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The Impact of WhatsApp on EFL students' Vocabulary Learning

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Abstract
Social networking applications have emerged as potential new tools for enhancing second language vocabulary learning. The current study explores the development of academic vocabulary knowledge of English as a foreign language (EFL) students using WhatsApp compared to the traditional method of vocabulary instruction. It also aims at investigating students' perceptions about the use WhatsApp in learning vocabulary. Forty Arab EFL students at the elementary level enrolled at a public university in the Arabian Gulf region participated in the study. Twenty one participants belonging to the same class were randomly assigned to the experimental group. They completed and submitted their vocabulary assignments which consisted of looking up the meanings of new words in a dictionary and building a sentence using each word and submitting their sentences via WhatsApp. Nineteen students from another class were assigned to the control group. They had to submit the same homework assignment using the paper and pencil method. Data were collected using pretest-posttest design. Results of t-test scores indicated that WhatsApp group significantly outperformed the traditional group on a vocabulary test. Furthermore, results of a questionnaire that gauged participants' perception of the use of WhatsApp in learning vocabulary show that generally participants have positive attitudes towards learning new vocabulary items via WhatsApp. Implications for teaching and future research are discussed.
***Keywords**:* EFL Saudi students, mobile learning, vocabulary learning, WhatsApp

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Introduction

There is a growing support among researchers and practitioners for the use of mobile devices in the teaching-learning environment because of their versatility, adaptability and the ability to help foster individual learning experiences (Moreira, Ferreira, Pereira, & Durão, 2016). Mobile devices may enhance productive learning "where learners show responsibility for and initiate their own learning, share learning with experts and peers" (Vavoula & Sharples, 2008, p. 297). Mobile devices can also help students enjoy an autonomous learning environment (Sharples, Taylor & Vavoula, 2005; Fisher & Baird, 2007; Petersen, Divitini, & Chabert, 2008; Benson & Chik, 2010) that is personalized (Harley, Winn, Pemberton, & Wilcox, 2007; Hayati, Jalilifar, & Mashhadi, 2013). As such, mobile learning is aligned with the learner-centered approach to learning.

The widespread of wireless networks and mobile devices has led to the proliferation of social-networking applications, which are designed to run on mobile devices, including smartphones and tablets (Karpisek, Baggili, & Breitinger, 2015). As of January 2017, WhatsApp is the most popular mobile messenger app worldwide with over 1.2 billion monthly active users ("Most popular mobile messaging apps," 2017). It is an application used for free texting and calls as well as content sharing namely audio, video, images, location, and contacts. It is available on different mobile platforms including Android, Apple, and Blackberry.

The popularity of such apps has raised the interest of many language educators in exploring the potential of using WhatsApp in teaching certain aspects of second language learning. One of the areas of language teaching that can benefit from WhatsApp is vocabulary, which is the single most important aspect of second-language learning (Knight, 1994). Some researchers argue that second-language (L2) readers must be familiar with more than 90% of the words used in order to achieve an adequate understanding of academic texts (Groot, 1994; Hazenberg & Hulstijn, 1996; Hirsh & Nation, 1992; Laufer, 1989). However, teaching a large amount of vocabulary in class is not feasible as it takes away the time needed for students to learn other language skills (Groot, 2000). Furthermore, the instructor can only teach a limited number of words at a time (Nation, 2005). Hence, WhatsApp can be used as a tool to help learners explicitly acquire the needed vocabulary, which is an important element of an effective vocabulary program (Nation, 2001). However, this potential powerful tool is an educational resource yet to be exploited by L2 language practitioners (Andújar-Vaca & Cruz-Martínez, 2017). Therefore, this study sets out to examine whether instruction via WhatsApp can help enhance students' vocabulary learning in comparison with the traditional method of vocabulary instruction.

Literature review

Theoretical framework

This study is grounded in the tenets of the constructivist learning theory. According to constructivism, knowledge is actively constructed by the learners from within based on their previous and current knowledge (Bruner, 1966). Learners are not seen as passive recipients but rather active constructors of knowledge. As such, learners should be provided with a learning environment where they can actively participate in the learning process. Vygotsky (1978) argues that such environment should foster interaction between learners and their peers as well as their instructor. Constructivists assert that the instructor should establish a learning environment where he/she acts as a facilitator rather than being the source of knowledge. In other words, the burden

of learning should fall on the students' shoulders. Vygotsky (1978) maintains that learners should be provided with tools to help them build their knowledge. One of these tools is social-networking applications such as WhatsApp which can be used as a medium to enhance the learning process. It can help create a learner-centered environment outside the classroom and create ample opportunities for collaboration between students and their peers.

Smartphones as learning tools

The rapid growth of mobile technologies such as mobile phones and hand-held computers has helped MALL Mobile-assisted language learning (MALL) reach new heights (George, 2014). Mobile phones are the most commonly used devices in MALL projects funded by the European Union since 2001 (Pęcherzewska & Knot, 2007). Smartphones as new platforms for language learning have replaced personal computers since they are more user-friendly (Sharples, Taylor, & Vavoula, 2007) and easy to access. Smartphones have turned into effective tools for delivering learning content to students (Thornton & Houser, 2005). The early attempts to use mobile phones in teaching were not particularly successful due to major drawbacks related to mobile devices technology. Learners complained about mobile phone's screen size (Hayati et al, 2013), drain on the battery as well as a complicated keyboard (Kim, Rueckert, Kim, & Seo, 2013), and limited storage capacity (Zhang, Song, & Burston, 2011). However, with the thriving of smartphones which have largely replaced mobile phones, those issues have been solved. Today's smartphones have bigger screens with a high resolution and are equipped with an onscreen keyboard. They have fast processing capability, which make navigation easy and smooth.

Smartphones as learning tools have gained popularity among many educators who believe that they offer flexibility in terms of time and location (Demouy & Kukulska-Hulme, 2010; Kukulska-Hulme, 2012) and allow students to enjoy a personalized learning environment (Harley, Winn, Pemberton, & Wilcox, 2007; Hayati, et al., 2013). Students tend to enjoy using their smartphones because they can easily access the learning materials and can practice the language anytime and anywhere (Chen, Hsieh, & Kinshuk, 2008) and continue their learning even after class time (Laurillard, 2007). White and Mills (2011) have reported that learners generally have positive attitudes towards using smartphones for language learning.

Research involving the use of mobile devices in L2 learning has focused on language skills such as reading comprehension (Chen & Hsu, 2008; Plana, Gimeno, & Appel, 2013); listening (Edirisingha, Rizzi, Nie, & Rothwell, 2007; Huang & Sun, 2010), speaking (Ducate & Lomicka, 2009; Han & Keskin, 2016; Mahmoud, 2013), and writing (Allagui, 2014; Andujar, 2015). Some studies have also examined the impact of mobile devices on other aspects of language learning namely grammar (Baleghizadeh & Oladrostam, 2010) and vocabulary (Chen & Chung, 2008; Levy & Kennedy, 2005; Lu, 2008; Stockwell, 2010; Thornton & Houser, 2005).

WhatsApp as a language learning platform

WhatsApp has become the most commonly used social-networking applications on mobile phones and computers (Yeboah & Ewur, 2014). This cross-platform application can be installed on different types of smart phones such as iPhone, Android, Blackberry, and Nokia. It allows users to send free messages to each other via Internet. Users can also share pictures, audio files, and videos. WhatsApp offers the option to create a group of users who can communicate among each

other. The creator of the WhatsApp group is also its manager. The group creator can add and delete users. Participants receive an alert for each message sent by any user.

Many instructors have opted for the use of WhatsApp as a platform through which students receive and submit their vocabulary learning assignments. WhatsApp helps instructors save time (Lauricella & Kay, 2013) and better manage the classroom as well as keeping students up-to-date with classroom activities (Awada, 2016). WhatsApp encourages active learning and develop high communicative expectations (Desai & Graves, 2006; Farmer, 2003; Rambe & Bere, 2013). Other functions of WhatsApp include communication with peers (Bouhnik & Deshen, 2014); and fostering interaction between students and instructors (Cifuentes & Lents, 2011). This will give students a sense of belonging to a learning community (Doering, Lewis, Veletsianos, & Nichols-Besel, 2008; Sweeny, 2010). Students may take assignments more seriously as their contributions in a WhatsApp group are public (Sweeny, 2010).

Undoubtedly, WhatsApp has a potential for learning enhancement (Smit, 2012). In the field of L2 learning, WhatsApp has become a powerful tool in L2 development (Andújar-Vaca & Cruz-Martínez, 2017) that can improve learners' language skills (Rambe & Chipunza, 2013) and help students become actively involved in a language class (Baffour-Awuah, 2015; Cifuentes & Lents, 2011).

WhatsApp and vocabulary learning

Before the widespread of smartphones and the rapid use of social networking applications such as WhatsApp, many studies explored the impact of Short Message Service (SMS), which is the basic feature of mobile phones, on vocabulary learning. Specifically, these studies examined different aspects of vocabulary such as idioms (Hayati, *et al*., 2013) and English collocations (Motallebzadeh, Beh-Afarin & Daliry Rad, 2011). Most of the studies that examined the use of SMS in learning vocabulary compared to traditional methods reported positive results (e.g., Alemi & Lari, 2012; Cavus & Ibrahim, 2009; Lu, 2008; Song, 2008; Thornton & Houser, 2001; Zhang, et al., 2011). However, there was a concern about the cost of SMS which could be quite expensive. Therefore, WhatsApp has positioned itself as a superior alternative since it is a free application and it is easy to use (Barhoumi, 2015).

In spite of the growing popularity of WhatsApp, the impact of this application as a platform through which students improve their second language skills has not been researched enough (Church & De Oliveria, 2013). One of the early studies was carried out by Fageeh (2013) who explored the impact of using WhatsApp to learn vocabulary among ESL students over the course of one semester at a Saudi university. The experimental group (N=27) received a list of words using WhatsApp 3 times a week after each class. Participants of the experimental group were instructed to define the words they received using an Online Dictionary application, use the words in sentences of their own and send those sentences to their peers and instructors for correction. Participants of the control group (N=31) were handed the same word lists in class. They were instructed to complete the same homework assignment and turn in their sentences on paper each class period. Results showed significant differences in posttest scores between the experimental and control groups. The WhatsApp group achieved higher vocabulary scores.

In a second study that involved South African students, Lawrence (2014) also used WhatsApp in order to introduce vocabulary items before reading texts to a group of five undergraduate learners of Afrikaans. Over the course of seven weeks, the researchers sent messages to the group that introduced target words with translations and different types of media such as sound or image. Results showed that WhatsApp is an effective tool for providing outside-the-classroom opportunities to practice vocabulary especially for weak students.

The impact of WhatsApp was also examined in the Turkish context. Basal, Yilmaz, Tanrıverdi and Sari (2016) examined the effectiveness of WhatsApp in learning idioms from the Michigan Corpus of Academic Spoken English compared to traditional classroom activities. The participants were 50 first-year students from a university in Turkey. Results indicated that participants in the experimental group achieved higher scores than the control group in the posttest. The researchers concluded that WhatsApp has a positive impact on learning idioms.

A recent study conducted by Dehghan, Rezvani and Fazeli (2017), however, does not lend support for the use of WhatsApp to teach vocabulary. The researchers explored the impact of using WhatsApp to learn new vocabulary items among 32 EFL Iranian teenage students. The experimental group received instruction of the list of new vocabulary from their textbook via WhatsApp, while the control group was taught the same list of new words through the traditional face-to-face instruction in the classroom. The results of the independent samples *t*-test showed no significant difference between the WhatsApp group and the traditional group. The authors attributed the results to distraction among the WhatsApp group who did not focus on learning the target vocabulary items. The instructors did not establish rules of conduct during the experiment, which could have prevented participants from spending time on chatting and listening to music instead of focusing on the task in hand. They also argued that the small number of participants and the limited number of vocabulary items did not yield any significant differences between the two groups.

The limited number of studies that have examined the impact of WhatsApp on vocabulary learning have not yielded conclusive results. Hence, there is a need to further explore the potential of social-networking applications, and conduct more studies on vocabulary acquisition through WhatsApp.

Rationale and research questions

The efficacy of learning vocabulary via WhatsApp has not yet been researched thoroughly especially among Arab EFL students who are part of an educational setting where the importance of reading to increase vocabulary knowledge is taken lightly (George, 2014). To the author's best knowledge, only one single study involving EFL students in the US has examined the impact of WhatsApp on L2 vocabulary learning. Therefore, this study contributes to further elucidate the impact of learning vocabulary via WhatsApp. Specifically, the present research aims at comparing the development of vocabulary knowledge of EFL students using WhatsApp to the traditional method of teaching L2 vocabulary. It also aims at investigating students' perceptions of the use WhatsApp in learning vocabulary. The findings of this study will contribute to the growing body of literature available on MALL.

This study seeks to address the following questions:
1. Is there a significant difference between university EFL students' learning of vocabulary items provided via WhatsApp and those learnt using traditional face-to-face instruction in the classroom.
2. How do learners perceive the use of WhatsApp for learning vocabulary?

Methods

Participants

The participants in this study were 40 Arab EFL learners at a public university in the Arabian Gulf region. They were enrolled in a compulsory elementary level English language course. They were all aged between 18 and 23, and were placed at elementary level classes by the English department. All participants were taught by the same instructor to maintain consistency across all classes in terms of teaching methodology and number of activities conducted for each class. Twenty one participants belonging to the same class were randomly assigned to the experimental group. They built sentences using new vocabulary and submitted their vocabulary assignments via WhatsApp. Nineteen students from another class were assigned to the control group. They completed the same vocabulary assignments on paper. Each participant of the experimental group owned a smartphone with WhatsApp installed. They were very familiar with the application as they used it on a daily basis.

Materials

Vocabulary Test

A vocabulary test was developed to measure students' knowledge. The test consisted of 40 multiple-choice items and 10 fill-in-the blanks items. The total fifty items were taken from the vocabulary lists that students had to learn over the course of the semester. The test content and face validity of the questions as well as the difficulty level were checked by experienced ESL professors who suggested some changes to the original test draft. The test was piloted with a group of 11 students who took the same English course in a different class. Necessary adjustments were made to the test. The test reliability was calculated using Cronbach Alpha. The alpha value was .87. The test length was similar to tests used in previous studies (ex. Hayati *et. al.*, 2013; Suwantarathip & Uwantarathip, 2015). The vocabulary test was administrated as a pretest prior to the treatment to measure participants' vocabulary knowledge and again after the completion of all homework assignments to measure participants' vocabulary gain. However, the questions were shuffled.

Questionnaire

Participants of the experimental group completed a questionnaire consisting of six items. Each item is rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire was translated into Arabic by a professional translator. The aim of the questionnaire was to elicit students' perceptions of using WhatsApp to learn new vocabulary.

Procedures

Prior to the beginning of the experiment, participants were briefed about the purpose of the study. All participants took a vocabulary pretest before receiving their first list of vocabulary test items. They were assured that their test scores would not count towards their final grade. They were informed that the purpose of the test was to check their knowledge about some vocabulary. Both the experimental and control groups were given the same list of 120 words over the course

of six weeks with an average of 20 words per week. Classes were held once a week for 100 minutes a week. The experimental group received word lists via WhatsApp after the instructor created a chat group and each participant was added to the group after obtaining their consent. The control group were handed printed copies of the same word lists in class. The recurrence of delivering vocabulary lists was governed by the frequency of class periods: once per week. Students had one week to complete each vocabulary assignment in order to receive full credit. The assignment consisted of looking up the meaning of new words in a dictionary and building a sentence using each word. The experimental group had the choice between using a monolingual dictionary app such as Longman mobile dictionary or visit an online dictionary following Fageeh's (2013) design to learn the meaning of target words. They had to build sentences using the target words and send them via WhatsApp for correction. Participants of the control group were permitted to use any monolingual English dictionary. After the completion of all homework assignments, participants took an unannounced vocabulary posttest during the day on which they had submitted their last homework assignment. The purpose of the posttest was to measure learners' vocabulary improvement. This helped determine the efficiency of each method of instruction in enhancing students' ability to learn new vocabulary. The pretest and the posttest were identical. The researcher had to reshuffle the items to avoid students memorizing the correct responses rather than answering the questions out of knowledge. At the end of the experiment, participants of the experimental group completed a questionnaire about their perception of learning vocabulary using WhatsApp.

Data Analysis

A *t*-test was performed on the data gathered from the pretests and posttests for both groups. First of all, a *t*-test was used to determine whether difference in means of pretests between the two groups was insignificant prior to the treatment. A second *t*-test was performed after the treatment to determine if there was a significant difference between the means of the posttest scores of the experimental group and control group. The significance level of the *p*-value was set at .05 in all statistical analyses. Data obtained from the post study questionnaire regarding participants' perceptions of using WhatsApp to learn vocabulary were calculated using descriptive statistics including means and standard deviations. A mean score of 3.51 to 5 implies a positive attitude, and a mean score of 2.51 and 3.5 signifies a neutral attitude. A score of 0 to 2.5 suggests a negative attitude.

Results

Findings on the effect of WhatsApp on vocabulary learning

As Table 1 shows, the WhatsApp group (M = 20.10, SD = 7.50) outscored the paper based (M = 17.32, SD = 5.73) on the pretest. To determine whether the control and experimental groups differed in their knowledge of the vocabulary items, a *t*-test was applied to their pretest scores (see Table 1). The assumption of homogeneity was tested and satisfied based on Levene's F test, $F(38) = 3.45$, $p = .071$. The independent samples *t*-test was associated with a statistically non-significant effect, $t(38) = 1.31$, $p = .199$, $d = 0.42$. These findings suggest that the experimental group and control group were not different in their knowledge of the vocabulary items before the experiment.

Table 1. *Comparison of Pre-test Scores between WhatsApp Group and Paper-based Group*

Group	*Test*	*n*	*M*	*SD*	*T*	*df*	*P*
WhatsApp	Pretest	21	20.10	7.50	1.31	38	.199
Paper-based	Pretest	19	17.32	5.73			

To examine whether there was an improvement in scores from pretest to posttest for the experimental group and the control group, a *t*-test was conducted. As Table 2 shows, the independent-samples *t*-test indicated that scores were significantly higher for the experimental group ($M = 43.14$, $SD = 5.44$) than for the control group ($M = 21.21$, $SD = 8.60$), $t(38) = 4.30$, $p < .000$, $d = 3.04$. These results suggest the experimental group significantly learned more new words than the control group.

Table 2. *Comparison of Post-test Scores between WhatsApp Group and Paper-based Group*

Group	*Test*	*n*	*M*	*SD*	*T*	*df*	*P*
SMS-based	Pretest	21	43.14	5.44	9.74	38	.000
Paper-based	Pretest	19	21.21	8.60			

Findings on perceptions of WhatsApp learning experience

Means and standard deviations for participants' responses to each item of the questionnaire regarding perceptions of using WhatsApp to learn new vocabulary are reported in Table 3. Results show that the overwhelming majority of students who participated in the survey (participants of the experimental group) had positive attitudes towards the use of WhatsApp in learning vocabulary. In fact, 90% of the participants thought that learning new words using WhatsApp was an interesting method of learning. Eighty one percent of the respondents enjoyed learning new vocabulary using WhatsApp.

Students' positive impressions of WhatsApp as a vocabulary learning tool have increased their motivation to complete course assignments. In fact, 76% of students indicated that WhatsApp motivated them to complete their vocabulary assignments because they found the app convenient; they could complete the assignments utilizing the convenience of flexibility of time and place available to complete their assignments at their own pace. No single student voiced concerns against the convenience of using WhatsApp.

When asked if given the choice between using WhatsApp and paper-and-pencil method of learning new words in future courses, the majority of students said they would choose WhatsApp. Only three students did not think they would like to renew the experience of learning new vocabulary using WhatsApp in future courses.

Table 3. *Descriptive statistics for participants' perception about the use of WhatsApp*

Item Statement	*Mean*	*SD*
1. Learning new words using WhatsApp is an interesting method of learning.	4.38	.805
2. I feel more motivated to complete my vocabulary assignments using WhatsApp because it is convenient: I can complete it anytime anywhere.	4.19	.814
3. I enjoyed learning new vocabulary using WhatsApp.	4.24	.768
4. If given the choice between using WhatsApp and paper-and-pencil method of learning new words in future courses I would choose using WhatsApp.	3.67	1.111
5. Using WhatsApp helped me remember the new words.	3.71	1.007
6. Writing sentences including the new words and sending them to the instructor via WhatsApp is a useful activity.	4.24	.831

6. Discussion

The present study is designed to determine if the use of WhatsApp mediation helps improve students' vocabulary learning compared to the traditional method. The results underscore that using WhatsApp mediation is more effective than traditional instruction in enhancing learners' vocabulary learning. This study lends support to the constructivist theory since WhatsApp has helped students construct their vocabulary knowledge. The evidence for the usefulness of WhatsApp corroborates the findings of Fageeh (2013) who conducted his study in a similar educational setting and other researchers (Lawrence, 2014; Basal et al., 2016). However, it does not support the findings of Dehghan, *et. al.* (2017) whose participants did not benefit from WhatsApp to boost their vocabulary learning. The researchers argued that the results were affected by the participants' lack of commitment to the tasks rather than by the usefulness of WhatsApp as a learning tool.

The findings of the current study also highlight the positive attitudes of the participants toward the use of WhatsApp in learning new vocabulary. These results are in line with the findings reported by previous studies such as Alhadhrami (2016) who surveyed Arab EFL students in Oman. His participants believed that the most useful app for English language learning was WhatsApp. The same results were reported by Gutiérrez-Colon, Gibert, Triana, Gimeno, Appel and Hopkins (2013) who studied the benefits of using WhatsApp to improve English reading skills of Spanish college students. The results of their study demonstrated that almost all participants acknowledged that the application of WhatsApp enhanced their motivation to read in English.

The effectiveness of WhatsApp in enhancing the learners' vocabulary that is reported in the current study can be attributed to different factors. First of all, the novelty of the experience of using a smartphone app to complete classroom assignments has intrigued students and got them

more involved in the learning process. They particularly liked the sense of immediacy as they were able to send and receive messages instantly. A second possible factor could be the sense of virtual community that has been created between students and their instructor, on one part, and among students themselves through the use of the WhatsApp group chat. In such an environment, a special bond could have been created between the different members as it was the case of Awada's (2016) experiment. She argued that participants' sense of belonging to a community of learning has prompted them to complete their assignments with more diligence.

Another plausible reason for the positive outcomes of the current study is that the use of WhatsApp has somehow liberated students who lack confidence to participate in class. As many studies have reported (e.g. Alrabai, 2014; Al-Saraj 2014) Arab students typically experience high levels of anxiety while speaking foreign languages in class. Using WhatsApp may have helped participants feel less inhibited and thus has boosted their confidence to be actively involved in the learning process as reported also by Awada (2016) and felt that it positively impacted their language performance. The same perception was shared by Turkish EFL learners who thought that using WhatsApp significantly impacted the students' language acquisition by lowering EFL speaking anxiety (Han & Keskin, 2016).

Conclusions and implications

This study sought to explore the efficiency of WhatsApp vocabulary learning among EFL students. Results show that using WhatsApp has significantly increased learners' vocabulary learning compared to the traditional method. Furthermore, using WhatsApp as a learning tool has been a positive experience for most participants as it has increased their motivation for learning.

In light of these findings, it is recommended that language instructors consider using WhatsApp in teaching vocabulary and integrate it in the curriculum. WhatsApp allows instructors to teach a larger number of vocabulary items given the fact that they may not have enough time to do that in class. It helps them also reach all students through virtual communication especially shy students who may not participate in a face-to-face interaction. However, instructors need to ensure the success of using WhatsApp by establishing some rules to keep students focused on task. Students tend to spend considerable time chatting and lose track of the purpose of using WhatsApp. Therefore, it is crucial that instructors monitor their students to maximize the gains of virtual learning.

Since students tend to constantly use their smartphones, it is recommended that instructors consider using WhatsApp to send and receive homework assignments. Over 90% of the participants of the current study completed and submitted all their homework assignments, while most students of the control group tended to submit only partial homework assignments.

Limitations

he present study has a number of limitations that need to be addressed. First, the researcher used a relatively small sample size with only one proficiency level (elementary). Therefore, the outcomes of the study should be interpreted with caution. Second, the focus of the study was only on general vocabulary. Incorporating idioms and other vocabulary categories may have yielded different results. Third, the researcher could not the control the amount of time spent by

each group to work on the vocabulary activities during the study. Extra practice on the part of some students could have influenced the results of the study.

Future research

More studies are needed to further examine the impact of WhatsApp on vocabulary learning across different levels of proficiency. It will be useful to focus on more than one category of vocabulary to include technical English, for example. Furthermore, future research should examine the effect of WhatsApp on students' vocabulary retention. Specifically, students should be tested a few weeks after the completion of the experiment to measure their ability to remember the words they learnt over the course of the experiment.

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