The Framework of an AR-Quest Instructional Design Model Based on Situated Learning to Enhance Thai Undergraduate Students' Khmer Vocabulary Ability

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Abstract

The application of Augmented Reality technology in education has been increasing from year to year. The researchers conducted this study to propose a framework for an AR-Quest instructional design model based on situated learning to enhance Thai undergraduate students' Khmer vocabulary ability. The proposed framework was evaluated by experts from the fields of Educational Technology and Communications, Instructional Design, and Language Teaching. The data from the evaluation form from the experts were calculated using the mean value. Then, thirty students were taught using the instruction developed from the model; and they were assessed by a pretest and posttest vocabulary test. The results found that the AR-Quest instructional design model comprises 1) analysis, 2) AR Package Development, 3) AR Quest Development, 4) Instruction Development, 5) Model Implementation, and 6) Model Revision. The result from the Khmer vocabulary ability score of the posttest of the students suggested a higher score than the pretest, showing a difference at a .05 significance level.

Keywords: augmented reality, instructional design, situated learning, vocabulary learning

Introduction

Learning a second language is vital due to globalization. The more languages one can speak, the more opportunities they are employed and have in life (Kubota, 2011). In the ASEAN context, after the establishment of the ASEAN Economic Community (AEC) in late 2015, immigration mobility in ASEAN has been increasing owing to the free movement of goods, services, investment, and free labor flow. According to ILO (2016), there are approximately 500,000 Cambodian immigrants who have come to Thailand for work. Additionally, the number of Cambodian outbound tourists has increased from 1,200,000 in 2015 to 1,400,000 in 2016, some of which between 24% and 30% traveled to Thailand and Vietnam for a visit and health service purpose (Huaifu & Marady, 2017). Subsequently, Khmer, the official language of Cambodia, has made its way to be one of the must-learn languages in Thailand.

The ability to speak a foreign language is essential and necessary for today's twenty-first-century skills, making language acquisition arouse the interest and attention of many educational researchers (Cook, 2016). Linguistic experts have broken down the process of language learning into its dependent components such as syntax and phonetic (Richards & Rodgers, 2014). If one can make sentences in a foreign language, the next most crucial thing is the knowledge of its vocabulary. For this reason, researchers have been working on how to improve students' vocabulary ability (Y.-M. Huang & Huang, 2015; O'rourke, 2019); and several teaching instructions and educational technology have been introduced (I. J. Chen & Yen, 2013; S. Joseph, Binsted, & Suthers, 2005; Lin, Young, & Hung, 2008; Pala, Singh, &

Gangashetty, 2011; Wu, Chang, Liu, & Chen, 2008). A more recent technology introduced into language instruction is augmented reality (AR) (Arvanitis, 2012; Safar, Al-Jafar, & Al-Yousefi, 2017). Researches have proven that AR applications in language instruction promise favorable outcomes (Tsung-Yu Liu, Tan, & Chu, 2010; Vate-U-Lan, 2012).

Beder (2012) describes Augmented Reality as a possible step between the real world and virtual reality. AR technology allows users to add computer-generated objects onto the real-world environment using a smart device's camera to capture images in a real-time environment (Beder, 2012). Today, AR technology has become so mature that its application has been introduced in many fields counting from medicine (Barsom, Graafland, & Schijven, 2016; Shuhaiber, 2004), to transportation (Schall Jr et al., 2013) and to education (Matsutomo, Miyauchi, Noguchi, & Yamashita, 2012; W. Tarng & K.-L. Ou, 2012), not to mention the field of entertainment (Klopfer & Squire, 2008).

In the educational context, Augmented Reality, in its nature, carries a situated learning theory, as its main feature allows users to overlay digital contents on real-world environment objects (Y. Fujimoto, Yamamoto, Taketomi, Miyazaki, & Kato, 2012). A situated learning theory within AR technology can provide students with authentic an learning experience, which is well-matched with the vocabulary acquisition theory as students remember second language vocabulary faster and better when the words are introduced to them in a situation where they are used (Dong, Hu, Wu, Zheng, & Peng, 2018). The researcher believes that AR technology can be used to modernize vocabulary teaching approaches. The integration of AR technology and inquiry learning is believed to help learners achieve a significant outcome. In an inquiry vocabulary learning environment, students are given opportunities to use content-specific vocabulary in given situations, which makes learning meaningful (Chang, Wu, & Hsu, 2013).

With the potential of the situated learning and inquiry learning theory in vocabulary acquisition, this paper aims to develop a framework for an AR-Quest instructional design model, which is primarily based on the theory of situated learning for enhancing Thai undergraduate students' Khmer vocabulary ability. The AR-Quest instructional design model is the instructional steps that are designed based on the grounded principles of situated learning theory and the inquiry-based learning approach together with augmented reality principles to design vocabulary learning activities by using an AR mobile application as the main resource. Despite the particular language studied, the researchers believe that this will set as a foundation for further researches on AR applications in the area of language instruction.

Review of Literature

Augmented Reality in Language Learning

Augmented Reality is defined as a technology where computer-generated objects are augmented into the real-world environment to produce a new layer to the environment that users can interact with (W. Liu, David Cheok, Mei Ling Lim, & Leng Theng, 2007).

W. Liu et al. (2007) research on developing AR instructional materials giving them positive results: learners' attention and learning outcomes have improved. When comparing AR materials with traditional teaching materials, practice time and the cost spent on the design of the AR materials are more efficient than those of traditional stimulation materials (Shelton & Hedley, 2002).

Asai, Kobayashi, and Kondo (2005) hold that AR, when applied in teaching, has great potential. They continue that this new instructional method can ease students with little computer skills to interact effortlessly (Asai et al., 2005). Different from traditional teaching methods that only use texts, AR instructional model promises a learning experience where

students can easily learn lesson contents. From the research of Woods et al. (2004), the advantages of AR used in classroom instruction are illustrated. They [the advantages] include (1) the favor of students towards AR materials over traditional teaching materials, (2) the ability to help students learn abstract concepts better, and (3) 3D virtual objects allowing learners to interact spontaneously, which, consequently, improve students' interaction, motivation, enthusiasm, and learning outcomes (Woods et al., 2004).

AR benefits students as they can remember lessons better when virtual contents are presented together with the context of a real environment (Yuichiro Fujimoto, Yamamoto, Kato, & Miyazaki, 2012; Y. Fujimoto et al., 2012). As AR can help learners with memorization, it is considered to be a good match for teaching languages (P.-H. E. Liu & Tsai, 2013; T.-Y. Liu, 2009). AR is used to trigger labels and symbols which are overlaid with videos, making location-related information such as the name and distance of a particular place such as buildings, hotels, restaurants, and many others more easily understood (Y. Fujimoto et al., 2012).

Possibilities of Augmented Reality in the Educational Context

The use of emerging AR technology provides favorable advantages to the educational sector. Researchers working on the possibility of AR technology in education have proved that AR is inextricably connected with cognition (T.-L. Huang & Liao, 2015; Küçük, Kapakin, & Göktaş, 2016) and interactivity (Di Serio, Ibáñez, & Kloos, 2013). AR allows students to relate with information better (Scholz & Smith, 2016). For instance, some AR applications in education are from Matsutomo et al. (2012) using AR to display virtual magnetic contents on physical magnets and from W. Tarng and K. Ou (2012), using AR to display a virtual butterfly on a real plant.

Besides being able to enhance real-world objects with digital information, AR can also benefit students in terms of remembering as learning contents are designed to be associated with digital contents and a real environment (Y. Fujimoto et al., 2012). AR, too, has been proved to be applicable in ubiquitous learning authentically as it presents digital information onto real-world objects which, then, creates an explicit relationship with the real environment (S. R. H. Joseph & Uther, 2009). Ubiquitous learning is often involved with the use of mobile devices. Moreover, today mobile devices, particularly smartphones, are equipped with built-in cameras, a fast processor power, a larger screen and other sensors that can be used to provide an AR learning experience (Billinghurst & Duenser, 2012). As AR can help learners with memorization, it is considered to be a good match for teaching culture and languages (P.-H. E. Liu & Tsai, 2013; T.-Y. Liu, 2009). In this sense, AR can be used to enhance situated vocabulary learning as words or animations are displayed in relevance to the objects found within the real environment.

Theories in Language Instruction

The theory of situated learning has gained interest from educators and has found its way in language education. Situated learning theory emphasizes learning through authentic activities that promote a more meaningful learning experience (Scott, Asoko, & Leach, 2007). Pg Hj Besar (2018) explains that the purpose of situated learning is to encourage learners and make progress in students' learning by highlighting the use of knowledge in that context. Pg Hj Besar (2018) continues that situated learning theory involves students in a social context intending to foster understanding and improve their learning in an authentic environment. This principle of the authentic learning experience is well-matched with the vocabulary acquisition theory as students remember second language vocabulary faster and better when the words are introduced to them in a situation where they are used (Dong et al., 2018).

S. Beaudin, S. Intille, Munguia Tapia, Rockinson, and Morris (2007) uses the theory of situated learning to combine with ubiquitous technology to teach students English and Spanish. C.-M. Chen and Chung (2008) build a context-aware vocabulary learning system using the studied theory to help students to improve their English vocabulary. The results of the two studies prove the success of the application of the situated learning theory as it helps the students remember faster and better compared to traditional methods. In a study by Hwang and Chen (2013) who developed a mobile system to help EFL students by presenting learning contexts in a familiar situation, the findings reveal that when students practice English in a familiar context, their English skills improved, especially in vocabulary use and fluency. Hu (2011), examining the current mobile vocabulary learning practice to support vocabulary learning, states that knowledge gained from the interaction in a situated environment reduces the learning time and enhances efficiency and retention. Specifically, the words learned from context will enable learners to naturally understand the meaning and use words appropriately (Hu, 2011). Similarly, findings of Özüdogru and Özüdogru (2017) on the effect of situated learning on students' vocational English learning suggest that situated learning can be used successfully in English instruction, evidenced by the higher score gained from the experiment. Another research study on facilitating English as a foreign language, learners' vocabulary learning, task completion and contextual vocabulary exploration processes in mobile supported situated learning environment also states that situated learning environment promotes long-term retention, contextual and incidental learning of vocabulary (Uz Bilgin, 2016). Efe, Demiröz, and Akdemir (2011), in their study on a situated learning practice for language teaching, state that spoken language, expressions, idioms and vocabulary score increase when authentic learning materials are presented in a situated learning environment.

The second keystone of the grounded theories of this instructional model is inquiry learning which provides students with opportunities to use content-specific vocabulary in given situations. Inquiry learning theory has been applied to different subjects. In recent years, the application of inquiry-based learning has been introduced in nursing education (Akinsanya & Williams, 2004; Finn, Fensom, & Chesser-Smyth, 2010). Inquiry-based learning is also applied in the social sciences (Barrett & Stauffer, 2009; Clandinin & Connelly, 2000; Nelson, Ketelhut, Clarke-Midura, Bowman, & Dede, 2005). Lakkala, Lallimo, and Hakkarainen (2005) practice the theory of inquiry learning in the combined history classes of the twelve elementary and junior high schools. Shih, Chuang, and Hwang (2010) apply the inquiry-based approach to mobile devices intended to help students to understand the culture associated with temples. Additionally, Chang et al. (2013) experiment the effect of the combination of mobile AR technology and pedagogical inquiry activities on a socio-scientific issue's context of the grade-nine students, which proves positive effects on students' understanding of the science content.

Inquiry learning comes to existence when it is believed that the science of learning is more about active learning activities such as those of exploring, asking questions, discovering understanding and testing those discoveries to make up new knowledge (Foundation, 2000). Inquiry learning encourages students to make their discoveries and generate knowledge by activating and reconstructing knowledge schema (Mayer, 2004). In inquiry learning, students also take the initiative in the learning process in a collaborative environment with authentic materials (Elen & Clark, 2006). There are more research studies on inquiry-based activities having been conducted to examine its effect. For instance, Sadikin (2016) uses the inquiry-learning approach in WebQuest to teach English vocabulary to EFL young learners, where the result shows that there is a significant difference in students' achievement in vocabulary mastery before and after inquiry treatment. Lee (2014), studying inquiry-based teaching pedagogy in second and foreign language education, states that inquiry-based teaching

reinforces students' learning and understanding of the course materials as well as enhances students' classroom engagement and fosters an effective and meaningful learning experience. A study from Vintinner, Harmon, Wood, and Stover (2015) whose results from the inquiry interactive word walls study reveals that such an integrated inquiry approach leads to deeper and longer-lasting retention of word knowledge of the students. Furthermore, another study on the development of an inquiry-based vocabulary ability reveals that the inquiry approach helps better students vocabulary learning with satisfying outcomes (Hicks Pries & Hughes, 2012).

Methodology

This research employed the research and development method so as to answer two research questions of the study.

1. What are the components of an AR-Quest instructional design model based on situated learning to enhance students' vocabulary ability?
2. Will the students who learn Khmer vocabulary through the instruction developed by the AR-Quest Instructional Model have a higher mean score on the posttest than that of the pretest mean score?

Population

The population of the study was divided into two groups. The first group comprised experts from the fields of educational technology and communications, instructional design and language teaching. The other group was made up of undergraduate students from the Faculty of Education, Chulalongkorn University, Thailand.

Sample

The first sample group used to develop the AR-Quest instructional design model based on situated learning to enhance students' vocabulary ability included six experts who were derived from purposive sampling. The experts were from the fields of educational technology and communications, instructional design models and language education and have over four years of experience in their specialized fields.

The second sample group, selected using the purposive sampling technique, was thirty undergraduate students from different majors and had enrolled in the course "Innovative and Educational Technology and Information," which is a compulsory course of every undergraduate student of the Faculty of Chulalongkorn University, Thailand.

Research procedure

The research methodology is separated into two phases as follows:

Phase 1: (Research 1) The researcher studied related documents in teaching and learning a second language, particularly vocabulary acquisition. The researcher, too, reviewed literature about the application and the possibilities of augmented reality language instruction.

Phase 2: (Development 1) The researcher synthesized the learning principles form situated learning, inquiry-based learning, and principles related to augmented reality technology to develop a framework of an AR-Quest instructional model. Instructional steps and AR application package were developed and revised here.

Phase 3: (Research 2) The researcher studied the effectiveness of the AR-Quest instruction model based on situated learning theory to enhance Thai undergraduate students' Khmer vocabulary ability.

Determining research design:

O1 X O2

- X is the AR-Quest instructional design model based on situated learning
- O1 and O2 are the Khmer vocabulary ability test

Implementing the instructional model in an authentic classroom

Before the intervention	**During the intervention**	**After the intervention**
Khmer vocabulary ability test (Pretest)	Teaching with the AR-Quest instructional model	Khmer vocabulary ability test (Posttest)

Phase 4: (Development 2) The researcher, then, revised and developed the framework of the AR-Quest instructional model based on situated learning theory to enhance Thai undergraduate students' Khmer vocabulary ability.

Research Instrument

Research tools for data collection in the study entitled "The Framework of an AR-Quest Instructional Design Model based on Situated Learning to Enhance Students' Second Language Vocabulary Ability" are as follows:

1. The model evaluation forms for experts' comments which cover the areas of the appropriateness of principles and theories related to the model, the appropriateness of the objective of the model, the appropriateness of the components of the model, and the appropriateness of the ease of use of the model
2. Lesson plans developed based on the newly developed AR-Quest instructional design model
4. An AR mobile application package developed based on the theories stated in the developed AR-Quest instructional model using Unity Editor and Vuforia
5. A pretest and posttest of Khmer vocabulary ability

Data analysis

The data from the evaluation forms from the experts were calculated to find the mean and standard deviation (SD). And the data from both pretest and posttest were compared using paired sample t-test.

Results and Discussion

The results of the framework of the AR-Quest instructional design model based on situated learning theory to enhance Thai undergraduate students' Khmer vocabulary ability

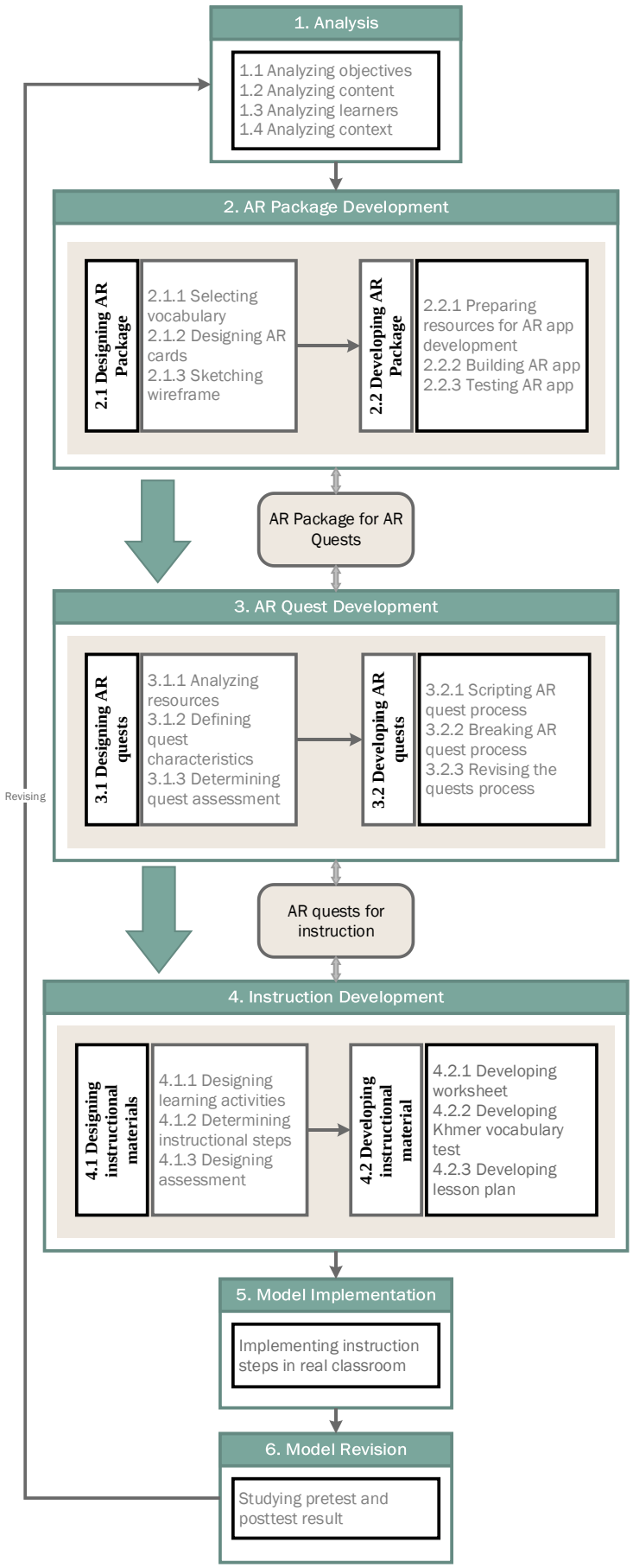

Figure 1. AR-Quest ID Model Based on Situated Learning

The AR-Quest instructional design model is a linear instructional design model for enhancing students' vocabulary ability. The model is based on situated learning theory and inquiry learning theory. The two are used as the instructional medium. The characteristics of the model are learner-centered and flexible with authentic context so that students can make use of the knowledge you have learned in real-life. After receiving the evaluation results from the experts, the framework of the AR-Quest instructional design model is approved to be valid and appropriate for language instruction as the model comes with systematic components and logical steps. The description of the development of the AR-Quest instructional design model is developed with six major steps and nine sub-steps. The entire process of the framework of AR-Quest instructional design model is illustrated as follows:

The Description of the framework of the AR-Quest instructional design model

1. Analysis	
1.1 Analyzing objectives Objectives keep teachers on the right track. Studying learning objectives is the first step of the AR-Quest Instructional Design Model. To analyze learning objectives, the existing curriculum and syllabus are to be studied. **1.2 Analyzing content** Analyzing content for instruction is one of the most critical steps in designing AR-Quest instruction. It tells teachers the level of difficulty and the instructional sequences of the content. With this knowledge, teachers can prepare well and know what is best for students.	**1.3 Analyzing learners** Teachers need to determine students of the course. This sub-step is helpful as teachers know the ability of the students. This also helps teachers to understand the starting level of the course and to choose applicable strategies to deliver the course effectively. **1.4 Analyzing context** Identifying the learning contexts for this technology-integrated instruction is necessary. This sub-step aims to identify the availability of technology and methodology for AR quests to ensure an authentic learning environment. For instance, required devices such as computers, smartphones, tablets, and other smart handheld devices must be kept in mind.

2. AR Package Development	
2.1 Designing the AR package **2.1.1 Selecting vocabulary** Vocabulary is the core content the AR-Quest instructional design works on. Thus, it is necessary that teachers select vocabulary carefully. Johnston (n.d.) suggests the following criteria for selecting vocabulary for teaching. **Importance** Teachers have to evaluate word lists presented in the learning content and value the words whether they are important for students to learn (Flanigan & Greenwood, 2007). **Transferability** The frequency of words appearing in the learning content is another way to select words for the students. Thus, it is advisable that teachers choose words that appear more often in learning contents. **Usefulness for generative studies** Root words that lead to other related words are another choice that teachers also consider choosing for their students. **2.1.2 Designing AR cards** AR cards are physical paper cards needed to be designed to use with AR mobile application for AR-quest activities.	**2.2. Developing AR package** **2.2.1 Preparing resources for AR app** Teachers need to gather all required resources before developing the AR app. The resources are based on the feature of the AR app teachers planned and designed. They may include AR cards, 3D models, and audios of selected vocabulary. Teachers also need to set up a development environment as follows: - Installing Unity version 2017.2.0f3 - Java Development Kit - Android SDK - Vuforia version 6-2-10 **2.2.2 Building AR app** Teachers can use Unity with built-in IDE and C sharp (C#) programming to develop the app. It is advisable to always consult programming experts when you want to build an AR app. **2.2.3 Testing AR app** Once the KhAR app is working fine with the laptop's camera. The app is to be built android system for testing. To do this, Android Studio is needed to generate the

2. AR Package Development	
The followings are principles to consider when designing the cards. **Size**: the cards should be designed with size to be as big as general cards, such as national ID cards, student ID cards, and bank cards that the students use and encounter every day. The design makes it convenient as the cards are neither not too small nor too big for carrying around to use with the KhAR mobile application (Gusarova et al., 2015). **Color**: The color of the cards should be black and blue as blue reduces excitement, which helps students to concentrate (Mehta & Zhu, 2009). **Letter**: As they are vocabulary cards of Khmer language, Khmer letters representing Khmer words should be included in the cards. This also helps make the cards more unique for the AR app to detect well (Godwin-Jones, 2016). **2.1.3 Sketching wireframe** Teachers can draw AR mobile application wireframes using draw.io to resemble what the app should look like on the phone screen.	app apk file for Android smartphones. The app should be set for a minimum API level Android 5.1 'Lollipop' (API level 22). Then, the app should be tested by colleagues for feedback, which can be used later to better the app in the new version.

3. AR Quest Development	
3.1 Designing AR quests **3.1.1 Analyzing resources** Teachers need to be clear about the learning objectives of the course. With the objectives in mind, teachers must determine the learning resources that students will need in order to solve AR quests. **3.1.2 Defining quest characteristics** Besides the resources, teachers have to work and determine the characteristics of the tasks that help enhance students' learning by providing an authentic learning experience. Teachers, too, need to consider the time needed, the locations, and the quest closure. **3.1.3 Determining quest assessment** Teachers need to keep in mind about the assessment of the AR quests. Vocabulary items can be listed down for ability tests.	**3.2. Developing AR quests** **3.2.1 Scripting AR quest process** Teachers write down AR quests and try to link them with both situated learning theory and inquiry-based theory. As the two are the main medium of instruction of the AR-Quest Instructional Design Model. The two learning theories promise favorable learning outcomes when they are carefully applied in the AR learning quests. **3.2.2 Breaking AR quest process** It is advisable to break down the scripted AR quests by: - Introduction - Task - Process - Process - Evaluation - Conclusion **3.2.3 Revising the quest process** Teachers may need to go through the developed AR quests again for revision as they are the heart of the instruction.

4. Instruction Development

4.1 Designing instructional materials

4.1.2 Designing learning activities

Teachers need to come up with ideas of learning activities to attract students' attention. While designing such activities, teachers may consider the procedure, time, and proportion of activities and following AR quests.

The unique goal of the AR-Quest model is to give students authentic learning experience through the use of AR mobile application.

4.1.2 Determining instructional steps

To smoothly run the AR quest activities, it is necessary that teachers determine logical instructional steps in order to attract students' interest in the topic and encourage them along the way through the entire learning process.

4.1.3 Designing assessment

Teachers design can design both formative and summative assessment so as to evaluate the learning processes and the outcomes of the students.

Formative assessment takes place during the instruction. It is useful because teachers can identify weaknesses or problems in the instructional steps. The summative assessment is conducted at the end of the instruction. Teachers can use the posttest to evaluate the effectiveness of the model.

4.2 Developing instructional materials

4.2.1 Developing worksheet

Worksheet to be used in the classroom are to be developed. It is suggested that worksheets should be developed with a chronological order of learning contents. Time spent and students' workload is also needed to be considered.

4.2.2 Developing Khmer vocabulary ability test

Suggested vocabulary test items are as follows:

- word matching
- word translation
- appropriate choice

Time spent is to consider.

4.2.3 Developing lesson plan

The following are suggested instructional steps employed for AR-Quest instruction.

Step 1: Linking students' personal experience

Step 2: Assigning AR quests to students

Step 3: Processing the AR quests

Step 4: Reflecting on the AR quests

Step 5: Ending the AR quests

5. Model Implementation

This is the step where teachers put their AR-Quest instruction into practice. It involves the preparation for conducting the instruction for students, which includes classroom setting and learning materials. This is to ensure an authentically meaningful learning experience.

The following are suggested instructional steps that teachers can use to apply their AR-Quest instruction in the classroom.

1. Linking students' personal experience

Before leading students to the prepared AR-Quests, the teacher needs to attract the students' attention to the topic by linking their personal experience to the topic. Teachers open a class discussion to share personal experiences with one another.

2. Assigning AR quests to students

The teacher brings about the AR quests, together with other necessary assistance, for the students. As the AR quests are designed based on the students' previous knowledge. Therefore, it is expected that the students use knowledge to help them go through the AR quests to seek practical solutions.

3. Processing the AR quests

After assigning the AR quests to the students, the teacher provides them with authentic learning experience by scaffolding them during the process of solving the AR quests in

5. Model Implementation

order to help them acquire new vocabulary.

3.1 Solving the AR quests

The teacher can either assign the students to work in a group of two or in a bigger group, based on the technology resources available. Working as a team, the students can divide task responsibilities among their peers and work collaboratively in order to solve the assigned AR quests.

3.2 Presenting results

After the students have completed the AR quests, the teacher has a student from each team to share with the whole class.

4. Reflecting on the AR quests

Once the students are done their sharing of the AR quests, the teacher lets the students reflect their own discovery of the AR quests they have just solved.

5. Ending the AR quests

There are many techniques teachers can use to bring the AR quests to an end. One of which is to have students summarize the AR quest processes they have been through. This can help students adapt and merge their personal experiences with new discoveries to develop new knowledge.

6. Model Revision

Teachers may study the pretest and posttest results to determine the effectiveness of the model.

Please notice that revision is a constant process. Whenever teachers find any parts in the learning process that are hard or unclear for learners, revision is done to adjust the lessons. It helps learners learn better and achieve instructional goals.

The result of the effectiveness of the AR-Quest instructional model based on situated learning theory to enhance Thai undergraduate students' Khmer vocabulary ability

After the lesson plans, developed based on the basis of the newly developed instructional model, were validated by a group of experts in the fields and piloted during the try-out phase, they were implemented in an authentic class of thirty students who were the subjects of this present study in order to evaluate the effectiveness of the developed AR-Quest instructional model. The results of the evaluation are shown based on quantitative data as follows:

Table 1. Compare pretest and posttest of the Khmer vocabulary ability

Paired sample	Paired Differences (%)		Sig. (2-tailed)
	Mean	Std. Deviation	
post - pre	9.771	3.557	.05

From Table 1, a paired sample t-test showed that the Pretest of the Khmer vocabulary ability was lower score than the Posttest (mean = 9.771), p=.05. The results of the statistical analysis using a Paired Sample t-test show that the posttest scores of the Khmer vocabulary ability test were significantly higher at the level of .05.

Discussion and Conclusions

The framework of the AR-Quest instructional design model based on situated learning to enhance Thai undergraduate students' Khmer vocabulary ability was systematically developed by integrating two learning approaches, situated learning and inquiry-based learning.

Firstly, the researcher studied and analyzed related documents in teaching and learning a second language. The results from the documents studied of the problems lead to the review of learning theories and learning approaches in order to enhance second language vocabulary ability of the students. As a result, two learning approaches, situated learning, and inquiry-based learning are used in the instructional model and with augmented reality integration. Secondly, the researcher synthesizes the learning principles from situated learning, inquiry-based learning, and principles related to augmented reality technology. The researcher, then, systematically develops the principles of the instructional model, learning steps and lesson plans of the instructional model using the principles of each learning approach. The researcher, too, validates the newly developed instructional model by six experts and pilot in an authentic classroom. Next, the researcher improves the instructional model using experts' comments and results from the pilot study in order to make the model more effective. Finally, the researcher implements the model in an authentic classroom in order to study the effectiveness of the instructional model with thirty second-year undergraduate students, who were purposively selected from the Faculty of Education.

According to the posttest of the Khmer vocabulary ability test of the students learning with the instructional model is significantly higher than the pretest at the level of .05. The results correspond with the research findings of Santos et al. (2016) developing a handheld AR system and one specific use case, namely, situated vocabulary learning with the result of bettering students' retention of words and improving student attention and satisfaction, and those of Safar et al. (2017) who developed Augmented Reality applications to teach English alphabet to kindergarten children with the results favoring the experimental. The results of this research also match with the research results of Chester, Stephen, Tosti, and Addison (2016) who developed a situated mobile learning approach where the results were superior to the results of those taught using traditional learning methods, and those of P.-H. E. Liu and Tsai (2013) using augmented-reality-based mobile learning material in EFL English composition and the result showed that such AR materials provide students with linguistic and content knowledge. Furthermore, a research conducted by Küçük et al. (2016) on investigating effects on student achievement and cognitive load by learning anatomy via mobile augmented reality, and Cai, Chiang, Sun, Lin, and Lee (2017) on applying augmented reality-based natural interactive learning application in a magnetic field instruction showed that AR-based applications can decrease students' cognitive load and improve students' learning outcome.

The effectiveness of the AR-Quest instructional design model based on situated learning results from three factors as (1) grounded theories of situated learning and inquiry-based learning, (2) learning principles of augmented reality technology, and (3) designed learning activities of the instructional model.

Implications

The research study reflects some theoretical aspects underlying the AR-Quest instructional design model. It also provides some insights and makes contributions to additional knowledge concerning how the implications of this learning theory affect the improvement of students' vocabulary ability and the promotion of student learning engagement. The researchers also expected that this research study will provide language teachers with some guidelines in enhancing students' vocabulary ability together with the level of student engagement. This study will, too, provide language teachers with some insights into how to

apply the integration of AR-Quest approach to other foreign language education contexts as well as how AR-Quest activities should be employed to develop other language vocabulary ability of students.

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