

A Scoping Review on Mobile Learning Empowering College Students' English Vocabulary Learning

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Abstract: Mobile learning, characterized by its convenience, flexibility and interactivity, has brought new opportunities for college students' English vocabulary learning. This paper employs a scoping review method, drawing upon 30 core journal articles indexed in CNKI and WOS from 2015 to 2024 as the primary data source. It systematically analyzed how mobile learning empower college students' vocabulary learning, its impacts and challenges. The results revealed the following: (1) Mobile learning supports vocabulary learning through means like vocabulary apps, online course platforms, and social media; (2) It not only accelerates vocabulary acquisition but also stimulates students' motivation, engagement and autonomous learning; (3) However, during implementation, it encounters challenges, including English vocabulary learning tools' insufficiency and learner capability constraints.

Keywords: Mobile Learning, College Students, English Vocabulary, Scoping Review.

1. Introduction

English is a global lingua franca, and vocabulary is the cornerstone of language learning, forming the basis of daily conversations and sentences. In the process of English learning, the importance of vocabulary is beyond doubt. Linguist Wilkins (1972) stated, "Without grammar, little can be conveyed; without vocabulary, nothing can be conveyed." Jeremy Harmer (1991), an expert in English teaching, once vividly portrayed that the language structure is the skeleton, while vocabulary is the flesh and blood. Mastering vocabulary is fundamental to students' language proficiency and a core aspect of college students' English learning. Whether students can grasp the vocabulary required by the exam syllabus directly impacts their overall learning outcomes (Tang, 2019). Namely, vocabulary plays a pivotal role in English learning. Mastery of English is fundamentally dependent upon efficient vocabulary acquisition. However, previous English vocabulary learning, relying on paper books or classroom teaching, are fraught with drawbacks like poor interaction, inflexibility, and lack of real-time support (Zhang & Li, 2019). Therefore, this might no longer meet the diverse and personalized learning needs of college students.

With the rapid information technology development and widespread mobile devices, mobile learning has emerged. This new approach, backed by mobile communication technology, lets learners use mobile devices to access learning resources anytime, anywhere, as needed (Ye et al., 2004; Liu & Ge, 2004). Exhibiting convenience, flexibility and interactivity (Dong, 2015; Cui, 2018), mobile learning offers new opportunity for college students' English vocabulary study. A host of relevant apps and online course platforms have emerged, providing flexible, efficient and diverse resources, and expanding learning means.

Research on mobile learning and college students' English vocabulary learning has covered various aspects, such as the development and application of vocabulary learning software or platforms (Su & Su, 2015; Chen & Han, 2017; Bilgin & Tokel, 2019), the effectiveness in improving vocabulary learning (Cao & Deng, 2019; Ling et al., 2019; Xodabande & Hashemi, 2023; Li & Gao, 2016), user usage (Zhang & Pérez-

Paredes, 2021), and influencing factors of user intention to use (Wang, 2023). However, few scholars have systematically reviewed these findings. To gain a comprehensive understanding of this research area, it's essential to review relevant literature. Thus, this paper aims to summarize existing research, analyze how mobile learning empowers college students' English vocabulary learning, its impacts, and the potential challenges. It is hoped that this paper can offer useful references for learners, educators, and application designers, helping them find new learning and teaching strategies, optimize mobile learning resources, enhance the effectiveness of college students' English vocabulary learning, and promote the sustainable development of mobile learning in this field.

2. Research Design

2.1. Research Questions

- 1) How can mobile learning empower college students' English vocabulary learning?
- 2) What is the impact of mobile learning in promoting college students' English vocabulary learning?
- 3) What challenges does mobile learning face in empowering college students' English vocabulary learning?

2.2. Research Method

This study adopted a scoping review method to comprehensively evaluate the application, impact and challenges of mobile learning in college students' English vocabulary learning. The scoping review is a rigorous and systematic research method aiming at comprehensive literature collection, evaluation and synthesis on a specific topic or research question. This method ensures comprehensive coverage and in-depth analysis of relevant research through clear research questions and systematic retrieval strategies. The scoping review follows a series of standardized steps, including literature screening, data extraction, quality assessment and result analysis, thus enhancing the credibility and objectivity of research results. This method can not only identify and integrate existing research achievements, reveal trends and gaps in the research

field, but also provide a scientific basis for practice, and has important guiding significance for policy formulation and future research directions.

2.3. Research Sample Screening

1) Literature Retrieval

For English literature, the Web of Science Core Collection was used for retrieval. The search formula was (“mobile learning” OR “m-learning” OR “mobile education” OR “ubiquitous learning” OR “Smartphone-assisted learning” OR “Tablet-assisted learning”) AND (“college students” OR “university students” OR “undergraduates” OR “learners”) AND (“vocabulary” OR “vocabulary learning” OR “lexical acquisition” OR “word learning”). The retrieval edition was confined to SSCI, the publication year was set from 2015 to 2024, and the categories were restricted to Education Educational Research, Linguistics, and Language Linguistics. Eventually, 35 articles were obtained.

For Chinese literature, the China National Knowledge Infrastructure (CNKI) database was used for retrieval. The following 10 search formulas were used successively: SU=移动学习*词汇*大学生、SU=APP*词汇学习*大学生、SU=在线*词汇学习*大学生、SU=移动*单词*大学生、SU=计

算机*词汇*大学生、SU=计算机*词汇*学生、SU=移动学习*词汇*大学、SU=应用*词汇*大学生、SU=移动*词汇*大学、SU=移动技术*词汇。The retrieval scope was limited to SSCI, CSSCI, and core journals, the retrieval time was set from 2015 to 2024, and the classification was limited to Philosophy and Humanities, Social Sciences Section I, Social Sciences Section II, and Information Technology. Eventually, 19 articles were obtained.

2) Literature Screening Criteria

After initial literature retrieval, to ensure the quality, relevance and timeliness of included literature, this paper set inclusion and exclusion criteria (see table 1) for manual screening. Firstly, the literature quality standard ensures the reliability and academic authority of selected works. Secondly, the timeliness standard makes sure referenced articles reflect recent trends and achievements. Thirdly, the research content standard requires literature to closely fit the review theme. Fourthly, the research object standard targets mobile learning for college students’ English vocabulary learning. By strictly applying these criteria, this paper aims to screen out valuable references for a comprehensive analysis of mobile learning in this context.

Table 1. Inclusion and Exclusion Criteria

Number	Inclusion Criteria	Exclusion Criteria
1	English literature from SSCI; Chinese literature from SSCI, CSSCI or core journals.	English literature not from SSCI; Chinese literature not from SSCI, CSSCI or core journals.
2	The publication year range from 2015 to 2024.	The publication year is either before 2015 or after 2024.
3	The research content involves mobile learning and English vocabulary learning.	The research content does not involve mobile learning and English vocabulary learning.
4	The research participants are college students.	The research participants are not college students.

3) Literature Screening Procedure

Before screening, research members discussed to clearly understand the criteria. During initial screening, researchers quickly browsed titles and abstracts, eliminated 3 non-research type literature pieces in the form of book reviews, with about 94% retention. Then, in re-screening, researchers read full texts of remaining literatures one by one, checked if

content and participants met criteria. For ambiguous ones (like unclear details but important results), researchers discussed. Finally, 16 content-inconsistent and 8 participant-deviated literatures were removed. A total of 30 eligible literatures were screened out, including 14 English literatures and 16 Chinese literatures (see figure 1).

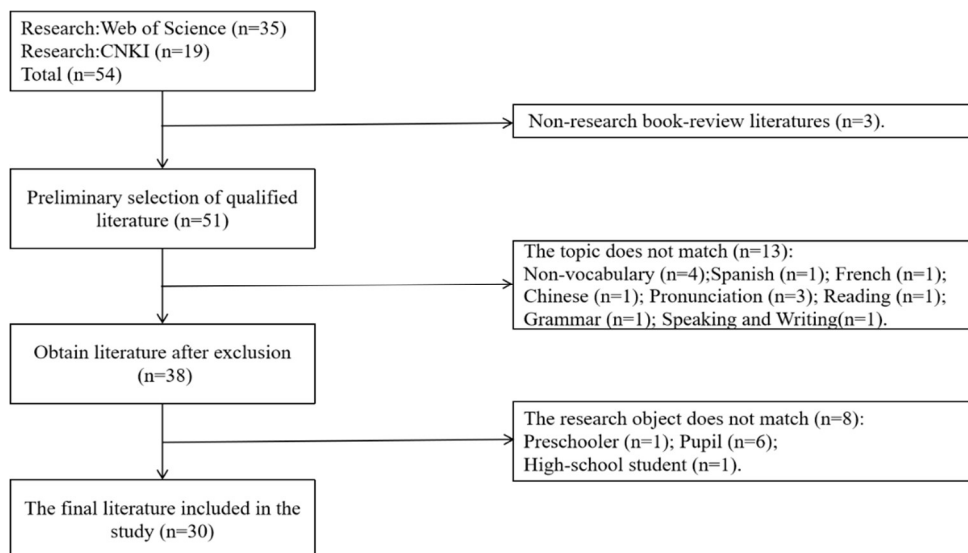


Figure 1. Literature Screening Procedure

3. Application of Mobile Learning in College Students' English Vocabulary Learning

The following represents a classification of various mobile learning tools that empower college students' vocabulary learning. These tools include specialized vocabulary applications, online course platforms, and other social media platforms, each with distinct features, and they have been widely utilized in the context of mobile learning to enhance vocabulary learning among college students.

3.1. Vocabulary Applications (APP)

Studies have indicated that mobile applications are among the most widely used mobile tools in college students' English vocabulary learning. Related research continues to emerge alongside the ongoing development and design of new English vocabulary learning apps. Su and Su (2015) developed a "Happy Farm" themed vocabulary game, integrating mobile learning with gaming to boost learners' engagement and motivation. The survey showed it significantly improved learning interest, usability, and vocabulary retention. Subsequently, Zhan and Zhang (2015) designed a lock - screen mobile vocabulary learning software for college students. A usability questionnaire revealed it enhanced students' learning efficiency, making the learning process more manageable while saving time. Additionally, Wu (2015) developed the Word Learning-CET6 Android app, which showed effectiveness in enhancing students' mastery of new vocabulary, with users acquiring about 89 new words on average. Wu and Liu (2016) created the Adult Degree English app, which increased learners' interest in English and vocabulary retention according to comparative tests and user feedback. Following this, Chen and Han (2017) designed a vocabulary learning app based on constructivist theory. Its features like mind mapping and audio explanations aided learners' understanding and retention of vocabulary and made good use of fragmented time.

Besides the development of new apps, scholars have extensively studied the effectiveness of existing popular English vocabulary apps. Ling et al. (2019) investigated the effects of gamified mobile learning for college English learners, and noted that through the gamified software Elevate, learners could more easily acquire English knowledge. Cao and Deng (2019) studied the "Bai Ci Zhan" app, Through questionnaires and interviews, they found it was widely recognized for vocabulary learning. Following this, Zhang and Pérez-Paredes (2021) explored the self-directed use of mobile English learning resources among Chinese graduate students, and discovered that mobile dictionaries and vocabulary learning apps were the most popular, further underscoring the importance of mobile learning tools in vocabulary acquisition. Finally, Lin (2022) introduced IdiomsTube, an app for acquiring formulaic language via YouTube videos, showcasing the potential of mobile technology in expanding vocabulary learning resources. Concurrently, Xodabande and Hashemi (2023) examined college students' use of e-textbooks as mobile applications for learning English vocabulary, emphasizing their positive impact on vocabulary learning.

This series of studies indicates that mobile learning apps are becoming essential for college students' English

vocabulary learning, providing diverse solutions to enhance vocabulary learning outcomes. Through the development and utilization of various applications, these English vocabulary apps have significantly increased learners' interest, engagement, and vocabulary retention efficiency. Therefore, various English vocabulary apps offer college students a wealth of resources and diverse learning methods, heralding the broad application potential and a promising future.

3.2. Online Course Platforms

Online course platforms have also injected new vitality into the field of education and play a crucial role, especially in college students' English vocabulary learning. They are digital learning environments that provide educational and training resources via the Internet. Such platforms allow teachers to upload teaching materials such as video lectures, reading materials, assignments and quizzes, and support the interaction between students and teachers as well as among other learners.

Several scholars have developed online course platforms to support college students' English vocabulary learning and tested their effectiveness through experiments. For instance, to assist learners in completing authentic tasks and promote contextual vocabulary learning within a situated learning environment, Bilgin and Tokel (2019) developed a mobile vocabulary learning system. The system provides experiment instructions and offers both visual and dictionary definitions with contextual sentences for each target vocabulary. Twenty-five elementary-level university students used the system to complete interactive experiments at a science and technology museum. And the results showed a significant difference in vocabulary scores across pretest, posttest, and retention test, with scores improving over time. Similarly, Luan et al. (2023) developed a situational English virtual simulation experiment teaching platform for English audiovisual-oral courses, which can be used for in-class training, testing, and students' autonomous practice. Sixty-eight non-English major undergraduates were divided into an experimental (VR players) and a control (video watchers) group. The results showed the experimental group's post-test vocabulary scores significantly outperformed the control groups. Furthermore, a corpus with a large amount of real vocabulary can be considered a special type of online course platform. With its assistance, students can more comprehensively and intuitively observe, analyze and summarize vocabulary features, collocation rules and other application knowledge, thus making vocabulary learning easier and effective (Yi, 2019).

Online course platforms are vital for college students' English vocabulary learning. Their diverse functions and innovative models provide ample resources and boost learning outcomes. But as an emerging thing, there's room for improvement. Future research could optimize platform design for individual needs, integrate advanced tech like AI and VR, and address challenges like access equity and teacher training. This will help unlock the full potential of these platforms and drive progress in college English vocabulary learning.

3.3. Social Media Platform

Social media platforms, with unique functions and large user bases, have also opened up new ways for college students' English vocabulary learning. Common social media platforms include WeChat, Xiaohongshu, Weibo, Tik Tok,

Facebook, etc. They provide rich and diverse vocabulary learning resources and create an interactive learning environment through user-generated content, sharing and interaction functions, and personalized push.

Several studies have been conducted to promote vocabulary development by integrating social media platforms into the English vocabulary learning process of college students. Research by Kurt and Bensen (2017), for instance, used Vine in their control experiment, which is a free mobile application that enables users to record and share an unlimited number of short, looping video clips with a maximum length of six seconds. The results showed that sixteen students from a private university in North Cyprus who prepared, produced, and watched Vine vocabulary videos (VVs) scored higher in the vocabulary test compared to those who had not used Vine. The results also indicated that VV was not only an effective tool for subconscious collaborative vocabulary learning but also an enjoyable and motivating one for learners. In another study involving 85 students in the Turkish EFL context, Avci and Adiguzel (2017) explored the effects of using mobile instant messaging application, WhatsApp on the language proficiency of EFL students. The students were assigned to create a class magazine as an out-of-school activity with the support of WhatsApp throughout seven weeks. The findings indicated the students had the opportunity to use the target language in an authentic group work project. In particular, had a chance to practice vocabulary knowledge, including various topic-based words and lexical collocations, and distinguished between formal and informal language through instant text messaging system during the magazine creation process.

These two studies focus closely on the specific applications of social media platforms in the context of college students' English vocabulary learning. They clearly demonstrate the great potential harbored by social media and the significant and non-negligible value of informal learning approaches in the field of education, thus providing rich and diverse inspirations for further attempts and in-depth explorations in this regard.

4. The Positive Impacts of Mobile Learning on College Students' English Vocabulary Learning

Previously, papers have delved into mobile learning tools and their applications. Then, what positive impacts can mobile learning actually bring to college students' English vocabulary learning? Next, the paper will concentrate on three aspects: vocabulary acquisition, enhancement of learning motivation and engagement, and strengthening of autonomous learning ability (See table 2).

4.1. Vocabulary Acquisition

In the education-technology integration context, mobile learning has exerted a remarkable promoting effect on college students' English vocabulary acquisition. This promotion is mainly shown in expanding vocabulary size, strengthening vocabulary knowledge mastery and application, enhancing memory, and improving academic performance.

Many studies confirmed the positive impact of mobile learning on expanding college students' English vocabulary size. Cao and Deng's (2019) questionnaire survey indicated that after using Baicizhan most college learners' English vocabulary increased, pronunciation improved, and they

could accurately use learned words. As Baicizhan enabling learning anytime, anywhere, providing diverse vocabulary lists with abundant resources, featuring novel learning forms, allowing immediate outcome testing, and facilitating timely review of poorly mastered words. Ling et al. (2019) explored the effect of the game software Elevate and found that learners' vocabulary proficiency improved, with an increased vocabulary size and notable progress in application. This was due to Elevate's rich multi-modal materials, which facilitated vocabulary understanding through multiple senses and application in context.

Mobile learning also demonstrates significant value in facilitating college students' mastery and application of English vocabulary knowledge. Research by Fang et al. (2021), showed that mobile-supported TBLT group outperformed the traditional TBLT group in vocabulary and conversation comprehension tests. More precisely, vocabulary knowledge and the functional use of the vocabulary. Li and Hafner (2022), found that both the mobile-based and paper-word cards enhanced L2 vocabulary learning. But the mobile application promoted greater gains on two-word knowledge components: namely, receptive knowledge of the form-meaning connection and productive knowledge of collocations. And in Xodabande and Hashemi's (2023) study, a better effect was found for using mobile-based electronic textbooks than using traditional materials on improving receptive vocabulary knowledge over a semester of experiment.

Learning vocabulary is just the starting point; retaining it in memory is key to achieving learning outcomes. Studies have pointed out that mobile learning is conducive to learners maintaining a favorable vocabulary acquisition effect. Under the network-based transnational cooperative teaching model, Feng et al. (2015, 2016) discovered that learners' acquisition of target vocabulary was promoted during real-time cross-cultural remote interactions, and the acquisition effect was well maintained in the one-week delayed test. With four groups of non-English major postgraduates, Li and Gao (2016) found that the combination of Mobile-Assisted Language Learning (MALL) and multimodality yielded the best retention effect on learners' vocabulary memory. Similarly, Klímová (2018) review also indicated that the use of mobile phones and/or smartphones and their apps generate positive effects on learning English, especially in the development and retention of vocabulary. Luan et al. (2023) conducted a quasi-experiment, with an experimental group doing virtual tasks and a control group watching videos. Results indicated that mobile-learning experimental group had better vocabulary learning outcomes, shown by increased interest, better knowledge retention, and higher test scores, due to contextualized learning and real-time feedback.

4.2. Motivation and Engagement in Vocabulary Learning

There also has been growing research on mobile learning technologies aimed at enhancing student motivation and engagement, demonstrating their significant potential in English vocabulary learning. Ling et al. (2019) emphasized the positive impact of gamified learning on student motivation, indicating that participants recognized the appeal of gamified content, believing that such learning methods effectively capture attention and stimulate motivation. Subsequently, Huang (2020) conducted research on virtual reality environments, revealing that these settings can provide

contextualized and immersive learning experiences, significantly improving vocabulary learning outcomes. Although learners' motivation still requires further enhancement, interview results indicated that students generally hold a positive attitude toward this novel learning approach. Following this, Luan et al. (2023) further explored the effectiveness of virtual reality environments in English vocabulary acquisition, highlighting their role in enhancing learners' situational experience and facilitating deep interaction. The study found that 54% of students reported that gamified learning allowed them to interact in real-time with characters in virtual scenarios, increasing the enjoyment of learning and further enhancing their motivation.

Building on this, Xodabande and Hashemi (2023) investigated the application of mobile e-textbooks in vocabulary learning through open-ended questionnaires and interviews. Their findings indicated three perceived benefits including situational learning, easy material access, and e-textbook-enhanced mobile vocabulary enjoyment, all of which collectively fostered active participation and enhanced

motivation among learners. Wang (2023) focused on the application of artificial intelligence technologies in mobile learning, showing that AI applications designed for mobile devices are user-friendly and can provide timely technical support during the learning process, thereby enhancing the overall learning experience. Driven by interest and motivation, the process of learning English vocabulary using artificial intelligence technologies was deemed as enjoyable, stimulating students' curiosity and willingness to learn.

In summary, mobile learning technologies significantly enhance college students' motivation and engagement by providing contextualized and interactive learning experiences, as well as enjoyable and intelligent learning support. These research findings suggest that the integration of modern technologies with vocabulary learning will be more effective in stimulating students' motivation and interest in vocabulary learning and promoting their active participation in future English learning contexts.

4.3. Autonomous Learning Ability

Table 2. Positive Impacts of Mobile Learning on College Students' English Vocabulary Learning

Positive Impacts	English Vocabulary Learning Tools	Manifestation	References
Vocabulary Acquisition	LiveOn System	Promote vocabulary acquisition; Maintain the acquisition effect well in the one-week delayed test	Feng et al. (2015, 2016)
	WeChat Public Account "Handheld English"	Yield the best retention effect on learners' vocabulary memory	Li and Gao (2016)
	mobile phones and apps	Promote the development and retention of vocabulary	Klímová (2018)
	Baicizhan	Increase college learners' English vocabulary; Improve pronunciation	Cao and Deng (2019)
	Elevate	Improve learners' vocabulary proficiency; Increase vocabulary size; Get progress in vocabulary application	Ling et al. (2019)
	A web-based Smartphone App and a Server	Promote the acquisition of vocabulary knowledge and the functional use of the vocabulary	Fang et al. (2021)
	Zhimi	Promote greater gains on receptive knowledge of the form-meaning connection and productive knowledge of collocations	Li and Hafner (2022)
	E-Books	Get better effect in improving receptive vocabulary knowledge	Xodabande and Hashemi (2023)
	Virtual Simulation Teaching Platform	Increase interest; Get better knowledge retention and higher test scores	Luan et al. (2023)
Learning Motivation and Engagement	Elevate	Capture attention; Stimulate motivation	Ling et al. (2019)
	VR	Provide contextualized and immersive learning experiences	Huang (2020)
	Virtual Simulation Teaching Platform	Enhance situational experience; Facilitate deep interaction	Luan et al. (2023)
	E-Books	Foster active participation; Enhance motivation	Xodabande and Hashemi (2023)
	AI applications	Provide timely technical support; Enhance the overall learning experience	Wang (2023)
Autonomous Learning Ability	WeChat Public Account "Handheld English"	Transform from passive recipients to active constructors to organize and process information	Li and Gao (2016)
	Evernote	Improve autonomous learning initiative; Cultivate learning strategies	Qian (2016)
	Corpus	Improve classroom satisfaction and the overall teaching effect; Strengthen awareness of learning initiative	Zhang and He (2017)
	Apps and Learning Systems	Increase students' opportunities for practice	Chai et al.(2019)
	Corpus	Stimulate learning initiative; Cultivate autonomous learning habits; Develop analysis and application ability in English vocabulary	Ji (2019)

In the mobile learning environment, students' roles have undergone significant changes. They have gradually

transformed from passive recipients of external stimuli to active constructors of meaning who can pay attention to,

organize and process information (Li & Gao, 2016). Meanwhile, the field of second language acquisition has been expanded. It is no longer confined to the classroom but extends to diverse places outside the classroom, which undoubtedly greatly increases students' opportunities for practice (Chai et al., 2019). These changes clearly indicate that mobile learning provides students with broad opportunities for autonomous learning.

Some scholars have introduced the positive roles that mobile learning plays in enhancing learners' autonomy in vocabulary learning. For example, the empirical research by Qian (2016) found that integrating Evernote, a closed-source multi-functional note-taking application from abroad, into teaching is beneficial for students to improve their autonomous learning initiative and cultivate learning strategies. Most students in the study indicated that they would take the initiative to spend more time independently studying syllabus vocabulary after class, and in learning strategies, they made breakthroughs by using pictures and sentence-making to assist memory instead of rote learning. Likewise, the research by Zhang and He (2017) found that applying the corpus to the vocabulary teaching of engineering specialized English could significantly improve students' classroom satisfaction and the overall teaching effect, strengthen students' awareness of the importance of specialized English and their learning initiative. This research result strongly corroborates the view put forward by Ji (2019) that in the autonomous learning of English vocabulary, the corpus can effectively stimulate students' learning initiative, thus cultivating their autonomous learning habits and developing students' autonomous analysis ability and creative application ability in English vocabulary.

All in all, mobile learning has transformed students' learning patterns. The conversion of learning roles and the expansion of learning scope endow students with more autonomous space. The research on tools like Evernote and corpus has strongly demonstrated the value of mobile learning in enhancing learners' autonomous learning abilities. Looking ahead, educators should further explore how to cultivate autonomous learners in the digital age.

5. The Challenges of Mobile Learning on College Students' English Vocabulary Learning

Mobile learning benefits college students' English vocabulary learning but has challenges. English vocabulary learning tools' insufficiency, learners' capacity constraints in resource selection and learning strategies need to be addressed. Joint efforts from software developers, learners, and teachers can solve these issues for effective mobile learning.

5.1. English Vocabulary Learning Tools' Insufficiency

In mobile learning, college students face a multitude of challenges, the first of which pertains to technology access and barrier. Qian (2016) conducted research on vocabulary learning in a computer-assisted language learning environment and identified potential problems when using software such as Evernote for vocabulary learning. For instance, managing the learning process with Evernote can consume more time for learners, as creating vocabulary lists takes longer than merely memorizing words mechanically.

Ling et al. (2019) pointed out that while there are numerous mobile learning-oriented applications available, the issue of localization within these applications deserves attention. Taking Elevate as an example; its fully English user interface and operating system settings can pose certain obstacles for language learners.

Following that, Lin (2022) developed an intelligent tool for computer-assisted formulaic language learning and explored its application in YouTube video learning. Despite some functional innovations, this tool still exhibits certain deficiencies, particularly in determining the teaching priority of each formulaic language element (FE), distinguishing between metaphorical and literal forms of FEs, and overcoming issues arising from the lack of uniformity in user-uploaded content. And Wang (2023) indicated that mobile applications based on artificial intelligence technology still need enhancement in terms of their entertainment features. Luan et al. (2023) highlighted that while students generally hold a positive attitude toward the application of virtual reality technology in vocabulary learning, certain technological barriers persist in practical usage. Interview results revealed that there is a necessity for more in-depth exploration in curriculum design concerning the content design and integration across different learning platforms. Furthermore, Xodabande and Hashemi (2023) found that the challenges perceived by students primarily relate to health issues, distraction, and external pressures associated with the mobile environment. These problems may stem from excessive mobile device use and have adverse effects on students' vocabulary development.

In summary, mobile learning faces multifaceted technical challenges when assisting college students in vocabulary learning. From the technological perspective, these challenges include the need for further improvement in technology's experimental content and platform design, functional deficiencies in intelligent tools, localization issues within applications, the scientific nature of learning content, and health problems and distraction caused by excessive mobile device use. To more effectively leverage mobile learning to promote vocabulary learning among college students, future research should further address these challenges and propose corresponding solutions in technological access.

5.2. Learners' Capacity Constraints

In the growing popularity of mobile learning, mobile devices like phones and tablets serve as new knowledge portals, making learning seem easy. But in fact, learners' capability deficiencies stand out when adapting to this new mode, posing an urgent challenge.

On the one hand, learners are deficient in resource screening. In the information explosion era, facing numerous English vocabularies learning materials like diverse vocabulary apps, online courses and electronic dictionaries, they often fail to identify suitable resources matching their learning levels and actual needs. According to Zhang and Pérez-Paredes (2021), few learners can choose appropriate mobile English learning resources for their current learning demands; instead, they rely on social media and experts' advice. This reliance on external guidance and lack of autonomous discrimination surely impedes learning. Without the capacity to independently identify high-quality resources, learners may intuitively squander time and energy on ineffective ones, inevitably undermining learning outcomes.

On the other hand, learners fail to utilize learning strategies effectively. Zhang and Pérez-Paredes (2021) also noted that the portability of mobile devices enables learners to quickly access mobile English learning resources, which should boost vocabulary accumulation. However, few students use these resources for over an hour daily. And Wang (2023) showed that, despite numerous AI apps with learning resources in the app store, only a few students use them to make and complete learning plans. Evidently, most students lack the habit of regular, active engagement. Moreover, Ling et al. (2019) further disclosed the issue. Their research indicated that, although learners rate gamified learning highly, they fail to integrate learning strategies like pre-learning planning, post-learning reflection, and resource management into learning. This reflects learners' weak ability in self-planning learning processes, lacking system and foresight.

To sum up, when college students use software for mobile learning of English vocabulary, they face difficulties in resource selection and time management, failing to fully tap the value of mobile learning resources. Meanwhile, they have obvious flaws in applying learning strategies, unable to make the best use of quality software tools.

6. Conclusion

In the study of mobile learning empowering college students' English vocabulary learning, the scoping review of relevant literature has yielded the following key findings in response to the three research questions. Firstly, mobile learning empowers vocabulary learning through diverse means like vocabulary app, online course platforms, and social media platforms. Secondly, mobile learning promotes vocabulary acquisition by enabling fragmented learning and using intelligent tools, boosts motivation and engagement through gamified, immersive, and convenient learning experiences, and cultivates autonomous learning abilities as students manage their own learning and use diverse strategies. Thirdly, despite the remarkable achievements mobile learning has made in the development of college students' English vocabulary, it is undeniable that there is still room for improvement. For example, aspects such as English vocabulary learning tools' insufficiency, learners' capacity for resource selection and learning strategies need further refinement.

Having presented the research outcomes above, the practical implications can now be explored, which can be categorized into three main areas: technological advancements, learner development, and teacher support. From a technological perspective, continuous innovation in software design is essential. Developers should focus on enhancing user experience through intuitive interfaces, localization, and accessibility, ensuring mobile apps cater to non-native English speakers. Integrating diverse resources like gamified content, multimedia materials, and real-time feedback mechanisms can improve vocabulary retention. Additionally, addressing technical barriers such as device compatibility, internet access, and data security is crucial for widespread adoption. For students, effective mobile learning requires developing digital literacy and autonomous learning skills. Students must learn to select and evaluate appropriate resources, with educators providing guidance on resource selection and quality assessment. Training in time management and learning strategies, such as goal setting and reflective learning, can maximize the benefits of mobile learning. Encouraging a growth mindset and active

participation in mobile learning activities can enhance motivation and long-term vocabulary retention. Teachers play a pivotal role in implementing mobile learning. They need professional development to adapt to new technologies, including training in software operation, virtual reality course design, and AI integration. Teachers should transition from traditional knowledge transmitters to facilitators, designing interactive activities that encourage collaboration. Providing ongoing feedback and personalized guidance helps students navigate challenges and stay motivated in mobile vocabulary learning. In short, the successful integration of mobile learning into college students' English vocabulary education requires a collaborative effort from technology developers, students, and teachers. By addressing the challenges and leveraging the opportunities in each of these areas, mobile learning can become a powerful tool for enhancing vocabulary acquisition, motivation, and autonomous learning abilities among college students.

Considering these implications, it becomes apparent that there are several promising avenues for future research. In the integration of new technologies, artificial intelligence (AI) is poised to profoundly empower vocabulary learning. Future research can focus on developing personalized learning pathways with machine learning algorithms, conducting accurate learning assessments with natural language processing (NLP) technologies, collecting and mining learning behavior data via big data analytics, and creating immersive environments with virtual reality (VR) and augmented reality (AR) technologies to boost vocabulary learning innovation. Regarding long-term effects research, it is necessary to design rigorous longitudinal tracking experiments. This involves expanding the sample size (Li et al., 2024) and selecting students from different levels and discipline to continuously monitor their mobile learning behaviors and vocabulary learning outcomes over an extended period (e.g., one academic year or more). Standardized testing tools should be employed to regularly assess improvements in vocabulary acquisition, while surveys and interviews can be used to gather data on changes in students' learning attitudes, interests, and motivations. The impacts of factors such as learning frequency, resource types, and interaction levels on the long-term effects of mobile learning are also worth studying to support educational policies and teaching. In the field of cross-cultural comparative research, there is significant potential for conducting comparative studies on the effectiveness of mobile learning across different cultural and educational backgrounds. Representative countries or regions can be selected to investigate how cultural values, educational system structures (e.g., curriculum standards, assessment methods), and linguistic characteristics influence the acceptance, application modes, and learning outcomes of mobile learning. This will provide comprehensive insights for the promotion and optimization of mobile learning in English vocabulary instruction on a global scale, ultimately contributing to educational equity and quality enhancement.

In the future, with the continuous innovation of mobile technology and the development of educational concepts, mobile learning is expected to play an even more crucial role in college English vocabulary teaching and learning. It will provide a more solid guarantee for the efficiency and long-term effectiveness of English vocabulary learning, enabling college students to continuously reach new level in English vocabulary learning and better meet their academic

development and personal growth needs.

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