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Development of a Mobile Game Application to Boost Students' Motivation in Learning English Vocabulary

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ABSTRACT Currently, the power to master the English language has become prominent in academia, research, and business. Therefore, many non-English speaking countries, including Arab countries, are striving to improve their education systems in teaching English as a foreign language, and English vocabulary is an important factor to boost English proficiency among Arab students. Moreover, in Arab countries, there is a lack of motivation among learners of English as a foreign language which affects the learning process of students. As such, digital gaming technologies, especially mobile games, are emerging as the best way to create enthusiasm for learning new languages. Therefore, a mobile application named VocabGame was developed based on a set of persuasive guidelines, and it was launched in the Google Play Store. This paper investigated whether the developed VocabGame can motivate native Arab students learning the English language to achieve better performance. Sixty-four students were divided equally into two groups: the control group (high-performance group) and the experimental group (low-performance group). Students in the experimental group improved their motivation level significantly after the mobile learning intervention. Our findings showed that mobile game application is helpful for those students who had poor performance initially while studying English and improves their confidence. There was also an association between the pre-test and the post-test scores according to the motivation to learn based on the analysis of the covariate analysis with η_p^2 being 0.148. A mobile application game was successfully developed to motivate Arab native students to learn English as a secondary language.

INDEX TERMS Mobile application, persuasive technology, ESL learners, English language, motivation.

I. INTRODUCTION

English is the language of the modern world. Apart from one's own native language, one might need it at work to interact with English-speaking people coming from different cultures and for travelling to other countries. Therefore, the dominant global use of the English language in the international academic community presents unique challenges for non-native English students [1]. For many Arabic countries, English is not an official language and is rarely used in daily life. Furthermore, formal English teaching is introduced late in these countries. According to [2], especially in Yemen and Saudi Arabia, children start studying English and taking English language classes very late in grade 7. When learning English, development of vocabulary is an important factor

for the learners' language development [3]. Due to limited vocabulary, Arabic students are not comfortable interacting in English [4]. Thus, they do not engage in long conversations [5] and they lack the genuine motivation to learn a foreign language [6]. Rababah [2] demonstrated that there are barriers in speaking English among English as a Second Language [7] learners such as the way they learn, the teaching strategies, and the learning environment. Moreover, students lack the required motivation to learn the English Language, which is often a compulsory educational item [8], as well as the lack of the desired engagement in the flow of learning due to the mismatch between their skill level and the learning challenge at hand [9]. Lack of motivation is the most recurrent problem in learning English as a second language [10]–[12]

found that the motivation factor is a persistent obstacle faced by English language learners. Therefore, this issue is addressed to create a language learning course to motivate students effectively.

Mobile-based learning has been successfully used to motivate learners instead of the traditional book-based approach [13]. Chang *et al.* [13] observed that lack of motivation affected students' learning, and this should be taken into account while developing a mobile-based learning application [8], [14]. However, educators and educational institutions often struggle to design and use motivational materials and methods on par with their students' expectations [15].

Persuasive technology is an interactive computing system to manipulate people's behaviors while using it. These technological programs gather important information according to the users' actions, which assist them in reaching their objectives [16]. This persuasive technology provides individual feedback, guidance through the activities, and encouragement. Therefore, mobile interactive games based on persuasive technology can be expected to influence the users' attitudes, support students with their studies, and improve their motivation. According to [17], persuasive designed courseware can have a positive impact on the learning performance of the children with learning difficulties compared to traditional teaching method. In their study, a multimedia-based courseware that integrated persuasive technology caused a significant improvement in students' syllable learning, measured by achieving better scores in a questionnaire-based test. Using mobile technology further, m-learning activities can much better engage students in the learning process. Students can easily change from passive learners to truly engaged learners who are behaviorally, intellectually and emotionally involved in their learning task [18].

Elaish *et al.* [19] combined persuasive technology with educational components to propose a mobile game framework, which can be used to develop mobile game applications that improve students' performance and their motivation to learn English vocabulary. Lucero *et al.* [20] present an example of how principles of motivation can be designed into educational software to support students in achieving their goals. Their software showed the importance of integrating principles from persuasion such as similarity, tailoring and credibility, together with theories such as Gardner's theory in educational software for motivating children to read and write. Using persuasive technology showed benefits even outside the classroom. De Oliveira and Oliver [21] have developed a mobile application that assists runners in doing predefined exercise goals via two persuasive techniques (glanceable interface, virtual competition) and musical feedback called TripleBeat.

TripleBeat has been developed based on previous system called MPTrain. In their paper, TripleBeat's software and hardware have been described, highlighting how it differs from MPTrain. After that, the results of 10 runners have been presented. MPTrain and TripleBeat have been compared

in term of enjoyment and efficacy in achieving proposed goals when running with them. The study concluded that significantly higher enjoyment and efficacy with TripleBeat and runner totally prefer TripleBeat than MPTrain. The main reason for improvement in the running experiences is virtual competition, and glanceable interface.

The effect of mobile game applications on the performance of English foreigner students has been investigated in this study. Additionally, in consideration of motivation theory, the empirical study has provided evidence on how intrinsic and extrinsic motivations are used in the field of foreign language [22]. Intrinsic motivation entails engaging in any activity that is fulfilling and enjoyable. On other hand, extrinsic motivation refers to achieving some proposed goals, including avoiding punishment or earning a reward. Aarts and McMahon [23] claimed that active motivation of students could push them to strive for hard work and better performance. Furthermore, these studies thought that mental status and the motivation of students in learning have not been considered by the researches that have used mobile learning in learning activities. These researches tend to mainly focus on interactions between the system and the students, and its effect on learning performance [24]. Palmer and Goetz [25] claimed that motivation is a fundamental factor for helping students to become more responsible during learning, and enhancer of self-learning. This research has also conducted an analysis of motivational learning.

Some studies have developed/used mobile application in related fields. However, these studies either presented incomplete or unclear experimental design. Firstly, some studies do not mention anything about the groups' size of participants, period of training, or assessment method. For example, Ashiyani and Salehi [26] have used WhatsApp software to enhance motivation of Iranian learners in learning English vocabulary. This study has not declared clearly the period of study. In [8], the study has not mentioned the groups size and study period. Scurtu *et al.* [27] have not specified the type of students who participated in the study. Secondly, there is a lack of details regarding the study period. For example, Alkhezzi and Al-Dousari [28] have listed out in details the experimental design procedure they followed, where they used t-test and questionnaire to measure university students' motivation and performance in learning vocabulary; however, they have not mentioned what is the specific time for each step among the 12 weeks of students' training. Finally, studies occasionally do not use the right assessment method. Some studies believed that questionnaire is the right way to measuring motivation [29], [30] but Rahimi and Miri [31] did not use questionnaire to measuring motivation for learners. To cope with all these limitations this study has declared the experiential design in deep details.

Particularly, this research refers to previously developed persuasive-based framework [19] to build a mobile game for teaching English vocabulary, targeting Arabic students in primary school. The developed mobile game has been

tested in a quasi-experiment to evaluate its effectiveness by investigating the following research questions:

- Do EFL students using the mobile game application show higher learning motivation than those students who learn with the traditional learning approach?
- Do EFL students using the mobile game application show better learning achievement than those students who learn with the traditional learning approach?
- Is there any relationship between the pre-test scores and the post-test scores on motivation to learn between these two groups (experimental group vs. traditional group) undergoing two types of intervention?.

II. LITERATURE REVIEW

A. MOBILE GAMES FOR LEARNING ENGLISH

The use of computer games is increasing in educational settings [32] and it is transforming pedagogical strategies. Games are useful instruments for the learning process of specific strategies, content, as well as for gaining knowledge, increasing motivation, and improving educational outcomes [10], [33]. Recently, research studies focus on how improved game design could address issues of producing learning tools and environments that are more motivating and effective.

The main assumption is that games are engaging irrespective of the learner's age [34].

Game-based learning increases the efficiency of learning due to intrinsic motivation when the learning materials are linked with a specific goal to 'win the game' [35]. In addition, games influence human attitudes towards learning [36]. Consequently, game-based learning is used to support students with their learning processes partly through enhancing their intrinsic motivation [37], [38]. New game-based applications offer the added value of fun and engagement in the learning process [37]. For example, an application called MEL enhanced was reported to be more engaging, enjoyable, and interactive than older versions of MEL original [9].

B. EDUCATIONAL MOBILE FRAMEWORKS

Pedagogical developments are still lagging in technological advancement. For example, practitioners (instructional designers and teachers) should know how to effectively employ and merge evolving mobile technologies into their teaching and instructional materials [39]. Elaiash *et al.* [19] has developed a mobile game framework based on principles of persuasive technology. The guidelines contain 17 principles (Table 1) that have been incorporated into the interfaces of the developed game. The framework has been revised and evaluated by experts (Fig. 1).

III. THE MOBILE GAME APPLICATION

The developed prototype of the mobile game was named VocabGame and it was implemented in the Google Play store: <https://play.google.com/store/apps/details?id=com.ahmedmubarak.vocabgame>. This prototype was developed to support beginner Arabic students in studying their

TABLE 1. Guideline principles based on persuasive technology [19].

Guideline principle	Description of the principle
Reduction	Makes the system simpler.
Tunneling	A method to guide the user through a set of predetermined sequence actions to encourage or dampen behaviour.
Self-Monitoring	Allows users to monitor their progress and performance.
Tailoring	The experimental design depends on requirements, personality, interests, and the usage of context or any aspect which belongs to the users' group.
Convenience	Easy to access.
Mobile Simplicity	This relates to applications on mobile phones that are uncomplicated to utilise and which have a greater chance of persuasion.
Mobile Loyalty	Serves its own user needs and wishes.
Information Quality	Delivers current, pertinent, and well-arranged information.
Kairos or JiTT (Just In Time Teaching)	Gives suggestion at the right moment.
Social Facilitation	Shows to the user other people performing the same behaviour.
Social Comparison	Allows comparison.
Social Learning	Allows users to observe the performance of others.
Competition	Technology motivates users to adopt a target behaviour or attitude to leverage the natural drive of human beings to compete with each other.
Cooperation	Technology motivates the user to adopt a target behaviour or attitude to leverage the natural drive of human beings to cooperate.
Recognition	By making the public aware of whether an individual or a group computing technology can raise the chance that an individual or a group will accept a particular behaviour or attitude.
Conditional Rewarding	Rewards depend on target behaviour.

course material. This prototype made use of the principles of persuasive technology [19], and allows for experimental evaluation using a sample of primary school students (32 students for each group (Control vs. Experimental)). So, this VocabGame is considered as an actual implementation of the framework to validate and illustrate its effectiveness. As such, the developed app and consequently the conducted study followed closely the framework components, which include only persuasive guidelines, blooms' taxonomy, and social-culture theory in the context of language learning. This intern restricted the addition of more domains or factors even though they would be seen as a good way to improve and reinforce the app. The app has showed a good impact on the students' performance and motivation after training the students on it.

Based on Multimedia Mobile Content Development MMCD process [40] and Fogg's procedures [41], VocabGame

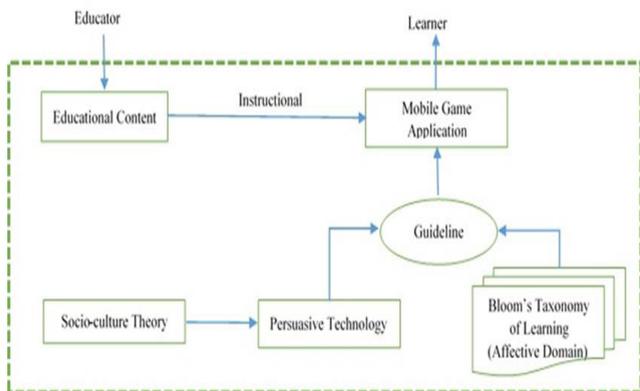


FIGURE 1. The mobile game framework.

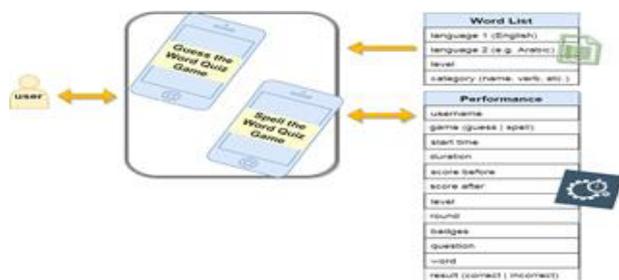


FIGURE 2. System architecture of VocabGame.

was developed from the planning stage to testing stage. As a software project, it first needed to serve as an evaluation tool for the persuasive principles. The analysis of this requirement was followed by the design of interfaces and software modules, taking into consideration the guidelines of the proposed framework. Finally, the implementation (coding) of the application was performed on the Android platform using its Software Development Kit. The application was then tested before the eventual human interactive experiments.

It was helpful to review some commercial applications before starting the development of VocabGame to understand how these types of games are developed. The reference games were chosen by searching in the Google Play store. The search term used was “vocabulary games for kids” and the results were further filtered based on a 4-star rating and satisfaction level, and after that, only vocabulary games were chosen (Please see Fig. 2 for the VocabGame architecture).

A. APPLICATION CONTENT

This application is focused on the vocabulary aspect, and the game vocabulary was extracted from a sample of actual course material and exercises. The idea behind the game is that the students can practice the target vocabulary list through matching quizzes first to get familiar with a list of words. Then, the student takes a series of quizzes that test his/her knowledge of the words, including the words' spelling. The following flow diagrams (Fig. 3 and Fig. 4) show how the students use the guess the word game and spell the word game.

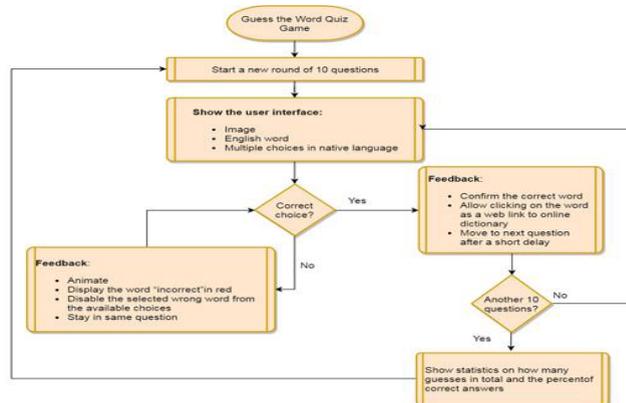


FIGURE 3. Guess the word game flow diagram.

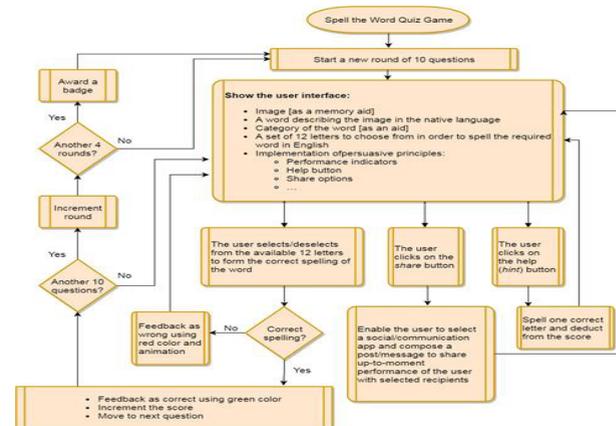


FIGURE 4. Spell the word game flow diagram.

Therefore, the game is divided into two parts, both of which implement the basic elements of persuasive principles. The game starts with a welcome screen where the user selects one of the two games. This section briefly presents these parts, along with their corresponding interfaces.

Factors like screen size, interactivity, and processing speed are very important to the experience of the learners' for a particular application [42]. The interface components are based on guideline principles to make them easy to use and to motivate students. Vocabulary learning (including warm-up stage, quiz, and dictionary) is the only scenario in the game for simplicity, focus, and ease of use. However, not all the principles are tangible (they do not have objects on the screen), but they exist on the application in intangible ways. Below are the application screens and components. For simplicity the application is referred to as an “app.”

1) THE WELCOME SCREEN

The app has an opening screen where the user is welcomed and asked to choose one of two quiz games. Fig. 5 depicts the main interface consisting of two buttons, Guess the Word Quiz and Spell the Word Quiz.

2) GUESS-THE-WORD SCREEN

When the student presses the “Guess the Word Quiz” button, it launches the first quiz game (Fig. 6). In this interface,

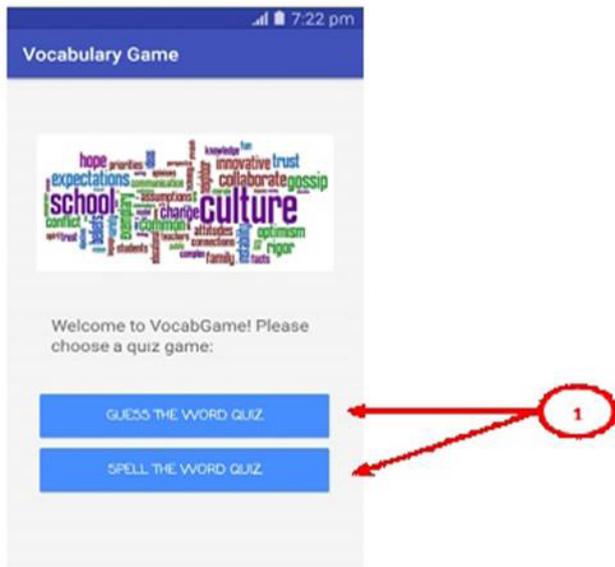


FIGURE 5. Main interface.



FIGURE 6. Guess the word interface.

one English word is shown at the center with an illustration, and four Arabic words are provided as options for the correct meaning of the English word. Only one option is correct, and the correct option must be chosen before the student can move to the next question. Upon selecting the correct choice, a large green text appears declaring the attempt correct and the screen will then move to the next question. A wrong choice would cause a red text to appear, declaring an incorrect attempt, and the user screen stays on the current question until the correct answer is chosen.

This quiz helps students review vocabulary with ease and prepare them for a spelling quiz. The accompanying image makes the guess much easier, but the purpose is to familiarize the student with the words and build the vocabulary using

visual aids with the fun element of winning or losing an attempt. The words list in the target vocabulary is divided into rounds of 10 words to add elements of achievement and progress, and the whole quiz can be repeated indefinitely. No scores are collected from this stage, and the performance of the student in this game is not considered in the experimental evaluation.

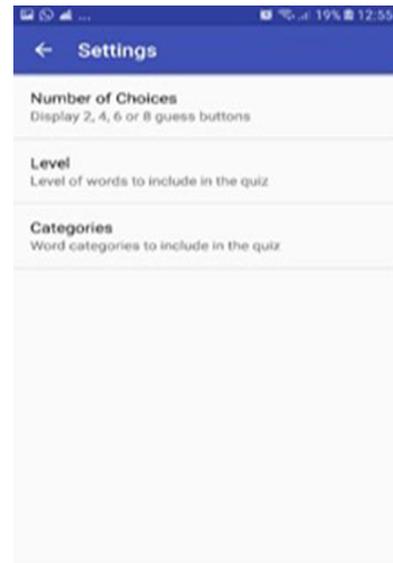


FIGURE 7. Setting of "guess the word" interface.

Besides the main guessing game interface, there is a screen that can be displayed via a settings icon at the top right corner. These settings are simple and aim to introduce an element of customization to the game. The settings screen shows two items (Fig. 7). The first item is to change the number of choices available (i.e. the number of guess buttons). Four options are available: 2, 4, 6, and 8. increasing the number of buttons increase the difficulty. The second setting enables the user to either turn the sounds on or off; the sounds are associated with taps on the buttons and the various events of right or wrong attempts.

This game provides access to the definition of a correct word from an online dictionary (when connected to the Internet). After guessing the correct word, the student can tap on the word in green to open a link to the definition from www.dictionary.com. This helps the student better understand a word's meaning and thus increase their vocabulary database.

The Arabic language has been used in the app as an intermediate language to help Arab students learn English at this stage. This method is commonly used in reviewed commercial applications.

3) SPELL-THE-WORD SCREEN

The second game in the app is a quiz to spell the English words from memory, using available aids and guides. Fig. 8 shows the Spell the Word interface, which displays one

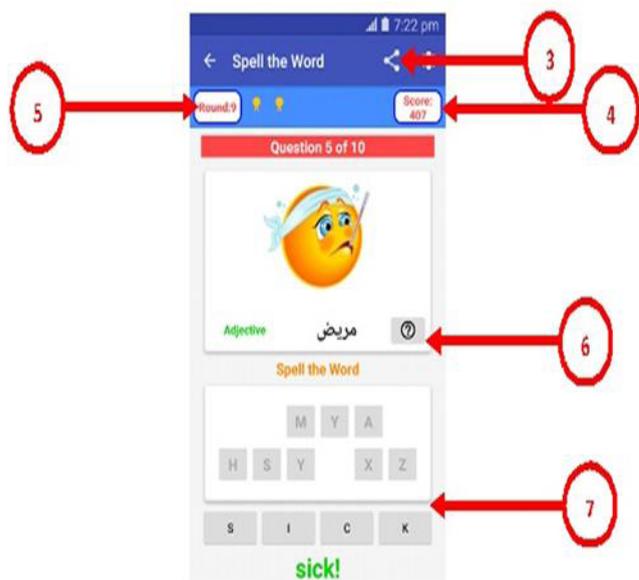


FIGURE 8. Spell the word interface.

image (from the same set of images as in the first game) and one Arabic word. The student is required to spell the English version of the word by filling up empty boxes. The number of these boxes will match the number of letters in the word, and the student is provided with a set of 12 letters (in small buttons) to select from by tapping on these buttons.

The interface displays the student's score every time he/she spells a word correctly. Each successful attempt increases the score by 5 points. Every 10 questions start a new round, and the current round is displayed at the top of the screen. Furthermore, the user earns a medal (badge) every 4 rounds. If the students cannot guess the right letters to the word, then they can tap on a hint button with a question mark sign to show one letter of the correct word. However, each time they use the hint feature, their score will be decreased by 2 points. This game has other features:

- A setting icon allows the user to turn the sound effects on or off.
- Another icon on the top action menu allows the user to share a summary of their performance (scores, round and badges) using various social networking channels (email and chat programs) depending on the networking apps installed on the device.
- With each quiz word, the category of the word (name, adjective, verb, etc.) will be displayed to increase the level of knowledge and make guessing the correct word easier.
- The user can select the letters from the available buttons and can deselect any letter without having to erase all the letters.
- The most important performance indicators are collected in the background in a local database and can be retrieved later for evaluation and analysis. The recorded stats include the word, start time, finish time, result, and old and new scores for each attempt by the user.

B. THE PERSUASIVE PRINCIPLES IN THE APPLICATION

So far, previous studies have not shown persuasive principles in the application. Table 2 summarizes the list of each principle with the game feature implementing the said principle and what component of the app reflects it. The numbers in the last column refer to the circled numbers in Fig. 2, Fig. 3 and Fig. 5.

Finally, Fig. 9 provides a summary of the main features of the second quiz game, showing their correspondence to the guideline principles.

IV. QUASI-EXPERIMENTAL DESIGN

This method has been used because previous research suggested that the quasi-experimental design is the rigorous way of finding out the effect of the manipulation [43].

A. POPULATION SAMPLE

According to [44], researchers who carry out their research in the same school would improve internal validity of their studies because it would eliminate some of the most important confounding variables. Therefore, third grade ESL students participated in this study and they were educated in a mainstream classroom in an international school in Putrajaya, Malaysia, with an Arabic native language background. Most of the target school students were born in Arab countries and then migrated to Malaysia. The study started with 68 students, but then decreased to 64 due to absences. Their ages ranged from 8-11 years old. The students were grouped into an experimental group (poor performance) and a control group (good performance). The pre-test provided data to compare with the post-test results to show students' improvements and to group students into two categories based on their language abilities [44], [45]. First, the students were categorized in two groups according to the classes they were attending. Then the groups completed the same pre-test and pre-questionnaire. They were then assigned to the experimental group if they scored lower than the control group.

B. QUASI-EXPERIMENTAL MEASURES/ INSTRUMENTATION

Target school holds a Certified Cambridge Registered International Schools which its curriculum is holistic and balanced, which is tailored to nurture future leaders. The curriculum focuses on the four English skills which include Writing, Reading, Speaking and Listening. Each of these skills are closely monitored with assessments every half term, whilst also providing intervention groups to further assist the students, ensuring that all the students' needs are met. There is also a great emphasis on Literacy across the school. The school sees literacy as a key to raising standards. It believes passionately that the key to raising students' attainment is to develop high standards in literacy as this is essential to preparing its students for their future education and careers.

- Vocabulary Test: The pre- and post-tests were developed based on a school textbook and exercises that a

TABLE 2. Guideline principles and their implementation in the application.

Principle	Game feature	Components (if tangible)
Reduction	<ol style="list-style-type: none"> The complex process of memorizing vocabulary is broken down into a two-step game: <ol style="list-style-type: none"> Warm-up game (to learn the vocabulary first). Spelling quiz game (to test the learned vocabulary). 	1
Tunneling	<ol style="list-style-type: none"> Users should follow a specific sequence of: <ol style="list-style-type: none"> Learning vocabulary, and Testing his/her knowledge. User should finish a stage to unleash the next one. 	7
Personalization	Personalized aspects: <ol style="list-style-type: none"> Learning: Levels of difficulty. Game environment: turning sound effects on/off. 	Settings screen
Self-monitoring	<ol style="list-style-type: none"> Create a scoring system and show the score all the time. Provide statistics on performance history. 	4
Kairos	<ol style="list-style-type: none"> Provide a hints option. Words are selected at random by default. However, it's better to increase the probability of selecting words that were not guessed correctly in the last session, as a corrective and JiTT action. 	2, 6, 7
Convenience	<ol style="list-style-type: none"> Interaction with the game is mostly through easy actions of clicks and taps on buttons. A minimum amount of steps are emphasized for every task. 	2
Mobile simplicity	[overlapping with convenience] <ol style="list-style-type: none"> The game is a mobile app in the first place. No previous training or special IT literacy is required to use the game. 	2
Mobile loyalty	<ol style="list-style-type: none"> This is an educational, research-produced game. It is free of charge. Its purpose is to serve the user. No advertisements; user feels he/she is the only beneficiary. 	No component
Information quality	<ol style="list-style-type: none"> Use current and modern vocabulary, divided over few categories. Provide definitions for vocabulary words drawn from authentic dictionaries/resources online. 	No component
Social facilitation	This feature is related to what is called the audience effect: Keep track of the user performance in each session and allow the user to share those stats with others. This way, the user knows that people will see his/her performance, so it might motivate him/her to improve it, while there is no pressure that might hinder the learning process, as the user knows that he/she can opt not to share.	3
Social comparison	[overlapping with social facilitation] Similar to the social facilitation feature above, provide the ability to share performance metrics with other users via social networking.	3

TABLE 2. (Continued.) Guideline principles and their implementation in the application.

Competition	Provide access to brief statistics on the top performers at each level of the game.	4, 5, badges
Social Learning	<ol style="list-style-type: none"> Add visual tutorials for how the game is played, and how one can learn from it. Try to incorporate a feature where success stories of users can be shared with other users. 	None
Recognition	Introduce a system of public recognition among the users of the game using the notion of badges to distinguish individuals.	5 and badges
Cooperation	Allow users to trade points for help and hints, through some social network.	None
Conditioning rewarding	<ol style="list-style-type: none"> Increase the score gradually with every correct answer. Provide bonus increase upon the completion of a stage or level. Award badges and titles upon the completion of certain levels. 	4, 5, badges
Normative Influence	Press on the users to play the game. In this case, just ask the student to play it.	No component

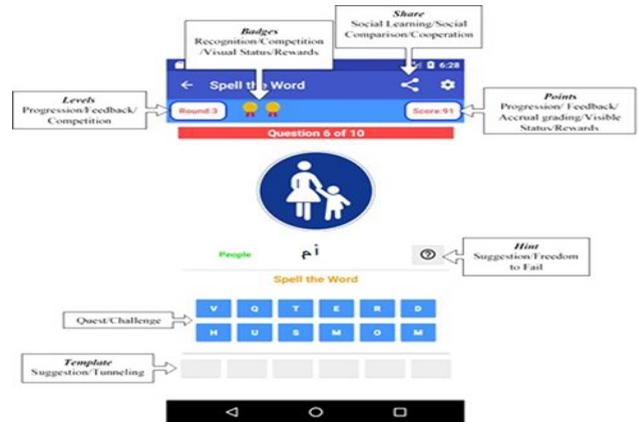


FIGURE 9. Mapping game features to guideline principles.

3rd grade English teacher checked and approved. The purpose of this vocabulary test is to find out the students' performance. The performance data was collected at the beginning and at the end of the experiment. The vocabulary test was reviewed by English teachers who had more than five years' experience of teaching English language subject in order to check its validity.

- Motivation Questionnaire:** The questionnaire consisted of two parts. The first part included questions that characterize the participants such as gender, age, and class, while the second part has been adapted from Sung *et al.* [46] which included the questionnaire of learning motivation that was modified from the MSLQ (Motivated Strategies for Learning Questionnaire). The questionnaire consists of 7 questions to measure the participants' motivation of learning English vocabulary. The participants rated the questions on a 5-point

(ranging from 1, strongly disagree to 5, strongly agree) Likert scale. The motivation score of the students in learning English language was collected both at the beginning and at the end of the project.

The students were divided into two groups (from 4 classes) based on the classes they attended. Then the groups completed the same pre-test and pre-questionnaire. They were then assigned to the experimental group if they scored lower than the control group. There were two English teachers which each one of them teach 2 classes and both groups used the traditional resources which provided by the school so the environment is same for the two groups except experimental group used the mobile application as extra material. There were two English teachers which each one of them teaches 2 classes. In this study, the reliability analysis was conducted. Seven questions were asked to the respondents. The respondents consist of mobile group and traditional group. In the traditional group, there are seven questions to measure the motivation and the result indicates that these questions are reliable with Cronbach's Alpha of 0.792. Similarly, for the mobile group, the measurement of motivation is reliable with Cronbach's Alpha of 0.825.

The development of mobile game apps for language learning resembles other software development projects in term of the required technical knowledge, assuming the content and basic flow has already been specified. The required technical skills may be beyond those of the average teacher, and the services of a professional developer (or a team of developers) may be needed. This professional service comes at a cost, which may be quite high depending on the size and features of the app. It is also possible to moderately literate educators in software development to design and build such apps albeit with extended periods of time development and/or lower polish. In the case of this specific study, the app was developed by one of the authors with background of software development but not as a profession. The design and development of the app took more than six months.

C. EXPERIMENTS AND PROCEDURES

The experimental procedure is illustrated below (Fig. 10). The researcher was introduced by the teacher to the students and the teacher explained the steps to them. Then, the students took part in the pre-test to test their performance and fill in the pre-questionnaire to measure their motivation level. During the learning task, the experimental group students studied the language using the mobile learning game application on the provided mobile phones while the control group students learned English in the traditional way using textbooks and computer labs. After the learning task, all students took part in a post-test and filled in post-questionnaire to measure their motivation level.

In the first week, all students performed the pre-test together with the pre-questionnaire for about 15 minutes. They were divided into groups and the researcher described the study aims and the application's features and functions to the experimental group. Application screenshots were distributed among the students to explain what they had to do. This meeting lasted 20 minutes.

In the second week, eight mobile phones (Samsung Galaxy S4 i9505) were provided to train these students. The experimental group (32 students) was divided into subgroups and each subgroup was trained by the researcher for 20 minutes on how to play the game. They were observed while playing. The application had been uploaded to the Google Play Store to allow the students to play the game at home or anywhere. Therefore, the app met the mobility (anytime and anywhere) criterion and allowed more time to practice. The control group only used their traditional study materials.

In the third week, students were required to undergo the post-test and fill in questionnaires as required to collect data to figure out if there were any improvements in performance and to see if their motivation to learn English had increased.

V. RESULTS

The independent sample t-test was implemented to find out differences in students' performance before and after conducting the training courses. The performance was measured by a ratio while the mobile and traditional groups were the categorical variables.

TABLE 3. Descriptive statistics of groups (Pre-Test).

Group Statistics					
	Group	N	Mean	Std. Deviation	Std. Error Mean
Pre-Test	Mobile	32	7.8750	1.68005	.29699
	Traditional	32	8.9688	1.55510	.27491

A. INDEPENDENT T-TEST FOR PRE-TEST (PERFORMANCE)

According to [47], while conducting an independent t-test, equal variance is assumed or it is not assumed. Each group consisted of 32 students with a mean score (±s.d) of 7.87 (±1.68) for the mobile group and 8.96 (±1.56) for the traditional group (Table 3). The value of n = 32 subjects was sufficient for this analysis [48].

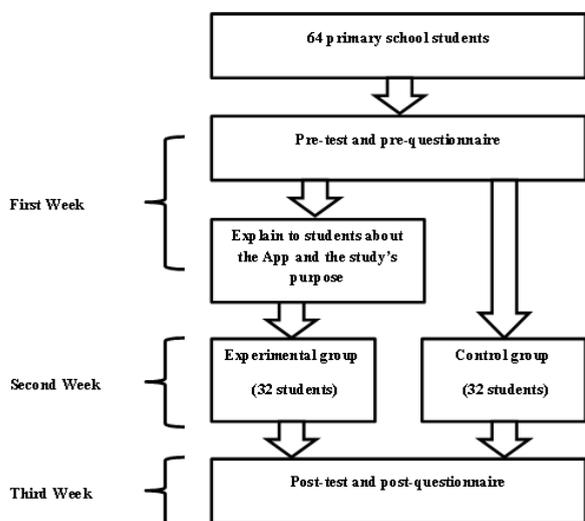


FIGURE 10. Experiment procedure.

TABLE 4. Independent sample T-Test between groups (pre-test).

	Levene's Test for Equality of Variances		t-test for Equality of Means			
	F	Sig. (p)	T	Df	Sig. (2-tailed)	Mean Difference
Equal variances were assumed	.65	.42	-2.70	62	.009**	-1.09
Equal variances were not assumed			-2.70	61.63	.009	-1.09

** p < 0.01, significant.

TABLE 5. Descriptive statistics of groups (post-test).

Group Statistics					
	Group	N	Mean	Std. Deviation	Std. Error Mean
Post-Test	Mobile	32	8.34	1.31	.231
	Traditional	32	8.87	1.36	.240

TABLE 6. Independent sample t-test (post-test).

	Levene's Test for Equality of Variances		t-test for Equality of Means			
	F	Sig.	T	df	Sig. (2-tailed)	Mean Difference
Equal variances assumed	2.102	.152	-1.59	62	.117	-.53
Equal variances not assumed			-1.59	61.90	.117	-.53

Table 4 shows Levene's Test for equality of variance was not violated. The statistical probability p-value was greater than 0.05, which indicates that there was equal variance between the two groups. Accordingly, Pallant [47] suggested that when an equal variance is assumed, 2-tailed significance for equal variance must be considered. The 2-tailed significance is 0.009 which indicates a statistical difference between the mobile group and the traditional group (Table 4). The mean difference between the two groups was found to be 1.09. The traditional group's mean score was greater than the mobile group's mean score by a difference of 1.09.

B. INDEPENDENT T-TEST FOR POST-TEST (PERFORMANCE)

Next, the independent sample t-test was conducted on the post-test data to identify any group differences between these two groups after training. The mean score (SD) of the mobile group was 8.34 (±1.31), while the mean score (SD) for the traditional group was 8.87 (±1.36) (Table 5).

Levene's equality of variance was not violated and the independent sample t-test result shows that there is no statistical difference between the two groups' mean scores as the 2-tailed significance is greater than 0.05 with p being 0.117 (Table 6). However, there was a reduction between the two group mean scores from 1.09 for pre-test to 0.53 for post-test.

This shows that improvement has taken place for the mobile group.

To identify the difference in the mobile group, an independent sample t-test was conducted. Table 7 shows the mobile group mean in pre- and post-performance and it shows an improvement in performance between pre (mean = 7.87) and post (mean = 8.34).

TABLE 7. Description of mobile group (pre-test and post-test).

Group Statistics					
	CODE	N	Mean	Std. Deviation	Std. Error Mean
Mobile	PRE	32	7.8750	1.68005	.29699
	POST	32	8.3438	1.31024	.23162

TABLE 8. Independent Sample T-test for Mobile Group (Pre and Post).

	Levene's Test for Equality of Variances		t-test for Equality of Means			
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
Equal variances assumed	.607	.439	-1.24	62	.22	-.47
Equal variances not assumed			-1.24	58.52	.22	-.47

To find out if there was any statistical difference in the improvement of learning English as foreign language based on the intervention, an independent sample t-test was conducted. There was no statistical difference between the mobile group in the pre-test and the post-test score (Table 7) (p > 0.05) despite an increase in motivation score of 0.47. Levene's Test for equality of variance is met (Table 8).

C. ANALYSIS OF THE COVARIATE (ANCOVA)

Pallant [47] emphasized that the ANCOVA analysis can be utilized when there is a two-group design (Pre-test vs. Post-test). The scores obtained on the pre-test experiment were considered as a covariate to monitor for differences that already existed between the two groups. In this way, ANCOVA is important in experiments that involve small sample size with only small effect or medium effect. Under these conditions, Stevens [49] suggested the utilization of two or three crucial covariates to decrease variance error as well as to improve chances for the detection of any statistically significant differences between the two groups.

A one-way analysis of covariance between these two groups (pre-test vs. post-test) was performed to compare how effective the two different interventions were in motivating students to learn English as a foreign language. The two independent variables were the Mobile group and the Traditional group, while the dependent variable was motivation score based on motivation administered after the intervention.

In this statistical analysis, the participants' motivation scores based on pre-intervention administration were employed as the covariate.

Statistical checks were done on the datasets to find out if there was any violation based on the assumptions of normality, homogeneity of variances, linearity, reliable measurement of the covariate, and the homogeneity of regression slopes. Table 9 demonstrates that after the pre-test scores adjustment, there was no significant difference between the two groups (Mobile Group vs. Traditional Group) on pre-test scores on motivation to learn English, with F-score being 0.355, $p = 0.554$ and $\eta_p^2 = 0.006$. There was a very good relationship between the pre-test scores and the post-test scores based on the motivation to learn as shown by a partial eta squared value of $\eta_p^2 = 0.148$.

TABLE 9. ANCOVA analysis for pre and post.

Tests of Between-Subjects Effects						
Dependent Variable: Post Result						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2.365 ^a	2	1.183	5.280	.008	.148
Intercept	16.444	1	16.444	73.406	.000	.546
Pre_result	1.880	1	1.880	8.394	.005	.121
Group	.080	1	.080	.355	.554	.006
Error	13.665	61	.224			
Total	1333.980	64				
Corrected Total	16.030	63				

a. R Squared = .148 (Adjusted R Squared = .120)

TABLE 10. One-way repeated measure (ANOVA).

Multivariate Tests ^a							
Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Time	Pillai's Trace	.125	8.825 ^b	1	62	.004	.125
	Wilks' Lambda	.875	8.825 ^b	1	62	.004	.125
	Hotelling's Trace	.142	8.825 ^b	1	62	.004	.125
	Roy's Largest Root	.142	8.825 ^b	1	62	.004	.125
	Time *	Pillai's Trace	.023	1.489 ^b	1	62	.227
Group	Wilks' Lambda	.977	1.489 ^b	1	62	.227	.023
	Hotelling's Trace	.024	1.489 ^b	1	62	.227	.023
	Roy's Largest Root	.024	1.489 ^b	1	62	.227	.023

a. Design: Intercept + Group
 Within Subjects Design: Time
 b. Exact statistic

The results indicated that, for the pre- and post-test of motivation, the training courses did not make a significant change. However, this could be due to the length of training, as only one week was given for the students to prepare and adapt to the newly developed mobile application. However, a repeated ANOVA, shown in Table 10, was used to validate the results to be more significant if a time factor is added. The

test shows a significant increase is detected when the time is considered. So, this mobile game framework may improve primary school Arabic students' abilities to learn English. They just need to consistently practice the mobile game for more than a week.

The repeated measures model has its origins in ANOVA. Thus, the term repeated measure ANOVA is often used to refer to the generic design. It is referred to as repeated measure General Linear Models (GLM). Repeated measures are used to enhance the statistical power or to gain knowledge about the type of response through time or through different situations [47]. According to [47], in ANOVA design, each subject is subjected to at least two experimental conditions using the same dependent, continuous scale data across those conditions or factors. Moreover, it can be utilized to compare responses of respondents for different questions or items. However, these aforesaid questions should be measured using the same scale (that is using a liker scale such as 1 = strongly disagree, to 5 = strongly agree).

ANOVA analysis was implemented to compare the scores based on the motivation to learn at two different periods of time that were called Time 1 (pre-test) and Time 2 (post-test). Table 10 shows the result from the ANOVA analysis. All the multivariate tests produced similar outcomes, but normally the mostly reported statistic is the Wilks' Lambda. In this research, Wilks' Lambda was found to be .87, with a statistical significance probability value of .004, which indicates a statistically significant effect for the factor time and suggests a motivation change through the two different periods of time.

VI. DISCUSSION AND CONCLUSIONS

In general, mobile game applications have been used mostly to improve motivation and performance to learn English language skills [11], [14] and many studies have shown that they have gotten a good results and impact [50]–[54]. The mobile game application developed in this study is based on a framework of persuasive guidelines. The study listed the features/functions and their association to persuasive principles. Some principles are clearly visible in the app and are classified as tangible while other principles cannot be shown as visible objects in the app (intangible).

To evaluate the mobile game application, a statistical t-test was conducted to measure the performance between the experiment and the control groups, and an ANCOVA statistical analysis test was conducted to measure motivation. The statistical t-test and ANCOVA did not show any statistical significance even though there is a difference in the average score between these two groups and within the experimental group. However, there was a strong association between the pre-test scores and the post-test scores on motivation to learn according to a high partial eta squared. From an ANOVA (one-way repeated measures) analysis, time had a statistically significant effect on the learning process, which suggests a change in motivation during the learning process across the two different time periods that were Time 1 (pre-test) and Time 2(post-test).

Prior to the study, the researchers found that students had low motivation to learn English vocabulary. The test provided an opportunity to evaluate student performance only on English vocabulary. The questionnaire evaluated the students' motivation to learn vocabulary for the first time at this school. Some results were surprising in that students showed a good performance in general, with a few students scoring low, but most of them doing well. Other results were somewhat predictable in that the students showed a low motivation toward English vocabulary language learning.

The results of the pre-questionnaire based on the two groups showed that students see the study of English as an unpleasant necessity. However, some students performed well even though their motivation was low. The post-questionnaire in the experimental group showed improvement in how they felt about learning English vocabulary. This led to the finding that some students may still do well even when they do not enjoy the task. However, even with all the learning resources at the target School, including a computer lab, the task of learning the English language, especially vocabulary, is still difficult. Nevertheless, a mobile game application could improve students' motivation in class [55], [56].

Meanwhile, some limitations have been observed from this research. The first limitation comes from the study itself, and the other one from the school. On the study side, there were only 8 mobile devices available, which required a division of the experimental group into four sub-groups, which reduced the training time.

Secondly, the students did not have sufficient time to play and use the mobile game application during their class time due to the other materials they had to study. The school only allowed training during their break time. This affected the results in two ways:

- Training time was insufficient, so the researcher lost the opportunity to ensure that the students spent enough time on the game.
- It was unrealistic to expect young students to spend their break time on further learning activities. After a long study day, the students need both rest and physical play. This was likely to have affected the results.

The main objective of this study was to develop a mobile game application that can improve Arabic native speakers' motivation and performance in learn English vocabulary. Statistically, there was no significant difference in using this kind of app to support the traditional way of teaching students. However, when considering the time period of training students and using repeated ANOVA to account for time in the results, they showed a significant difference in using this kind of app. The outcome of this study has answered the research questions and supported the study hypotheses.

The students enjoyed the mobile application in class, and some of them expressed that they were happy to play at home during their free time. Since using mobile games to support English language learning has received little attention com-

pared to other mobile technologies, this study has received significant attention.

This research shows that a mobile game application should be part of the daily English curriculum for learning the English language. The app should be used over the whole semester to measure its effect over an extended period to really understand the full potential of the application. This kind of study would be expensive and time-consuming, and that should be considered before starting such a learning process for the English language. Following the feedback and statistical analysis, the features of the VocabGame app can be improved in terms of designing better graphics to motivate students in their learning process.

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