ABAC ODI JOURNAL Vision. Action. Outcome

ISSN: 2351-0617 (print), ISSN: 2408-2058 (electronic)

Vocabulary Instruction Using Mobile Applications to Improve Vocabulary Breadth of English Major Chinese Undergraduate Students

Xue Tao, Prannapha Modehiran

ABAC ODI JOURNAL Vision. Action. Outcome Vol 11(1) pp. 56-77

www. http://www.assumptionjournal.au.edu/index.php/odijournal

Published by the
Organization Development Institute
Graduate School of Business and Advanced Technology Management
Assumption University Thailand

ABAC ODI JOURNAL Vision. Action. Outcome
is indexed by the Thai Citation Index and ASEAN Citation Index

Vocabulary Instruction Using Mobile Applications to Improve Vocabulary Breadth of English Major Chinese Undergraduate Students

Xue Tao[1], Prannapha Modehiran[2]

[1]PhD Candidate, Graduate School of Human Sciences, Assumption University, Bangkok, Thailand Associate Professor, Heilongjiang International University, Harbin, China, Email: taoxue123@163.com
[2]PhD, Associate Professor, Graduate School of Human Sciences, Assumption University, Bangkok, Thailand, Email: prannapha@gmail.com

Received: 10 April 2023. Revised: 3 June 2023. Accepted: 29 June 2023

Abstract

Vocabulary is crucial in English language learning and teaching as acquisition of vocabulary is a primary requisite for English language use. In today's technological advancement where mobile applications affect all aspects of people's lives, designing a vocabulary instruction using mobile applications to improve students' vocabulary breadth is in line with the development of the time and can meet technophile students' preferences in learning English language. This research aimed to develop vocabulary instruction using mobile applications to improve the vocabulary breadth of sophomore English majors in a private international university in China (experimental group, N=30; control group, N=27). This research was an explanatory sequential design and employed a mixed method combining quantitative and qualitative methods to answer research questions. The instruction, which comprised of selected language learning principles as the foundation, was designed by putting into account the findings of the learners' needs. The mobile applications were applied during the process of vocabulary instruction. The results revealed that the experimental group who were taught vocabulary using mobile applications outperformed the control group who were taught vocabulary using the conventional method of teaching on the posttest scores of vocabulary breadth on both receptive and productive vocabulary at the significance level of .05. The semi-structured interview results indicated that students held positive attitudes towards learning vocabulary with mobile applications, vocabulary learning activities, and the effects of improvements in vocabulary breadth. The findings yield pedagogical implications on vocabulary learning and teaching using mobile applications.

Keywords: vocabulary breadth, mobile applications, Chinese undergraduate students

Introduction

English is crucial in today's global economy, serving as a universal language that facilitates communication and collaboration across industries and countries, particularly in business and commerce. As the world's lingua franca, English is also vital for China's

development in the new era. To meet this need, the Teaching Guidance Committee of Higher Schools of the Ministry of Education has issued the National Standards for the Teaching Quality of Foreign Languages and Literature in 2018, which includes specific requirements for cultivating English skills, focusing on vocabulary acquisition. This has led to a greater emphasis on cognitive vocabulary and vocabulary in use in college and university English Teaching Syllabi for English Majors.

The performance of Chinese undergraduate English majors when it comes to vocabulary knowledge was not optimistic as evidence from the results of TEM, the Test of English Major the compulsory, authoritative national English proficiency test for English majors in China, in both two levels: TEM-4 (Test of English Major Band-4) for the sophomores and TEM-8 (Test of English Major Band-8) for the seniors. The current research opted to deal with the sophomores so as to investigate into the students in the earlier year of the national test taking.

In 2020, the passing rate for the Test of TEM-4 was reported at only 57%, indicating poor vocabulary knowledge (Pan & Zou, 2020). Low passing rates were also observed in other TEM-4s from 2009-2019. Heilongjiang University (HIU), a private university in China, was also found to have low passing rates for TEMs among its students.

In accordance with the Standards, the TEM-4 national test requires English major sophomore students to have a grasp of 5,500-6,000 words for cognitive vocabulary and 3,000-4,000 words for vocabulary in use. The test includes various task types, such as dictation, listening comprehension, language usage, reading comprehension, and cloze tests, to measure receptive vocabulary. Productive vocabulary is measured through writing and oral tests. Passing this exam showcases the expertise of English majors and provides job opportunities in the future. However, despite students' serious preparation for the exam, their results were unsatisfactory, mainly due to a lack of vocabulary breadth (Zheng, 2009). To meet national, educational, and pre-professional requirements, it is crucial for Chinese English majors to strengthen their vocabulary mastery, which can be achieved by making vocabulary teaching more engaging and stimulating for the students.

The conventional Chinese English teaching methods for vocabulary involve teachers using cramming teaching methods which focuses on memorization rather than application, with little context or opportunities to use the vocabulary learned. This approach can lead to disinterest in learning and learners may struggle with the flexibility of vocabulary usage (Huang & Shu, 2020; Xing, 2021).

The 5G era provides an opportunity to improve teaching methods and encourage student output in vocabulary instruction. Mobile phones with their portability, social connectivity, context sensitivity, and individuality can be a useful tool for this purpose (Sung et al., 2015). The use of mobile applications in vocabulary instruction can be a practical solution to the vocabulary teaching problem. Chung et al. (2015) found that students were more receptive and effective when using mobile apps for learning words compared to the traditional methods. The current research aimed to construct a vocabulary instruction using mobile applications to improve the students' vocabulary breadth. As part of a consecutive research project, the instructional design exploited the results of the HIU students' experiences and preferences on vocabulary learning using mobile applications conducted precedingly by Tao (2023) and Tao and Modehiran (2023). The instruction was implemented on the HIU sophomores in the

experimental group. The effectiveness of the designed instruction and the students' opinions toward it were subsequently investigated.

The research questions of the current study include the following:

1.To what extent can the designed instruction improve vocabulary breadth of English major second-year undergraduate students in Heilongjiang International University in China?

2.What are the students' opinions towards the vocabulary instruction using mobile applications?

Literature Review

The construction of teaching mode of vocabulary instruction using mobile applications to improve vocabulary breadth was based on related studies involving the principles of constructing instructional design, mobile applications in vocabulary instruction, vocabulary breadth – the receptive and productive, findings of needs analysis on vocabulary learning and vocabulary learning by mobile applications, teacher's role and students' role in vocabulary learning and teaching as follows.

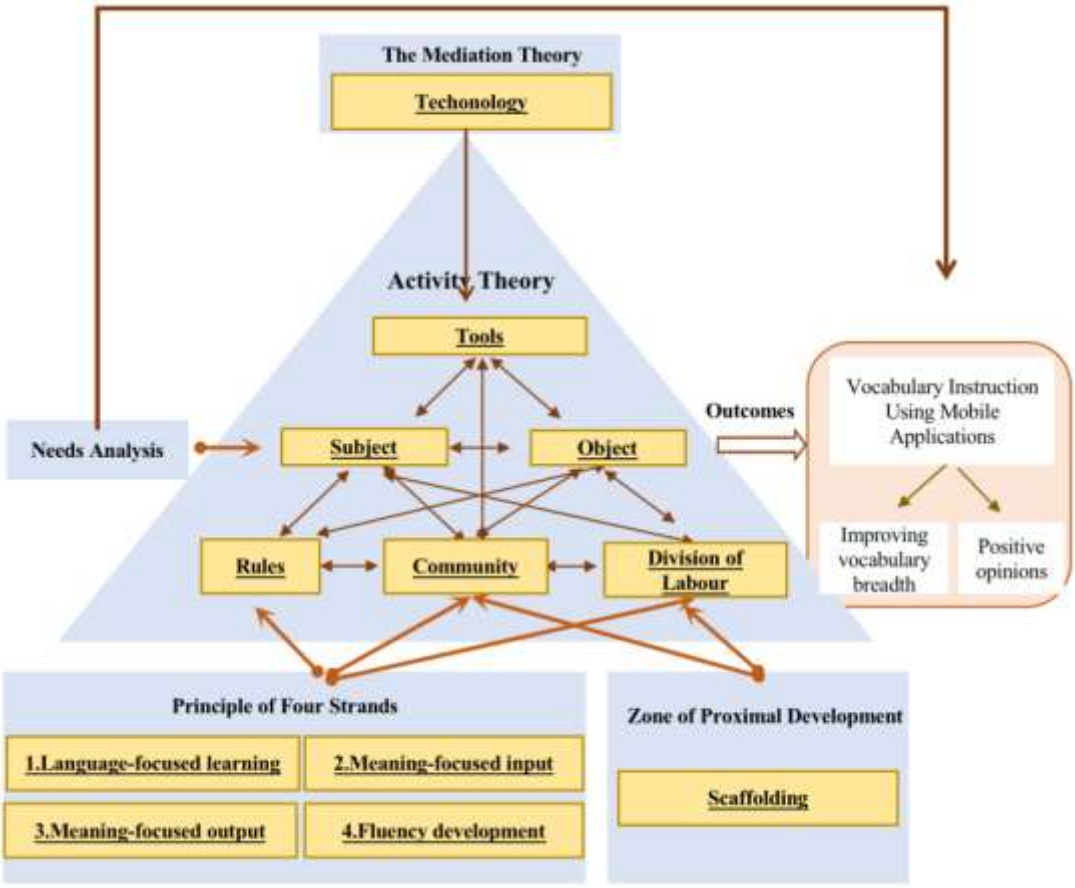
Principles Constructing the Instructional Design

The learning principles that were used in the construction of the instructional design of the current research included the activity theory, the four strands, the mediation theory, and the zone of proximal development (scaffolding).

The Activity theory (Engeström, 2015) was employed as a grand scheme of the designed vocabulary instruction by mobile applications. Six components of the activity system including subject, object, community, tools, rules and division of labour regulated the occurrence and sequence of the teaching and learning activities, the selection of the teaching contents, and the design of the teaching materials. The Four strands (Nation, 2007) which includes language-focused learning, meaning-focused input, meaning-focused output, and fluency development supplied a framework and balance the appropriate learning time as the teaching procedures and layout of the learning activities. Mediation Theory (Verbeek, 2015) the mediating role of technology applications based on the relationship between humans and technologies, was used to guide to design activities using mobile applications. The selected mobile applications in the current instructional design included WeChat, Fif, Keke English, Kahoot!, Flashcard, wenjuan.com, and e-dictionary(Youdao dictionary, momo dictionary, and Bing dictionary). The Zone of Proximal Development (Vygotsky & Cole, 1978) and the principle of "scaffolding" (Shabani et al., 2010; Wood et al., 1976) revealed the dialectical relationship between teaching, learning and development and was defined as the distance between the learner's ability to solve problems when learning alone and the ability to solve problems under the guidance of an experienced person. The scaffolding in this research was embodied in building student-centred vocabulary instruction, selecting and sequencing teaching contents in which the new vocabulary knowledge was added upon the student's background or existing knowledge, supporting and encouraging students systematically to complete the tasks and activities. The conceptual framework of this research is shown in Figure 1.

Figure 1

Research Conceptual Framework



Vocabulary Instruction Using Mobile Applications

Mobile applications have been used in many studies on vocabulary instructions including the studies that used the already existing applications, such as figurative idioms (Basal et al., 2016), word phrases (Klímová, 2019), and idiom instruction (Shahbaz & Khan, 2017) and the study that used their own invented application, such as Makoe and Shandu (2018). Several studies conducted experimental research and reported the findings that using mobile applications in the instruction overcame the problem of using conventional method (Govindasamy et al., 2019; Yafei & Osman, 2016). Other studies reported positive changes in students' cooperative learning, self-confidence, and learning style after using mobile applications to guide students' vocabulary learning (Rezaei et al., 2014; Gürkan, 2018; Elaish et al., 2019). These studies suggested the possibility, superiority, and advanced nature of using mobile applications to instruct vocabulary learning.

To date, there is no research using mobile applications to improve vocabulary breadth, therefore, this research applied mobile applications as tools combined with relevant theories to investigate and explore the ways to improve vocabulary breadth.

Vocabulary Breadth

Anderson and Freebody (1981) put forward that vocabulary knowledge included two dimensions: vocabulary breadth and vocabulary depth. Vocabulary breadth refers to the number of words individual learner knows, while vocabulary depth means how well the learner know them. The focus of the current study was on vocabulary breadth, since the number of words were fundamental but urgent to improve as it was specified and required by the Standards and the TEM.

Vocabulary breadth includes two parts: the cognitive and skill. The cognitive part includes the person's cognitive vocabulary (Harmon et al., 2010) or the number of words and their essential meanings the person knows in his vocabulary knowledge (Binder et al., 2017). The skill part includes the proficiency-in-use vocabulary of a person (Cavalli et al., 2016; Richard, 2011). Vocabulary breadth therefore comprises a person's receptive and productive vocabulary (Karakoç & Köse, 2017). Receptive vocabulary includes the vocabulary knowledge and skills a person has when receiving oral and written messages through listening and reading, while productive vocabulary includes the knowledge and skills being used when producing oral and written messages through speaking and writing (González-Fernández & Schmitt, 2017). Receptive vocabulary is the vocabulary input while listening and reading and productive vocabulary is the vocabulary output while speaking and writing (Nation, 2006).

Some previous research on vocabulary breadth dealt with either receptive or productive vocabulary (Amirzai, 2021; Chao et al., 2015; Che Hashim et al., 2018). Several others dealt with both receptive and productive vocabulary, for example Kirmizi and Kömeç (2019) found the influence of flipped classrooms on receptive and productive vocabulary learning from the perspective of non-modern technology, while from the perspective of modern technology, Dizon and Tang (2017) claimed the efficacy of digital over paper flashcards in improving receptive and productive vocabulary. Mortazavi et al. (2021) reported the satisfactory role of mobile devices in the primary language learning phase in improving productive and receptive foreign language skills. More research on applying mobile applications to improve students' receptive and productive vocabulary is still needed, especially for college English majors.

Current Situation of Chinese Undergraduate Students learning English Vocabulary

Studies have examined the learning of English vocabulary among Chinese undergraduate students. These investigations have excavated the methods that students use to learn English and vocabulary. Feng and Webb (2020) discovered that most Chinese students employ rote memorization and repetition when learning vocabulary, while emphasizing listening and reading over speaking and writing. Similarly, Fan (2022) identified common strategies such as repetition, inferencing, and self-initiated strategies. Scholars have proposed using multimedia technology and peer-to-peer interaction to engage and motivate students, ultimately improving their vocabulary and language proficiency. For instance, Li et al. (2021) recommended incorporating videos, songs, and games, while Chen (2021) found that cooperative learning can increase students' positive attitudes towards vocabulary learning. However, scant research has been conducted regarding the use of mobile applications to study vocabulary, particularly vocabulary breadth in the context of Chinese EFL students.

Needs Analysis on Vocabulary Learning and Vocabulary Learning by Mobile Applications

Using a needs analysis questionnaire, Tao (2023) and Tao and Modehiran (2023) conducted a study to analyze the target learners 'experiences and preferences and found that the HIU sophomore English majors expressed the necessity to improve their vocabulary breadth through a non-conventional teaching method. They showed doubts on the vocabulary memorizing method. They hoped the teacher or experienced peers could introduce or instruct them to learn the vocabulary by mobile applications and helped them to overcome lack of perseverance while improving their ability of learning vocabulary. They reported preferred ways and mobile applications to learn vocabulary using multiple means, including videos, audio, pictures, taking notes, definitions, and reading materials. Though students were weak in listening and speaking, they showed preferences to improve vocabulary knowledge by these two skills. As for vocabulary learning activities, students were fond of word dictation, vocabulary game, role-playing, storytelling, and group discussion. Students also reported their use of mobile applications which include mobile apps for vocabulary learning the most, followed by mobile social apps, and mobile entertainment apps, accordingly.

Research Methodology

Research Design

This research was an explanatory sequential design using both quantitative and qualitative data collection and analysis. The instructional instrument, the vocabulary instruction using mobile applications, was designed and implemented to the experimental group. Both experimental group and control group had the same vocabulary teaching contents but using different teaching methods. The experimental group adopted the new designed student-centered teaching method, while the control group employed the conventional direct instruction method. Both the pre-test and post-test including the writen test and oral test were constructed and used to investigate whether there was a significant improvement in student' s vocabulary breadth after the treatment. A semi-structured interview was conducted to investigate students' opinions towards the vocabulary instruction by mobile applications.

Research Participants

The research population included 215 English major sophomores in HIU, China. The 215 students were put into seven classes according to their English scores from the college entrance examination. The experimental group (N=30) and control group (N=27) were selected through convenience sampling as the researcher was also assigned to teach the two intact groups. The English proficiency levels of both groups were comparable, as evidenced by the similar exam results from the previous semester, with 74.38 as the mean score for the experimental group and 75.89 for the control group. Seven students were randomly chosen from the experimental group to participate in the interview after the posttest.

Research Instruments

The research instruments included the instructional treatment, the pretest and posttest, and the semi-structured interview.

Instructional Instrument – Lesson Design and Implementation

The instructional design involved the design of scope and sequence, lesson plan, learning activities, and instructional materials.

For the scope and sequence, all the target words which were the contents of the whole course were identified using the means of functions of Excel to select 537 target words which included 255 nouns, 156 verbs, 111 adjectives, 14 adverbs and one preposition based on the TEM-4 high-frequency vocabulary manual (The SISU Vocabulary Compiling Group of TEM-4, 2021) and the textbook used by students. After selecting the target words for the course, the themes, texts, activities and tasks were developed along the obtained words and lastly added into the sequence in the lessons. The lesson plans were created based on the planned amount of the learning contents and the order of the contents. Three experts checked the scope and sequence and lesson plan using the Item-Objective Congruence (IOC) index and the researcher modified the design based on the problems identified by experts regarding the scope and sequence and lesson plan.

As for the learning activities, the design of the activities followed the learning principles that frame the research. For example, the activities were added gradually in the according to the level of difficulty allowing the students to scaffold acquiring the new knowledge using the learned knowledge and the activities were put into receptive and productive skills within the four strands framework. The instructional design also took into consideration the findings of Tao (2023) and Tao and Modehiran (2023), the HIU sophomores'experiences and preferences, in designing the scope and sequence and lesson plans and in designing the learning activities and materials/resources. For example, the students preferred learning vocabulary by taking notes the most, the activities designed in assignment sheets allowing them to produce word bank cards using Flashcard mobile app to present a vocabulary item with the word spelling, pronunciation, part of speech, spelling, definition, original example sentence, and word relations. The activities responding to the students' preferences included uses of social and entertainment applications to learn words, such as Ding Talk, Fif, KeKe English, Flashcard, wenjuan.com., WeChat– the most popular social application in China, Tencent Online Document (mini program in WeChat) and Kahoot! an app of edutainment. Table 1 presents examples of learning activities.

Table 1

Examples of Learning Activities in and out of Class

	The Name of Activities	**The Details of Activities**	**Four Strands**
1	Key words located – Word form and function located in the sentence structure (Ding Talk)	In group of five, students read and learn the word list from assignment sheet on Ding Talk and are required to help within group to scan the reading text to locate the vocabulary in the word list. Then students compared the sentences that the words appear in the word list and in the reading text regarding their definitions, parts of speech, and functions in the sentence structure and report the findings to the class.(Teacher and/or students can recap the definitions of the words learned with the words in Chinese language.)	Language-focused learning

	The Name of Activities	The Details of Activities	Four Strands
2	I describe, you guess (WeChat)	The activity is a timed pair work. One sees one target word in the wordlist sent by the teacher in WeChat group, and describes the word to his/her pair by only giving its definition, part of speech, or word relation, allowing his/her pair to guess what the word is. The more correct answers in the limited time, the higher the score.	Language-focused learning
3	Guess the target words' meaning of the text by direct and wide context (Fif)	Students are assigned to read the reading text in Fif according to the requirement in Assignment sheet. 1) skimming reading - reading rapidly to get a general idea of the reading passage to get the general view of the text to answer the questions the teacher posed. 2) working in a group of five, students are assigned to read the text by scanning reading - reading rapidly to find specific facts in the reading passage to answer specific questions posed by the teacher. This is done in a competition style, which group get the answer first will get the score. 3) teacher and students recap the meaning of the vocabulary learned that appeared in the reading text and the meaning of the reading text itself using Chinese language.	Meaning-focused input
4	Homework check-class survey and report (Ten cent Online Document)	One student interview at least five students randomly to fill the survey list about the learn target words and their usage in Tencent Online Document according to the requirement in Assignment sheet. Students fill the blanks during asking interviewee's answer to assignment and then report the results in class.	Meaning-focused input/ Meaning-focused output
5	KeKe English Time (KeKe English)	Listening to the video examples of target words (assigned by teacher in assignment sheet) and try to use the contents of example as clue to make up a word mini-story and present. (e.g., word-freedom. The Video script: People in prison have lost freedom and want it back. The mini word story could be: I am a noun but I am very important. I begin with the letter f. People in prison have lost me and want me back. People demand me when it is taken away by dictators. I can be related to speech. Who am I?)	Meaning-focused input/ Meaning-focused output
6	Homework: word Bank (Flashcard)	Creat the word bank by Flashcard using the target words. The information (original example sentences and relative picture) of target words are required according to the assignment sheet.	Meaning-focused output
7	Fif Time (Fif)	Listen to the example sentences in Fif, and write down which target word you heard in the sentence and then followed the example sentences to practice sentences with target words.	Fluency development
8	Kahoot! Competition (Kahoot!)	Contents: target nouns (questions about synonyms, antonyms, superordinate or hyponyms), target verbs and adjectives (question designed based on example sentences from KeKe English and assignment sheets)	Fluency development
9	Picture Description Competition WeChat)	Group work: describe the picture sent by teacher in WeChat group using target words they have learned. The more target words in the sentences you describe, the more scores you get. Teachers select a few pair to present the competition.	Fluency development

For the instructional materials, assignment sheets were designed according to the planned content and the sequence of the learning activities. The mobile applications, as significant instructional tools were selected and assembled with the proper information related to the learned target words, example sentences, example contexts, and the activity instructions. The assignment sheets were designed to use together with the lessons which included the title and the detailed text instruction of each activity for guiding students to complete all the activities in and out of the class. The mobile applications selected for vocabulary instruction were all in line with students' learning experience and catered to students' preferences. For example, choosing KeKe English to design activities in the phase of meaning-focused input was based on its comprehensive function, which could meet students' preferences for video-audio materials to learn vocabulary.

The Pretest and Posttest

Vocabulary breadth can be measured by vocabulary-breadth scale in terms of receptive vocabulary and productive vocabulary. The current research employed a similar pretest/posttest in which test items were in a different order. All the test questions were examined by three experts through the IOC method, and the problematic items were modified by the researcher and were finally approved by the experts. All the test items were checked and the researcher took 537 TEM-4 high-frequency words required in the syllabus of General English as material to design the pretest and posttest. All the words used in the pretest and posttest were selected randomly.

The pretest and posttest were constructed including written and oral tests. Both the written test and oral test were composed of two parts: Part I Receptive and Part II Productive vocabulary tests. The distribution of word class from different levels of word frequency in Part I and Part II of written and oral test fell into a ratio of 3 noun groups: 2 verb groups: 1 adjective group (Schmitt et al., 2001).

For the written test, Part I was designed based on Vocabulary Level Test (Schmitt et al., 2001) to assess the receptive vocabulary, while Part II was designed based on Folse's (2006) Vocabulary Knowledge Scale to measure the productive vocabulary. Part I of the written test included three groups of verbs, two groups of nouns, and one group of adjectives. Each group had six words. Students needed to select 3 proper words to match the corresponding definitions or descriptions of the words. In part II of the written test, six verbs, four nouns and two adjectives were tested. Figures 2 and 3 present examples of the test items in the verb group testing the students' receptive and productive vocabulary.

Figure 2

Example of Test Item Measuring Students' Receptive Vocabulary Breadth

verb	A. revitalize	1)____to show that somebody/somethingis right or reasonable
	B. justify	2)____to make something stronger, more active or more healthy
	C. stabilize	3)____to take control of a country or city and its people by force
	D. recreat	
	E. conquer	
	F. assure	

Figure 3

Example of Test Item Measuring Students' Productive Vocabulary Breadth

1. I don't know what the word 'elaborate' means.
2. I know this word. It means _____. [Provide an English synonym or definition or a translation in your native language.]
3. I can use this word in a good example sentence. Here is my example sentence: _____. [If you do #2, you must also do #3.]

For the oral test, the first part assessed students' receptive vocabulary through listening, while the second part evaluated their productive vocabulary through speaking. Students randomly selected one test from ten oral tests. Part I of the oral test required the student to listen to six sentences with six target words (three nouns, two verbs and one adjective) and then the researcher would ask the students what the target word meant in the sentence. Part II of the oral test required students to make six sentences according to the six target words (three nouns, two verbs and one adjective). Figure 4 presents the example of the two parts of the oral test.

Figure 4

Example of One Set of Oral Test

Set 1 (Example)			
Part I: Listen to the following sentences and tell the meaning of the target words.			
1. They are fully **aware** of the harm of smoking.			
2. In Chinese culture the tiger is a **symbol** of king of animal.			
3. Jay Chou's concert has attracted a large number of **audiences**.			
4. The balloon burst with a **bang**.			
5. I want to **apply** for a job after having a baby.			
6. The police have the right to **arrest** criminals.			
Part II: Make sentences with the following target words.			
	adjective	noun	verb
Target words:	aware	symbol	apply
		audience	arrest
		bang	

Semi-structured Interview

The semi-structured interview aimed to investigate students' opinions towards using mobile applications to learn vocabulary through different activities and students' comments on mobile applications, activities process and teaching steps designed for improving the

vocabulary breadth. Five sets of questions in the semi-structured interview included 1) What is your general impression of vocabulary learning using mobile applications? What do you think of it when compared to the conventional vocabulary teaching? 2) What are your opinions towards the mobile applications which were used in and out of class activities (Fif, KeKe English, Flashcard, WeChat and Kahoot!)? How do you like the order of the activities carried out by the mobile applications? 3) What do you think are the effects of the learning activities? 4)What are your opinions on collaborative approaches to solving challenges in learning activities? What are the positive effects of cooperative methods on vocabulary learning? 5) To what extent do you think you improved your vocabulary breadth by this vocabulary teaching? Three experts checked the interview questions by the IOC index, and the questions were modified according to the experts' amendments.

Data Collection

The data collection had two phases: the first phase was the pilot study, and the second phase was the main study. Because the entire study was conducted during the epidemic of COVID-19, both phases of the study were completed online. The pilot study lasted two weeks. After the pilot study, the researcher revised the scope and sequence and lesson plans according to the problem identified in the pilot phase. Before the main study, both experimental and control group students finished the written part of the pre-test on the wenjuan.com, which was a popular questionnaire website in China and had an oral test on Ding Talk Meeting (Online Meeting Application), which was an online meeting and office platform in China. After 16 weeks, the posttest was conducted online in the same way as the pretest. After the posttest, for the semi-structured interview, seven students selected randomly from the experimental group were interviewed through Ding Talk Meeting. Both oral tests and interviews were recorded by video for further analysis.

Data Analysis

For the quantitative data, the scores of the pretest and posttest of the experimental and control groups were analyzed through a statistical analysis computer software SPSS 22.0. The descriptive statistics was used to analyze the mean and standard deviation within groups, while the referential statistics, the independent samples t-test, was used to compare between groups. The performances of the students' oral tests in the pretest and posttest were also recorded for the inter-rating scoring. For the qualitative data, the semi-structured interview was recorded and transcribed into texts using the deductive approach (Braun & Clarke, 2019) for thematic analysis to analyze the qualitative data. To ensure the consistent scoring of the oral part of both pretest and posttest and to ensure the coding validity and reliability of the interview, the two experienced ELT university instructors with 15 and 20 years of teaching experience were invited to assist with both the inter-rating pretest/ posttest scoring and the inter-coding for the semi-structure interview. The results showed 95% consistency in the scoring and 90% agreement in the coding.

Findings

The findings of the current study are presented in two parts: 1) the effects of the designed instruction on the students' vocabulary breadth and 2) the students' opinions towards the designed instruction.

The Effects of the Designed Instruction on the Students' Vocabulary Breadth

To investigate into to what extent the vocabulary instruction using mobile application improved the vocabulary breadth of the English major second-year undergraduate HIU students, the scores from the pretest and posttest of the experimental group and the control group were statistically analyzed by a computer software. The findings revealed that the students in the experimental group outperformed the ones in the control group.

Table 2

Independent Samples T-test – Comparison Between Groups in Pretest and Posttest

Item	Group	Pretest			Sig	Posttest			Sig
		N	M	SD		N	M	SD	
Total Score	Experimental	30	57.21	10.27	0.432	30	78.67	7.62	0.000
	Control	27	55.13	9.54		27	65.31	8.48	
Receptive Vocabulary	Experimental	30	36.06	4.96	0.124	30	41.67	5.28	0.000
	Control	27	33.87	5.64		27	36.48	4.27	
Productive Vocabulary	Experimental	30	21.15	7.46	0.953	30	37.00	5.96	0.000
	Control	27	21.26	6.33		27	28.83	5.92	

As can be seen in Table 2, in the pretest, the students in both experimental and control groups obtained quite similar. They had close total mean scores and standard deviation (Exp. M=57.21, SD=10.27; Ctrl. M=55.13, SD=9.54). They both got higher scores in receptive vocabulary (Exp. M=36.06, SD=4.96; Ctrl. M=33.87, SD=5.64) than in productive vocabulary (Exp. M=21.15, SD=7.46; Ctrl. M=21.26, SD=6.33). It can also be seen in the pretest results between the experimental group and the control group there is no significant difference at the level of .05 in the total score ($p=.432 > 0.05$), receptive vocabulary ($p=.124 > 0.05$), and productive vocabulary ($p=.953 > 0.05$). However, in the posttest, both groups performed significantly different, as can be seen from the results of the posttest between the experimental group and the control group which revealed a significance difference at the level of .05 in the total score ($p=.000 < 0.05$), receptive vocabulary ($p=.000 < 0.05$), and productive vocabulary ($p=.000 < 0.05$).

It can therefore be inferred that in the pretest, the students in the experimental group and the control group had no significant difference in their vocabulary breadth as a whole including the receptive and productive vocabulary as shown in the total score. Nonetheless, considering the posttest, the scores of the students in the two groups showed a significance difference. However, the scores of students in the experimental group in terms of vocabulary breadth, receptive and productive vocabulary are higher compared to the scores of students in the control group. It can be concluded that the students in the experimental group outperformed the students in the control group in their vocabulary breadth both receptive and productive

vocabulary.

However, the results of samples T-test conducted to see the comparison of scores within group revealed a significant increase of the posttest scores than the pretest ones in both groups (see Table 3). Despite the significant increase of the scores in both groups, it can be seen in Table 3 that the percentage of mean differences of the students' scores in the experimental group surpassed the ones in the control group by more than 50% in every aspect including the total score (Exp 37.51%; Ctrl 18.47%), receptive vocabulary (Exp 15.56%, Ctrl 7.71%), and productive vocabulary (Exp 74.94%, Ctrl 35.61%) respectively.

Therefore, it can be concluded that although the experimental group and the control group have both significantly improved considering the pretest and posttest scores, the students in the experimental group excelled themselves in improving vocabulary breadth in the total scores, receptive and productive vocabulary.

Table 3

Dependent Samples T-test – Comparison Within Group

Experimental Group (N=30)	**Pretest**		**Posttest**		**M Diff**		**Sig**
	M	**SD**	**M**	**SD**	**Score**	**%**	
Total Score	57.21	10.27	78.67	7.62	21.46	37.51	**0.000**
Receptive Vocabulary	36.06	4.96	41.67	5.28	5.61	15.56	**0.000**
Productive Vocabulary	21.15	7.46	37.00	5.96	15.85	74.94	**0.000**
Control Group (N=27)	**Pretest**		**Posttest**		**M Diff**		**Sig**
	M	**SD**	**M**	**SD**	**Score**	**%**	
Total Score	55.13	9.54	65.31	8.48	10.18	18.47	**0.000**
Receptive Vocabulary	33.87	5.64	36.48	4.27	2.61	7.71	**0.007**
Productive Vocabulary	21.26	6.33	28.83	5.92	7.57	35.61	**0.000**

The Students' Opinions Towards the Designed Instruction

The findings from the semi-structured interviews revealed the students' positive opinions towards the vocabulary instruction using mobile applications. The interview data supported the findings by the quantitative analysis of the pretest/posttest scores previously mentioned that the designed instruction significantly improved the students' vocabulary breadth. Table 4 shows the themes and topics from the coding and interview excerpt examples.

As can be seen in Table 4, the students in the experimental group expressed their positive opinions toward vocabulary instruction using mobile applications in the semi-structured interview in three themes and ten topics.

Mobile applications in Vocabulary Learning – Increase of Learning Motivation

Students thought learning vocabulary through mobile applications was beneficial in increasing their learning motivation. They thought conventional vocabulary instruction was too tedious to learn words but using mobile apps to learn vocabulary was interesting, effective, innovative and not monotonous with their specific functions, therefore they became fond of learning words by using mobile applications. Many useful mobile apps introduced and demonstrated by the teacher provided the students many brand-new means to learn words, such as following the reading on Fif which provided the students with the opportunity to practice their oral English while learning vocabulary, watching videos in KeKe English from different

sources with different contexts, joining words competition on Kahoot! with the sense of achievement after the word learning, enjoying the fun of learning words in a team, and making well illustrated word bank by Flashcard which could increase their motivation for learning and using vocabulary. All these learning activities through mobile apps inspired and motivated them to learn vocabulary.

Table 4

Themes, Topics and Examples of Students' Opinions Towards the Vocabulary Instruction Using Mobile Applications

Theme	Topic	Interview Excerpt examples
1. Mobile applications in Vocabulary Increase of Learning Motivation	1. General comments on learning vocabulary with mobile applications	1). "I used to learn words by reciting wordlists from textbooks. In class, I just learned what the teacher taught, and I recited words by rote. I thought learning words was a necessary but boring task. After using mobile applications to learn words, I think the method is an interesting, not boring, innovative learning method. A variety of mobile applications provide a variety of forms of learning, breaking the conventional way of learning words." 2)." In class, the teacher introduced and arranged many mobile learning activities through mobile applications, which were interesting and made usmore willing to explore the meaning and use of words. Everyone seemed to become very active, excited, and willing to work hard to complete the activities.
	2. Comments on vocabulary learning on Fif	1). "I needed to listen to each sentence carefully before I can complete the dictation of the target words. Then I repeated the sentences on Fif, and Fif showed me my score for accuracy and fluency. I sometimes read these sentences many times to obtain a satisfactory score. I like this scoring function and learning and reciting words this way." 2). "On the Fif, I can also strengthen my pronunciation of the words after remembering the meaning and usage of words."
	3. Comments on the vocabulary learning process by using KeKe English in and out of class	1)."KeKe English provided me with a wealth of video example sentences. While completing the activity, I could understand the usage and meaning of words in different contexts through videos." 2)."The video examples in KeKe English are classic examples from American TV shows, documentaries or TED Talks. These examples are also impressive and very helpful for learning words." 3)."While learning the words, I can also listen to the native pronunciation and expression, which kills two birds with one stone."
	4. Comments on the assignment task of making the process of word bank by using Flashcard and its significance	1). " In the process of completing the word bank with flashcards, we needed to discuss how to make sentences, illustrate example sentences and how to make flashcards. I gradually deepened my

Theme	Topic	Interview Excerpt examples
		understanding of the word' s usage." 2). "Making a word bank was a great achievement for all of us in our team. I was excited to learn to use these words as I thought about how to make a sentence with context."
	5. Comments on Kahoot! Competition in class	1)."Before the Kahoot! competition, we needed to do many word reviews to get good results. During the competition, group members encouraged each other even if anyone answered questions incorrectly. The Kahoot! competition greatly motivated me to study words well." 2."The excited Kahoot! Vocabulary competition motivated and interested me to work with my teammates to compete for group honor."
2. Benefits of Activities in Vocabulary Instruction	6. Group cooperation played a positive role in vocabulary learning	1)."We love using mobile applications to learn vocabulary together. After group members interacted with each other and discussed how to better complete the word learning activities, we had different duties to complete the activity. During this process, word knowledge was naturally mastered. Such learning experiences were so attractive." 2). "'To complete the task, get better grades and not hold the team back, we all studied vocabulary knowledge very hard and made positive efforts for the group' s achievement and honor. We like working and learning with teammates, and I feel excited about Kahoot! Competition and satisfying in making a good sentence with the target word or selecting the proper pictures for the original sentences while making the word bank by Flashcard.
	7. Solving various challenges encountered during the process of vocabulary learning activities	1). " During the completion of the activity, when we encountered problems, such as the use of mobile apps or the problems in the completion of the activity, we would discuss how to solve them together. As the saying goes, two heads are better than one. In the face of learning difficulties together, difficulties were not so difficult. In the process of solving difficulties, vocabulary knowledge was naturally improved." 2)."In discussing the solution of activity problems, we processed and pondered the words we have learned many times, which naturally improved our understanding of the words."
	8. The order of vocabulary learning and its effect	1). "Learning words in this order consolidated my word memory." 2)." This order of learning words not only helped me to remember the basic knowledge of words, such as pronunciation, spelling and usage but also helped me to improve my oral and written expression ability."
	9. Promoting vocabulary input and output by	1)." Various mobile applications have been applied to vocabulary classes. I felt new and interested, and

Theme	Topic	Interview Excerpt examples
3.Improvements in Vocabulary Breadth: Receptive Vocabulary and Productive Vocabulary	activities designed by using mobile application constellation	I truly felt the improvement in vocabulary through listening, speaking, reading and writing activities on different mobile applications. I was more willing to consider whether the word's context was appropriate when making sentences than ever." 2)."After various activities through mobile apps, I can use words better than before in speaking and writing. I can use words to make sentences and consider their context." 3)." This way of learning expanded my vocabulary knowledge, improved the ability to listen, speak, read and write in the process of learning words and enabled me to learn how to use words."
	10. Promoting vocabulary input and output by cooperation.	1)."The process of group discussion deepened the understanding of the words repeatedly and help us use the words." 2). "Everyone actively participated in the group discussion and continued to discuss a certain word, which was very helpful to our memory and mastery of words."

Benefits of Activities in Vocabulary Instruction

In different phases of four strands, the students completed different vocabulary learning activities. Most of the vocabulary learning activities were conducted in group cooperation using mobile applications. Students reported that they actively completed the vocabulary learning tasks, had fun in learning vocabulary in a cooperative way, and got a sense of accomplishment during the process. For example, they felt excited when they did well in Kahoot! They liked to join the competition and cheering for a good sentence they made or a good picture they selected for the target word while making the flash cards. Students liked the vocabulary learning in a group because they could confront difficulties and challenges together and work hard for the same task goal through divisions of labor, cooperation and discussion to achieve acquisition of vocabulary knowledge, and application of vocabulary. At the same time, students were very cognizant of the sequence of activities and expressed that the sequence facilitated their memorizing the words, deepening the impression of the words and promoting the use of the learned words in contexts.

Improvements in Vocabulary Breadth: Receptive Vocabulary and Productive Vocabulary

Activities designed by using different mobile applications promoted improving students' vocabulary breadth. Students completed a series of activities and practiced words in group through various mobile applications, which accelerated heir mastery of the words and improved their ability to listen, speak, read and write, especially the speaking and writing. Students benefited from the functions of mobile applications, which could provide them with proper contexts, decent pronunciation and attractive ways to increase their vocabulary knowledge. Besides, students expressed that repeated learning of the same word on different mobile applications and constant discussion during the cooperation not only deepened their understanding, but also promoted the use of the words in contexts.

Conclusion and Discussion

This study employed a qualitative and quantitative mixed research method to conduct the empirical study on vocabulary instruction to improve students' vocabulary breadth by using mobile applications. Based on the results of learners' needs questionnaire and selection of the required words in the TEM4 corpus and the curriculum, combined with the selected theories, the vocabulary instruction including scope and sequence, lesson plans, learning activities and instructional materials were designed and implemented in the experimental group. From the statistical results, a highly significant difference between the scores from the pretest and posttest of the control and experimental groups, in the total score and scores of the vocabulary both productive and receptive revealed the better performance of the experimental group yielding the positive effects of the designed instruction on the improvement of vocabulary breadth both in perceptive and productive vocabulary. The result of semi-structured interview also showed the students' positive opinions towards vocabulary learning by mobile applications.

The research results unfolded the process of 'conducting vocabulary instruction using mobile applications to improve vocabulary breadth' and 'students' opinions towards the learning vocabulary activities completed by mobile applications.

In the current research, the course was designed by employing learning principles to guide the instruction that was not the conventional vocabulary teaching or grammatical translation method, the method that has been criticized because students only acquire words and words knowledge limited to the textbook and have no chance to practice the words they learned (Pan & Xu, 2011; Samikova, 2022). From the perspective of course construction, the advantages of the designed vocabulary course were mainly reflected in the following aspects.

First, the course followed the four strands to conduct the experiment. After deliberately the teaching and learning of the vocabulary knowledge, students had meaning-focused input of vocabulary through listening and speaking activities and meaning-focused output of vocabulary through speaking and writing activities. Finally, they achieved a good use of words through repeated practice of listening, speaking, reading and writing. During this process, the teacher played small role in teaching but played an important role in planning, organizing the course and instructing and facilitating students to complete activities in each strand (Nation, 2021). The students were the protagonist in this research which ensured students obtained more chances to practice the vocabulary actively.

Second, the activities were various in content and form. In addition to the conventional method of understanding the meaning of words from the context of the text, students were involved in many activities such as learning vocabulary knowledge using wordlist, making a word bank, taking online tests, making dialogue and word stories using the target words after watching videos, conducting classroom vocabulary surveys, and 'I describe, you guesse', Kahoot! competition, dictation, describing pictures, etc. The vocabulary breadth and students' ability in listening, speaking, reading and writing are mutually reinforced, as a variety of activities promote the improvement of students' vocabulary breadth (Nation & Chung, 2009).

Third, the use of different kinds of mobile applications not only broadened the source of vocabulary knowledge, but also increased the interest of vocabulary learning and greatly stimulated the enthusiasm of students in learning. Hao et al. (2019) also got the similar findings;

that is, vocabulary learning conducted by mobile applications not only promoted cooperation among students, but also increased students' confidence in learning and promoted students' positive attitude towards learning. The advantages of using the combination of mobile applications to learn words can help promote students' continuous learning, and overcome the unfavorable factors that affect vocabulary learning, such as lack of perseverance and ineffective learning methods, as in the findings reported by Huang et al. (2018).

In this research, mobile applications (KeKe English, Kahoot!, Fif, Flashcard, e-Dictionary and WeChat) gave students a positive perception of vocabulary learning. They thought learning vocabulary by mobile applications was interesting, exciting, innovative and not monotonous, which was in line with the findings of Cakmak's (2019) and Klimova and Polakova's (2020) in that mobile language learning indeed led to enjoyable and innovative learning experiences and learning vocabulary through mobile applications that can surely expand students' learning time and space (García-Martínez et al., 2019).

Furthermore, students were also enthusiastic about learning vocabulary through various activities by mobile applications. Students benefited a lot from the division of labor and group cooperation, promoting students' understanding and mastering vocabulary knowledge and further using the words. The interview results coincided with the previous research of Ciampa (2014) that learning cooperatively, interacting, motivating and engaging with each other on learning tasks by modern technology led to a positive outcome. Students were excited, working together to overcome difficulties and strive for a common word-learning goal by taking Kahoot! competition as an example. Dindar (2021) and Lo and Lin (2016) also concluded that cooperation in the game could create meaningful connections among group members and increase learning achievement in learning vocabulary through mobile applications.

The findings of the current research revealed the construction process of vocabulary instruction by mobile applications, the effect of the designed teaching mode and students' perception towards vocabulary learning activities by mobile applications. The results can be generalized to other types of vocabulary instruction activities by mobile applications rendering help to English teachers to understand how to construct vocabulary learning activities by using mobile applications.

References

Amirzai, G. A. (2021). Assessing the effects of teaching vocabulary in developing receptive skills: A review article. *Journal of World Englishes and Educational Practices, 3*(3), 15-21. https://doi.org/10.32996/jweep.2021.3.3.2.

Anderson, R., & Freebody, P. (1981). Vocabulary knowledge. In J.T. Guthrie (ED.), *Comprehension and teaching: Research reviews* (pp. 77-117). Newark, DE: International Reading Association.

Basal, A., Yilmaz, S., Tanriverdi, A., & Lutfiye, S. (2016). Effectiveness of mobile applications in vocabulary teaching. *Contemporary Educational Technology, 7*(1), 47-59. https://dergipark.org.tr/en/pub/cet/issue/25743/271548.

Binder, K. S., Cote, N. G., Lee, C., Bessette, E., & Vu, H. (2017). Beyond breadth: The contributions of vocabulary depth to reading comprehension among skilled readers. *Journal of Research in Reading, 40*(3), 333-343. https://doi.org/10.1111/1467-9817.12069.

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health, 11*(4), 589-597. https://doi.org/10.1080/2159676X.2019.1628806.

Cakmak, F. (2019). Mobile learning and mobile assisted language learning in focus. *Language and Technology, 1*(1), 30-48. https://dergipark.org.tr/en/pub/lantec/issue/42816/517381.

Cavalli, E., Casalis, S., El Ahmadi, A., Zira, M., Poracchia-George, F., & Colé, P. (2016). Vocabulary skills are well developed in university students with dyslexia: Evidence from multiple case studies. *Research in Developmental Disabilities, 51*, 89-102. https://doi.org/10.1016/j.ridd.2016.01.006.

Chao, S. L., Mattocks, G., Birden, A., & Manarino-Leggett, P. (2015). The impact of the raising a reader program on family literacy practices and receptive vocabulary of children in pre-kindergarten. *Early Childhood Education Journal, 43*(5), 427-434. https://doi.org/10.1007/s10643-014-0670-5.

Che Hashim, N., Abd Majid, N. A., Arshad, H., & Khalid Obeidy, W. (2018). User satisfaction for an augmented reality application to support productive vocabulary using speech recognition. *Advances in Multimedia, 2018*, 9753979. https://doi.org/10.1155/2018/9753979.

Chen, R. (2021). A review of cooperative learning in EFL Classroom. *Asian Pendidikan, 1*(1), 1-9. https://doi.org/10.53797/aspen.v1i1.1.2021.

Chung, H. H., Chen, S. C., & Kuo, M. H. (2015). A study of EFL college students' acceptance of mobile learning. *Procedia-Social and Behavioral Sciences, 176*, 333-339. https://doi.org/10.1016/j.sbspro.2015.01.479.

Ciampa, K. (2014). Learning in a mobile age: an investigation of student motivation. *Journal of Computer Assisted Learning, 30*(1), 82-96. https://doi.org/10.1111/jcal.12036.

Dindar, M., Ren, L., & Järvenoja, H. (2021). An experimental study on the effects of gamified cooperation and competition on English vocabulary learning. *British Journal of Educational Technology, 52*(1), 142-159. https://doi.org/10.1111/bjet.12977.

Dizon, G., & Tang, D. (2017). Comparing the Efficacy of Digital Flashcards versus Paper Flashcards to Improve Receptive and Productive L2 Vocabulary. *The Euro CALL Review, 25*(1), 3-15. https://doi.org/10.4995/eurocall.2017.6964.

Elaish, M. M., Ghani, N. A., Shuib, L., & Al-Haiqi, A. (2019). Development of a mobile game application to boost students' motivation in learning English vocabulary. *IEEE Access, 7*, 13326-13337. https://doi.org/10.1109/ACCESS.2019.2891504.

Engeström, Y. (2015). *Learning by Expanding: An Activity-theoretical Approach to Developmental Research* (2nd ed.). Cambridge University Press.

Fan, N. (2022). *A Study of Vocabulary Knowledge and Vocabulary Learning Strategies of Chinese EFL Learners* [Doctoral dissertation]. Macquarie University. https://doi.org/10.25949/19440122.v1.

Feng, Y., & Webb, S. (2020). Learning vocabulary through reading, listening, and viewing: Which mode of input is most effective?. *Studies in Second Language Acquisition, 42*(3), 499-523. https://doi.org/10.1017/S0272263119000494.

Folse, K. S. (2006). The effect of type of written exercise on L2 vocabulary retention. *TESOL Quarterly, 40*(2), 273-293. https://doi.org/10.2307/40264523.

García-Martínez, I., Fernández-Batanero, J. M., Cobos Sanchiz, D., & Luque de La Rosa, A. (2019). Using mobile devices for improving learning outcomes and teachers' professionalization. *Sustainability, 11*(24), 6917. https://doi.org/10.3390/su11246917.

González-Fernández, B., & Schmitt, N. (2017). *Vocabulary Acquisition*. Routledge.

Govindasamy, P., Yunus, M. M., & Hashim, H. (2019). Mobile assisted vocabulary learning: Examining the effects on students' vocabulary enhancement. *Universal Journal of Educational Research, 7*(12A), 85-92. https://doi.org/10.13189/ujer.2019.071911.

Gürkan, S. (2018). The effects of a mobile assisted vocabulary learning application on vocabulary learning. *Turkish Online Journal of Qualitative Inquiry, 9*(3), 288-311. https://doi.org/10.17569/tojqi.407512.

Hao, Y., Lee, K. S., Chen, S. T., & Sim, S. C. (2019). An evaluative study of a mobile application for middle school students struggling with English vocabulary learning. *Computers in Human Behavior, 95*, 208-216. https://doi.org/10.1016/j.chb.2018.10.013.

Harmon, J. M., Buckelew-Martin, E., & Wood, K. D. (2010). The cognitive vocabulary approach to word learning. *English Journal*, 100-107. https://www.jstor.org/stable/20787701.

Huang, L., & Shu, Y. (2020). Current situation, problems and prospects of English vocabulary teaching in China. Journal of Foreign Languages, (1), 70-74. https://doi.org/10.16263/j.cnki.23-1071/h.2020.01 .010.

Huang, Y. M., Liang, T. H., & Su, Y. S. (2018). Effects of mobile apps in vocabulary learning: A meta-analysis. *Educational Research Review, 24*, 18-33. https://doi.org/10.1016/j.edurev.2018.01.003.

Karakoç, D., & Köse, G. D. (2017). The impact of vocabulary knowledge on reading, writing and proficiency scores of EFL learners. *Journal of Language and Linguistic Studies, 13*(1), 352-378. https://dergipark.org.tr/en/pub/jlls/issue/36109/405467.

Kirmizi, Ö., & Kömeç, F. (2019). The impact of the flipped classroom on receptive and productive vocabulary learning. *Journal of Language and Linguistic Studies, 15*(2), 437-449. https://doi.org/10.17263/jlls.586096.

Klímová, B. (2019). Impact of mobile learning on students' achievement results. *Education Sciences, 9*(2), 90. https://doi.org/10.3390/educsci9020090.

Klimova, B., & Polakova, P. (2020). Students' perceptions of an EFL vocabulary learning mobile application. *Education Sciences, 10*(2), 37. https://doi.org/10.3390/educsci10020037.

Li, R., Meng, Z., Tian, M., Zhang, Z., & Xiao, W. (2021). Modelling Chinese EFL learners' flow experiences in digital game-based vocabulary learning: The roles of learner and contextual factors. *Computer Assisted Language Learning, 34*(4), 483-505. https://doi.org/10.1016/j.compedu.2018.07.014.

Lo, J. J., & Lin, Y. J. (2016). Investigation of the influence of gameplay anonymity and cooperation mode on an English vocabulary learning game. *Journal of Information Technology and Applications, 10*(2), 31-39.

Makoe, M., & Shandu, T. (2018). Developing a mobile app for learning English vocabulary in an open distance learning context. *International Review of Research in Open and Distributed Learning, 19*(4), 208-221. https://doi.org/10.19173/irrodl.v19i4.3746.

Mortazavi, M., Nasution, M. K., Abdolahzadeh, F., Behroozi, M., & Davarpanah, A. (2021). Sustainable learning environment by mobile-assisted language learning methods on the improvement of productive and receptive foreign language skills: A comparative study for Asian universities. *Sustainability, 13*(11), 6328. https://doi.org/10.3390/su13116328.

Nation, I. (2006). How large a vocabulary is needed for reading and listening?. *Canadian Modern Language Review, 63*(1), 59-82. https://doi.org/10.3138/cmlr.63.1.59.

Nation, P. (2007). The four strands. *International Journal of Innovation in Language Learning and Teaching, 1*(1), 2-13. https://doi.org/10.2167/illt039.0.

Nation, P. (2021). Is it worth teaching vocabulary?. *TESOL Journal, 12*(4), e564. https://doi.org/10.1002/tesj.564.

Nation, P., & Chung, T. (2009). *Teaching and testing vocabulary. The Handbook of Language Teaching (Blackwell Handbooks in Linguistics)* (1st ed.). Wiley-Blackwell.

Pan, M., & Zou, S. (2020). Test for English majors in the new era: challenges, solutions and future endeavors. *Technology Enhanced Foreign Language Education, 2*(8), 62-68.

Pan, Q., & Xu, R. (2011). Vocabulary teaching in English language teaching. *Theory & Practice in Language Studies, 1(*11). https://doi.org/10.4304/tpls.1.11.1586-1589.

Rezaei, A., Mai, N., & Pesaranghader, A. (2014). The effect of mobile applications on English vocabulary acquisition. *Journal Teknologi, 68*(2), 73-83. https://doi.org/10.11113/jt.v68.2912.

Richard, J. (2011). Does size matter? The relationship between vocabulary breadth and depth. *Sophia International Review,* 107-119.

Samikova, R. (2022). Grammar-translation method on acquiring English as a foreign language and its disadvantages. *Академические исследования в современной науке, 1*(19), 327-330.

Schmitt, N., Schmitt, D., & Clapham, C. (2001). Developing and exploring the behaviour of two new versions of the Vocabulary Levels Test. *Language Testing, 18*(1), 55-88. https://doi.org/10.1177/026553220101800103.

Shabani, K., Khatib, M., & Ebadi, S. (2010). Vygotsky's zone of proximal development: Instructional implications and teachers' professional development. *English Language Teaching, 3*(4), 237-248.

Shahbaz, M., & Khan, R. M. I. (2017). Use of mobile immersion in foreign language teaching to enhance target language vocabulary learning. *MIER Journal of Educational Studies Trends & Practices*, 66-82. https://doi.org/10.52634/mier/2017/v7/i1/1448.

Sung, Y. T., Chang, K. E., & Yang, J. M. (2015). How effective are mobile devices for language learning? A meta-analysis. *Educational Research Review, 16*, 68-84. https://doi.org/10.1016/j.edurev.2015.09.001.

Tao, X. (2023). *Vocabulary instruction using mobile application constellations to promote vocabulary breadth of English major Chinese undergraduate students* [Unpublished doctoral dissertation]. Assumption University, Thailand.

Tao, X., & Modehiran, P. (2023). Experiences and preferences of Chinese EFL students in vocabulary learning and mobile applications in vocabulary learning in a private international university in China. *The New English Teacher, 17*(2).

The SISU Vocabulary Compiling Group of TEM-4. (2021). *The Vocabulary of TEM-4. World* Book Press.

Verbeek, P. P. (2015). Cover story beyond interaction: a short introduction to mediation theory. *Interactions, 22*(3), 26-31. http://dx.doi.org/10.1145/2751314.

Vygotsky, L. S., & Cole, M. (1978). *Mind in Society: Development of Higher Psychological Processes.* Cambridge: Harvard University Press.

Wood, D., Bruner, J., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Child Psychiatry, 17,* 89-100. https://psycnet.apa.org/doi/10.1111/j.1469-7610.1976.tb00381.x.

Xing, Z. (2021). A brief discussion on college English vocabulary teaching. *Journal of Liaoning University of Science and Technology, 23*(5), 62-63. https://doi.org/10. 3969 / j. issn. 1008 - 3723. 2021. 05. 020.

Yafei, O. A., & Osman, M. N. M. (2016). Mobile phone apps: an emerging e-platform for vocabulary learning and retention. *Journal of Applied Linguistics and Language Research, 3*(7), 286-308. http://www.jallr.com/index.php/JALLR/article/download/481/pdf481.

Zheng, Y. (2009). Exploring Chinese EFL learners'receptive and productive vocabulary knowledge: Implications for EFL vocabulary teaching. *Journal of Asia TEFL, 6*(1), 163-188.