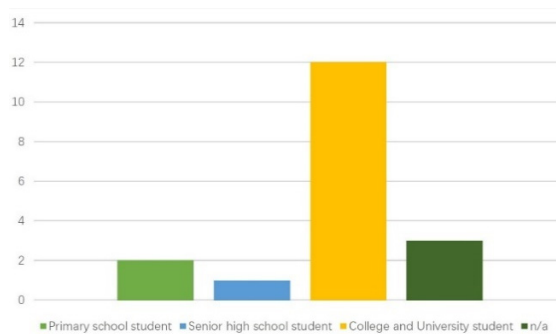


Figure 3: Numbers of studies based on grades of students. *n/a=not applicable.

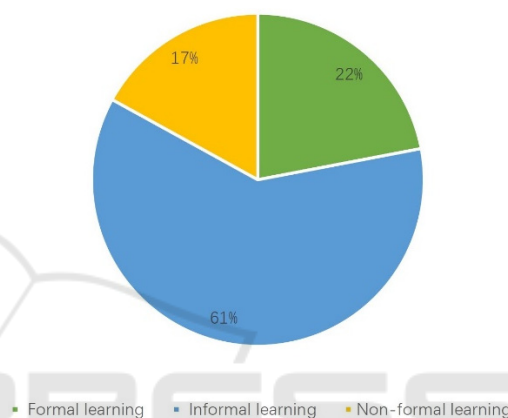


Figure 4: Numbers of studies distributed based on learning contexts (Eaton, Ph, & Eaton, 2010).

In terms of research methods, the studies reviewed adopted both qualitative and quantitative research methods. The quantitative research methods mainly included quasi-experimental designs with assessment and questionnaire surveys. Interview, observation, reflection, and transcript analysis were encompassed in qualitative research methods. As shown in the bar chart below (Figure 5), most studies adopted quantitative research methods (11). On the contrary, qualitative research methods (1) was hardly used. Also, a growing number of researchers relied on mixed-methods (6), compared with single adoption of qualitative studies or quantitative studies. Since this study began in early 2020, the total number of studies in 2020 is relatively small. However, the general trends in the chart indicate that the number of studies on mobile apps assisted vocabulary learning is increasing, and the employments of all research methods are on the rise.

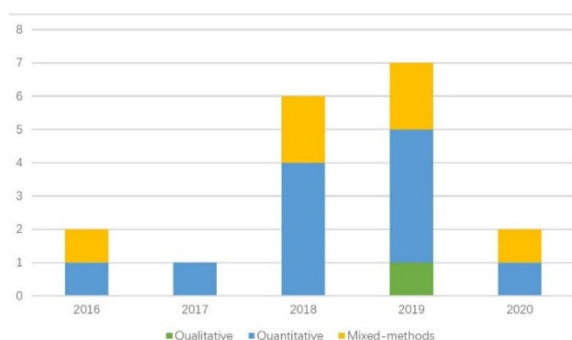


Figure 5: Numbers of studies distributed based on research methods.

3.2 RQ2: What Are the Impacts (if Any) of using Mobile Apps in EFL Vocabulary Learning?

To figure out what the impacts of using mobile apps in EFL vocabulary learning are, Table 1 and Table 2 are provided below. Table 1 is about the application systems and related learning strategies reported in the studies reviewed. Eight categories of impacts that emerged from the study are presented in Table 2.

3.2.1 Vocabulary Acquisition and Retention

Vocabulary acquisition and retention refer to learners' ability to memorize and acquire vocabulary assisted by using the mobile application. For instance, according to Demmans Epp and Phirangee (2019), Students' test scores improved while the mobile tool was being frequently used and failed to improve when usage subsided. It was indicated that students' acquisition and retention were likely to improve after using mobile applications in a high frequency. Likewise, Ma and Yodkamlue (2019)'s study results indicated that students with the mobile apps showed a statistically significant acquisition of words. Chen et al. (2019) found that game-related functions of mobile applications were conducive to vocabulary acquisition. It was shown that there existed reasonable and strong correlations between learning outcomes with the usage time of gamified functions, thus improving vocabulary acquisition performance. The results of Ma and Yodkamlue (2019)'s study demonstrated that the participants with the mobile app were able to retain more words in their long-term memory because of spaced review and the convenience of using the mobile app to review everywhere. Similarly, compared with MEVLA-NGF (mobile English vocabulary learning apps without game-related functions), Chen et al.'s study(2019) confirmed that MEVLA-GF (mobile English

vocabulary learning apps with game-related functions) achieved its educational goal and effectively assisted learners in improving their vocabulary size. Analytical results show that MEVLA-GF positively influenced learners' vocabulary acquisition and was helpful in augmenting the learners' ability to dispel the graduated interval recall hypothesis (Pimsleur,1967), thus effectively assisting learners in retaining vocabulary. However, Chen and Lee (2018)'s study indicated that both students in the experimental group and control group obtained a significant improvement in the performance test and revealed no significant differences between the two groups. Studies also indicated that the apps were not very supportive of their vocabulary acquisition and retention (Klimova & Polakova, 2020).

3.2.2 Administration for Learning

Administration for learning refers to the function of mobile applications to push notifications such as sending events reminders. Studies showed that app's notifications were helpful because it served as a constant reminder to engage in learning for most distant students who have other work to do besides studying (Makoe & Shandu, 2018). On the contrary, Klimova and Polakova's (2020) study indicated that students did not reach a consensus on the notification. Half of the students appreciated the notifications, which helped them study regularly, and the other half did not, which was also reflected in replies of most students that the app had a neutral effect on their study behavior. Again, this might have been caused by receiving the notifications at a not suitable time of the day.

3.2.3 Pronunciation Feature

One important feature of mobile applications that also seems to be connected with vocabulary is the pronunciation feature.

Students used the pronunciation model of the app to train their English skills. For example, based on the questionnaire, the users found the app beneficial – they especially liked features such as listening to word pronunciation (Enokida et al., 2017). The other study showed that participants requested to include a word pronunciation feature for VocUp, a mobile application for vocabulary learning (Makoe & Shandu, 2018).

3.2.4 Motivation and Interest

Students' motivation, interest, engagement, and confidence improved when involving mobile

Table 1: Apps Availability on Mobile and Tablet platform and Related Learning Strategies.

Apps	iOS	Android	Surface App	Web based	Collaboration	Phonological Analysis	Morphological Analysis	Contextual Analysis	Game	Quiz/ Assessment
Busuu App	✓	✓	✓	✓		✓	✓	✓		✓
Vocabulary Flashcards 2016	✓	✓						✓		✓
WhatsApp	✓	✓	✓	✓	✓		✓	✓		
GREvocabulary application	✓	✓	✓	✓	✓					✓
PHONE Words		✓			✓				✓	✓
Vocabulary Notebook	✓	✓	✓	✓		✓		✓		✓
Socrative			✓	✓	✓					✓
VocabGame	✓		✓			✓	✓	✓	✓	✓
Excel@EnglishP olyU				✓				✓	✓	✓
Quizlet				✓		✓	✓	✓		✓
HiroTan App	✓	✓	✓	✓		✓	✓	✓		✓
My-Pet-Shop				✓				✓	✓	
VocUp		✓				✓	✓	✓		✓
3 rd World Farmer				✓				✓	✓	
English Today	✓	✓		✓		✓		✓		✓

Table 2: Impacts of using mobile applications in EFL vocabulary learning.

Impacts	Contents	Freq.	Studies
Vocabulary acquisition and retention	Students' ability to acquire and remember vocabulary	14	(Ma & Yodkamlue, 2019) (Andarab, 2019) (Franciosi, Yagi, Tomoshige, & Ye, 2016)
Pronunciation feature	Students use application's pronunciation model to train their English skills	5	(Demmans Epp & Phirangee, 2019) (Makoe & Shandu, 2018)
Usage Frequency	Students show different frequency in mobile applications usage	7	(Ebadi & Bashiri, 2018) (Zhang & Pérez-Paredes, 2019)
Learners' perceptions and attitudes	Learners' beliefs, perceptions and attitudes about their vocabulary competence and the use of apps	9	(Demmans Epp & Phirangee, 2019) (Chen & Lee, 2018) (Makoe & Shandu, 2018)
Motivation & Interest	Promoting learning motivation, learners' interests, engagement and confidence.	12	(Ma & Yodkamlue, 2019)
Learning environment	Learning conditions that affect the behavior and development of students' learning	5	(Chen & Lee, 2018) (Ma & Yodkamlue, 2019)
Evaluation & Feedback	Quick delivery of and access to evaluation and feedback through quiz, assessment and game	6	(Makoe & Shandu, 2018) (Yarahmadzahi & Goodarzi, 2020)
Administration for learning	Pushing notification such as sending events reminders	2	(Makoe & Shandu, 2018) (Klimova & Polakova, 2020)

applications in learning. According to Demmans Epp and Phirangee(2019), students understand words easily with the help of a mobile application that provides a multimedia learning environment for learners to learn the target words. The mobile application also stimulates students' motivation. Results of studies indicated that assisting the lexical items with a theme or visual aids could help to motivate vocabulary learning (Andarab, 2019). Also, studies suggested that mobile game applications mostly had been used to improve motivation and interest to learn vocabulary (Elaish, Ghani, Shuib, & Al-Haiqi, 2019).

3.2.5 Usage Frequency

Students use mobile applications at different frequencies. For instance, one study identifies users into 4 groups: excited users, just-in-time users, responsive users, and frequent users (Demmans Epp & Phirangee, 2019). In this study, students tended to use the application to support learning activities in more protracted sessions. These sessions were spaced over time but tended to last upwards of 40 to 50 min (students' entire spare period). This amount of focused time is well outside the range expected for microlearning activities (Beaudin et al., 2007; Edge et al., 2011), especially those conducted through mobile devices (Ferreira, Goncalves, Kostakos, Barkhuus, & Dey, 2014). Studies also suggested that the students with the new, cross-platform application exhibited a relatively significant tendency of frequent, steady, and periodical logins than those with the old, PC-only one. The analyses suggested that the cross-platform, mobile-optimized web application elicited the students' ability to regulate their everyday self-accessed online learning (Enokida et al., 2017).

3.2.6 Learners' Perceptions and Attitudes

Learners' attitudes and perceptions towards their vocabulary competence and the usage of the mobile application is of great importance to vocabulary learning. The studies suggested that the users held positive attitudes towards the application because it influenced their learning positively and provided them with both form and meaning-focused instruction, even though they were dissatisfied with the levels and authenticity of the contents presented by the app (Ebadi & Bashiri, 2018). Likewise, findings indicated that students held different attitudes towards different functions and perceived the mobile apps as facilitative for some learning actions. In addition, students would choose the implementation of the mobile app in other courses taught by teachers.

Therefore, the teachers should always think about the purpose of the use of the mobile app in encouraging students' learning for generating higher learning outcomes (Klimova & Polakova, 2020).

3.2.7 Learning Environments

Mobile applications provide learners with learning environments different from the traditional learning context, which affect the behavior and development of students' learning. Studies found that mobile application provided a multimedia learning environment for learners to learn target words (Ma & Yodkamlue, 2019). According to Chen & Lee (2018), incorporating digital games to support language learning provided students with an interactive environment to enrich students' learning experience. Also, ubiquitous, inexpensive, powerful, and creative learning environments can provide new and fantastic interaction opportunities and multi-synchronous modes of learning environments by employing portable social network applications such as WhatsApp and Viber (Mellati, Khademi, & Abolhassani, 2018).

3.2.8 Feedback and Evaluation

Evaluation and feedback can be provided immediately by mobile applications. For instance, Makoe and Shandu (2018)'s study found that learners showed their satisfaction towards the fact that the mobile app was interactive in that the exercises helped them to get prompt feedback on assessing their understanding of the content. The app provided device-human interaction that facilitated feedback in the absence of human-human interaction. Students considered the feedback very strict when they made just a small mistake, such as the lack of a full stop, but they enjoyed the correction feedback of their performance. Nevertheless, the strictness of feedback is on purpose to make students realize the importance of accuracy (Klimova & Polakova, 2020).

4 DISCUSSIONS

4.1 Using Context of Mobile Applications in Vocabulary Learning

Results of this study indicated that research methods of studies in mobile apps used in EFL vocabulary learning were mostly quantitative research. However, qualitative research methods can be introduced to the

studies of mobile apps used in vocabulary learning. Moreover, the advantages of qualitative methods and quantitative methods can be combined to improve the validity of the study (Creswell, 2014). The qualitative study contributes to understanding the human condition in different contexts and a perceived situation, which can also help to study the influences of using mobile apps in different learning contexts (Creswell, 2013).

Also, mostly the mobile apps were used in informal and non-formal learning contexts. The research found students had a waning interest in using the mobile application over the term. However, the impetus for some students to use the support tool was maintained (Demmans Epp & Phirangee, 2019). This result implies that teachers could adapt mobile applications in a formal learning context by which can help students increase their vocabulary knowledge and give test which is closely related to what they learn from mobile vocabulary learning. As shown in the literature, test scores could be improved when mobile tools were frequently used and failed to improve when usage subsided (Demmans Epp & Phirangee, 2019).

As regards students' grades, most of the app users are college students, which is comprehensible for most university students equipped with touchscreen smartphones (Yu et al., 2018). The second large group is primary school students. It is suggested that developing a good educational game is an optional method to arouse young children's interests in English vocabulary learning and assist them to achieve their immediate and long-term vocabulary goals. As Chen & Lee (2018) mentioned, the mobile application used in vocabulary learning especially educational games, enhanced motivation in terms of the goal, feedback, autonomy, and immersion aspects. Meanwhile, the finding leads us to think about how to use mobile applications to learn vocabulary in senior high school. Most importantly, students should be given brief orientation and lectures by instructors (Demmans Epp & Phirangee, 2019). Research implied that students were more likely to use mobile applications to assist their vocabulary learning when they spent most of their time on individual work (Demmans Epp & Phirangee, 2019). This result suggests that providing brief instructions and facilitating students to work individually will contribute to the increasing use of mobile applications for vocabulary learning in secondary school.

4.2 Impacts of using Mobile Applications on EFL Vocabulary Learning

The studies reviewed indicate that the reason to design and implement mobile applications is mainly to improve the learners' vocabulary acquisition and retention and enhance English vocabulary teaching and learning (Makoe & Shandu, 2018). Different studies result in different conclusions. Most studies found mobile applications are effective in promoting students' vocabulary learning (Ma & Yodkamlue, 2019; Mellati, Khademi, & Abolhassani, 2018). On the contrary, some studies imply that mobile applications are not supportive of vocabulary learning (Chen & Lee, 2018; Klimova & Polakova, 2020). These two different results demonstrate that the impacts of using mobile applications in EFL vocabulary learning still remain controversial, and more empirical studies are in need to further explore this topic. It should be cautious about adopting mobile applications in vocabulary learning. The results of this study demonstrate special features of mobile applications which can be applied by learners, teachers, software designer, and government to enhance learning outcomes.

Mobile applications provide learners with learning environments different from traditional learning contexts, which give learners much more freedom and break the boundaries of time and space. Learners should learn to use mobile applications effectively at any time and any place with their own learning paces. However, the existence of too much freedom also challenges language learners to overcome numerous distractions (Mellati et al., 2018). Therefore, parental and teachers' supervision is of great importance to mobile application use. Students should develop the ability to be self-disciplined. In addition, different mobile applications have different features, such that learners can choose the suitable one according to their own learning style, cognitive competence, vocabulary knowledge, and the one which can best improve their learning motivation and interests.

Moreover, the results of this study indicate that the notification feature of mobile apps is supportive because it served as a constant reminder to engage learners in learning (Makoe & Shandu, 2018). Thus, with this feature, teachers can give timely notifications to administrate distant vocabulary learning. On the other hand, students did not reach the consensus on notification mostly because receiving notifications at a not suitable timing (Klimova & Polakova, 2020), which implies that teachers should

give notifications in seasonable timing and in an appropriate frequency. Otherwise, students may feel annoyed with this notification feature.

Considering the feedback and evaluation of mobile applications, teachers cannot depend much on them. While the exercises on mobile applications help learners to obtain prompt feedback on assessing their understanding of the content (Makoe & Shandu, 2018), the strictness of feedback and the absence of human-human interaction makes students feel uncomfortable (Klimova & Polakova, 2020). Accordingly, teachers can adopt the effectiveness and accuracy of feedback and evaluation from the mobile application with the provision of formative evaluation and student-oriented feedback in the teaching and learning process. Also, the findings suggest that mobile game applications have been mostly used to improve motivation and interest to learn vocabulary (Elaiish, Ghani, Shuib, & Al-Haiqi, 2019), which can be adopted to teach lower grade students. Likewise, students' acquisition and retention are likely to improve after using mobile applications in a high frequency (Demmans Epp & Phirangee, 2019). Thus, teachers should integrate the mobile applications in traditional and formal learning contexts, which promise students to use mobile applications frequently.

Pronunciation features, administration for learning, evaluation, and feedback, and gamification are proved to be inductive to EFL vocabulary learning. This implies that software developers ought to add these features to mobile applications. The problem of downloading mobile applications should be taken into account as some users are wary of the applications costly, others are concerned about the security of applications. Therefore, failure to study the protection and security of mobile applications can obstruct their adoption and use (Makoe & Shandu, 2018). Although mobile applications facilitate student-content and student-device interaction where the learners appreciate the privacy of working alone, other learners may feel that they needed student-student and student-teacher interaction (Makoe & Shandu, 2018). Hence, the developer should include interaction and collaboration components in mobile applications such as chatting and ranking.

Based on the results, the challenges of using mobile applications include phone problems, network, and connectivity, as well as a lack of familiarity (Makoe & Shandu, 2018). One possible reason may be that not all learners possess a smartphone or the required application (Lander 2015). Hence, the government should make an effort to support the use of mobile applications officially

and financially and provide an established framework. A common understanding should be reached in schools and universities, which creates a sense of trust to relieve teachers, parents, and learners' concerns. Government and schools should also work together to establish programs to train skillful teachers. Furthermore, particularly online sources, managerial cooperation, and administrative structure should be provided to control online distractions (Mellati et al., 2018).

5 CONCLUSION AND FUTURE DIRECTIONS

This study investigated how mobile applications assisted vocabulary learning by conducting qualitative research. The results of this study indicated that mobile applications assist vocabulary learning with different features, such as feedback and evaluation. However, the problems of using mobile applications still exist.

A number of factors limited the results of this study. The first limitation is concerning data sources. The reviewed studies were searched from three selected databases, and the only peer-reviewed journal articles were included. Therefore, studies from other resources were excluded, such as other databases, book chapters, dissertations, and government reports. Second, the key words for searching were "application vocabulary learning," which might exclude some studies that involved applications but defined in other ways.

No literature searched and reviewed in this study was found exhaustive. Hence, further research should use more data sources to obtain a more holistic picture of the relation between mobile applications and vocabulary learning. According to the results of the study, more qualitative research should be conducted. Particularly, empirical research could be conducted to investigate mobile applications and vocabulary learning. First, how different elements and functions of mobile applications interact with each other to impact learning outcome and learning competence. For instance, researchers could explore how to use mobile applications as a resource to design vocabulary learning activities for students. Then observe how students develop their vocabulary acquisition and learning competence through these activities. Second, how the mobile applications can be integrated into teaching could be investigated as a context-based understanding of the educational potential of different technologies is partly

determined by teachers' perceptions (Brown, 2012). Third, where mobile applications might be adopted in different educational settings, and cultural contexts could be investigated. As found in this study, the use of the mobile application is limited to certain regions and learning contexts.

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APPENDIX

Table 3: Summary of 18 studies reviewed.

#Studies	Research question	Main findings
1 (Demmans Epp & Phirangee, 2019)	How application use related to changes in student vocabulary knowledge?	Learning is likely tied to the task design (i.e., whether it encourages deep processing) and repeated effort rather than the mobile tool's support for noticing or fast and extended mapping.
2 (Ma & Yodkamlue, 2019)	The effects of a self-developed mobile app on Chinese university EFL learners' vocabulary learning and retention.	The mobile app was feasible and effective in helping EFL learners learn more words and retain them in their long-term memory.
3 (Chen & Lee, 2018)	How application-driven model influence aspects of learning performance?	A quiz game with the support of application-driven model contributed to enhance flow experience and better learning self-regulation.
4 (Enokida, Sakaue, Morita, Kida, & Ohnishi, 2017)	How the HiroTan app assists Japanese students with effective vocabulary learning?	Users found the app beneficial and they especially like several features.
5 (Makoe & Shandu, 2018)	How to design and implement a mobile-based application aimed at enhancing English vocabulary teaching and learning?	Technological, as well pedagogical, aspects of mobile-app interventions are essential for vocabulary teaching and learning.
6 (Chih-Ming Chen, Huimei Liu, & Hong-Bin Huang, 2019)	The effects of PHONE Words, a novel mobile English vocabulary learning app (application) designed with game-related functions (MEVLA-GF) and without game-related functions (MEVLA-NGF), on learners' perceptions and learning performance.	Mobile English vocabulary learning application with game-related functions is more effective and satisfying for English vocabulary learning than without game-related functions.
7 (Yarahmadzahi & Goodarzi, 2020)	Whether utilize mobile phones in EFL classroom can influence the process of vocabulary formative assessment and consequently improve vocabulary learning of Iranian pre-intermediate EFL learners or not?	Applying technology to facilitate study improves vocabulary learning of participants better than those who are assessed formatively based on traditional way.
8 (Ebadi & Bashiri, 2018)	EFL learners' perspectives about their vocabulary learning experiences via a smartphone application.	The users held positive attitudes towards the application because it influenced their learning positively and provided them with both form and meaning-focused instruction, but they were dissatisfied with the app's levels and authenticity.
9 (Klimova & Polakova, 2020)	Students' perception of the use of a mobile application aimed at learning new English vocabulary and phrases and describe its strengths and weaknesses as perceived by the students.	Students perceived the mobile app as facilitative for some learning actions but was not supportive regarding communication performance.
10 (Enokida et al., 2018)	The new, cross-platform application or the older, PC-based Web-Based Training (WBT) system, which is mor effective for vocabulary learning?	The total learning duration, the outcome, and learning efficiency are almost equivalent between the experimental and control groups. However, the cross-platform, mobile-optimized web application elicited the students' ability to regulate their everyday self-accessed online learning.
11 (Andarab, 2019)	Has humor been also extensively indicated to carry a significant role in vocabulary learning? The effect of humor-integrated pictures on vocabulary acquisition of 45 intermediate English as foreign language (EFL) learners on Quizlet.	The significant effectiveness of technology in vocabulary learning can be boosted with the help of humorous context.

Table 3: Summary of 18 studies reviewed. (cont.)

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11 (Andarab, 2019)	Has humor been also extensively indicated to carry a significant role in vocabulary learning? The effect of humor-integrated pictures on vocabulary acquisition of 45 intermediate English as foreign language (EFL) learners on Quizlet.	The significant effectiveness of technology in vocabulary learning can be boosted with the help of humorous context.
12 (Mellati, Khademi, & Abolhassani, 2018)	The impact of creative interaction in social networks on learners' vocabulary knowledge in Online Mobile Language Learning (OMLL) course.	New technologies established authentic and effective interaction between human and computer in learning contexts as well as challenges that developing countries are faced with in conducting OMLL courses.
13 (Bazo, Rodríguez, & Fumero, 2016)	How Vocabulary Notebook assists vocabulary learning?	By using the application Vocabulary Notebook, the students were able to tackle the problem of incorporating specialized vocabulary derived from the use of Content and Language Integrated Learning (CLIL) in their classes.
14 (Franciosi, Yagi, Tomoshige, & Ye, 2016)	Could less complex simulation games also support the acquisition of a foreign language?	Gameplay with a simple simulation does enhance long-term vocabulary retention which may be beneficially applied in acquisition of foreign language vocabulary.
15 (Kohnke, Zhang, & Zou, 2019)	The effects of the app to enhance undergraduate students' knowledge retention of business vocabulary of different difficulty levels through extended ubiquitous learning opportunities.	Mobile gamified educational programs are a fruitful avenue for students to expand their business vocabulary knowledge and retention.
16 (Rosell-Aguilar, 2018)	How did users perceive the mobile app busuu?	A large proportion of users consider apps a reliable tool for language learning with vocabulary as the main area of improvement.
17 (Elaish, Ghani, Shuib, & Al-Haiqi, 2019)	Whether the developed VocabGame can motivate native Arab students learning the English language to achieve better performance?	VocabGame app should be part of the daily English curriculum for learning the English language. Following the feedback and statistical analysis, the features of the app can be improved in terms of designing better graphics to motivate students in their learning process.
18 (Zhang & Pérez-Paredes, 2019)	What are the uses and the motivation behind language learners' selection of mobile assisted language learning (MALL) resources?	Vocabulary development remains Chinese postgraduate EFL learners' biggest concern. Vocabulary resources, including vocabulary learning and mobile dictionary applications, are rated as Chinese postgraduate EFL learners' most favorite resources. They also prefer to take recommendations from social media and experienced experts.