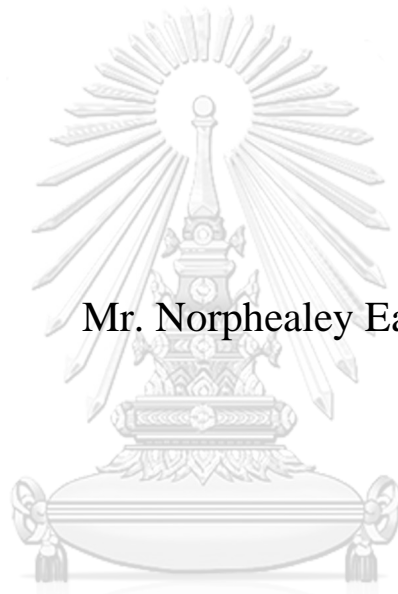


THE DEVELOPMENT OF AN AR-QUEST  
INSTRUCTIONAL DESIGN MODEL BASED ON  
SITUATED LEARNING TO ENHANCE THE ABILITY TO  
REMEMBER KHMER VOCABULARY OF THAI  
UNDERGRADUATE STUDENTS



Mr. Norphealey Eang

จุฬาลงกรณ์มหาวิทยาลัย  
CHULALONGKORN UNIVERSITY

A Thesis Submitted in Partial Fulfillment of the Requirements  
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Department of Educational Technology and Communications

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การพัฒนาโมเดลการออกแบบการสอนเออาร์ควสท์ตามการเรียนรู้ที่เหมาะสมเพื่อส่งเสริม  
ความสามารถในการจำศัพท์ภาษาเขมรของนักศึกษาระดับปริญญาบัณฑิต



วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาครุศาสตรมหาบัณฑิต  
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By	Mr. Norphealey Eang
Field of Study	Educational Technology and Communications
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นอเพ็ญลี เอียง : การพัฒนาโมเดลการออกแบบการสอนเออาร์ควีสต์ตามการเรียนรู้ที่เหมาะสมเพื่อส่งเสริม  
 ความสามารถในการจำศัพท์ภาษาเขมรของนักศึกษาระดับปริญญาบัณฑิต. ( THE DEVELOPMENT  
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 STUDENTS) อ.ที่ปรึกษาหลัก : รศ. ดร.ใจทิพย์ ณ สงขลา

การวิจัยครั้งนี้เป็นการวิจัยและพัฒนา ซึ่งมีวัตถุประสงค์เพื่อ 1) พัฒนาโมเดลการออกแบบการสอนเออาร์ควีสต์  
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 สำหรับการเรียนศัพท์ภาษาเขมร ซึ่งการพัฒนาโมเดลการออกแบบการสอนนี้ได้รับการประเมินโดยผู้เชี่ยวชาญด้านการออกแบบ  
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 ครั้งนี้ ประกอบด้วย แบบประเมินความเหมาะสมของโมเดลการออกแบบการสอนเออาร์ควีสต์สำหรับการเรียนศัพท์ภาษา  
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 เรียนศัพท์ภาษาเขมร มีการวัดผลการเรียนด้วยแบบทดสอบก่อนเรียน-หลังเรียน และวิเคราะห์ผลโดยใช้การทดสอบค่าสถิติ t

ผลการวิจัยพบว่า โมเดลการออกแบบการสอนเออาร์ควีสต์สำหรับการเรียนศัพท์ภาษาเขมร ประกอบด้วย 6  
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 .05

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ลายมือชื่อนิสิต .....  
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# # 6083322427 : MAJOR EDUCATIONAL TECHNOLOGY AND COMMUNICATIONS

KEYWORD AR-QUEST INSTRUCTIONAL DESIGN MODEL, AUGMENTED REALITY, INQUIRY-BASED APPROACH, INSTRUCTIONAL DESIGN MODEL, KHMER LANGUAGE, SITUATED LEARNING THEORY, UNDERGRADUATE STUDENTS, VOCABULARY ABILITY, ABILITY TO REMEMBER VOCABULARY

Norphealey Eang : THE DEVELOPMENT OF AN AR-QUEST INSTRUCTIONAL DESIGN MODEL BASED ON SITUATED LEARNING TO ENHANCE THE ABILITY TO REMEMBER KHMER VOCABULARY OF THAI UNDERGRADUATE STUDENTS. Advisor: Assoc. Prof. JAITIP NA-SONGKHLA, Ph.D.

This study employed a research and development, which was conducted with the purposes 1) to develop AR-Quest Instructional Design Model to enhance the ability to remember Khmer vocabulary of Thai undergraduate students and (2) to investigate the effect of the AR-Quest Instructional Model on learners' Khmer vocabulary ability. The subjects in the model development consisted of six experts from the fields of the instructional design model, educational technology, and Khmer language teaching. The participants for the model experiment were thirty undergraduate students. The research instruments consisted of a Khmer vocabulary ability test, KhAR application (Khmer AR-Quest mobile application for Android), and a lesson plan. The data-gathering instruments consisted of a pretest and a posttest. The students' scores from both the pretest and posttest were compared using paired sample t-test.

From extensively and systematically reviewing and commenting from experts to polishing through trying out, it brings about the components of the AR-Quest instructional design model that consist of four major components which are 1) Analysis, 2) AR Quest Development, 3) AR Package Development, and 4) Instructional Development. The Khmer vocabulary ability score of the posttest of the students suggested a higher score than the pre-test showed a difference at .05 level of significance.

Field of Study:	Educational Technology and Communications	Student's Signature .....
Academic Year:	2019	Advisor's Signature .....

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## CHAPTER 1

### INTRODUCTION

#### 1.1 Background of the Study

Learning a second language is vital as people have grown to be aware of the magnitude of language abilities in today's globalised world (Houwer, 2017). Being able to articulate thoughts and ideas in a foreign language is an indicator of one's knowledge. The more languages one can speak, the more opportunities they are employed and have in life (Kubota, 2011). Moreover, a study by Chibaka shows that people who can speak more than one languages have better problem-solving and communication skills comparing to those who speak on their month tongue (Chibaka, 2018). Learning a second language is not only for enhancing career path, but also providing personal fulfilment and mental discipline. Studies have suggested that people learning a new language unconsciously develop higher-order thinking ability, memory ability, and attention span; they also score higher in both non-verbal and verbal test. Furthermore, learning a second language broadens our knowledge as it is not only a means to communicate; deeply, it introduces us to different cultures. Given this, we know how to be better accustoming ourselves to different cultural contexts with cross-cultural skills learned from the new language. The awareness of other cultures also makes us to better appreciate our own culture, our friends' culture and even cultures of strangers. With a new language, a whole new world is open to us.

In the ASEAN context, the language of each nations has become crucial as the nations' borders are open for people to travel and work across countries, which was resulted from the official establishment of the ASEAN Economic Community (AEC) in late 2015, promising free movement of goods, services, investment, labour flow.

Consequently, immigration mobility in ASEAN has been increasing. Cambodian immigrants, for instance, according to ILO (2016), exceeded half a million in number to come to work in Thailand in 2016. To be exact, there are 117,493 MOU migrant workers (ILO, 2016), 111,493 registered migrants completing nationality verification based on Office of Foreign Workers Administration, Department of Employment, Ministry of Labour, Thailand (February 2016) as cited in ILO (2016), and 461,851 migrants registered at one-stop service centres based on Office of Foreign Workers Administration, Department of Employment, Ministry of Labour, Thailand (July, 2015) as cited in (ILO, 2016). 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% travelled to Thailand and Vietnam for a visit and health service purpose (Huaifu & Marady, 2017). As a result, Khmer language has become undeniably crucial for better communication in Thailand.

Because of the growing awareness of the significance of Khmer language for inter-regional communication, there comes the problem of how such a language can be taught in Thai context. According to Huffman (1973), there is the syntactic parallelism between Thai and Khmer language. Not only is the order and inventory of individual form classes almost identical, but also many semantically equivalent forms seem to share identical ranges of syntactic occurrence. Given syntactic similarity of such range and magnitude between the two languages, Khmer language is considered to be easy to learn by Thai learners as Richards and Rodgers (2014), the linguistic experts who have broken down language learning processes into their dependent components, such as syntax and phonetic, claim that if one can make sentences in a foreign language, the

next most crucial thing is the comprehension of its vocabulary. Given this Khmer vocabulary is the core learning element for Thai learners.

Vocabulary ability is a crucial element of language learning. Researchers have been working on how to enhance vocabulary ability of students (Y.-M. Huang & Huang, 2015; O’rourke, 2019); and several teaching instructions and educational technology have been proposed. Some examples of which are hypertext annotation in e-learning (I. J. Chen & Yen, 2013), collaborative multimedia (S. Joseph, Binsted, & Suthers, 2005), word games (C. Lin, Young, & Hung, 2008), virtual environments (Pala, Singh, & Gangashetty, 2011) and interactions with robots (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 integration for language instruction promise favourable outcomes (Tsung-Yu Liu, Tan, & Chu, 2010; Vate-U-Lan, 2012). Despite many teaching approaches and technological tools proposed for vocabulary instruction, they all adopt one prevailing learning theory that is the theory of situated learning, where context awareness is used (I. J. Chen & Yen, 2013; Ogata, Misumi, Matsuka, El-Bishouty, & YANO, 2008).

To learn vocabulary well, context is vital as it gives students a stronger association of the learned words with the corresponding items in the physical world (Ogata et al., 2008). Contextual learning is employed in different ways to provide students with the best vocabulary learning experience. One example use of contextual learning applied into vocabulary instruction is from (F. O. Yang, 2012) who use personalised learning systems to match objected vocabulary with students competence level of their internal context (F. O. Yang, 2012). Researchers have also built

vocabulary applications that have capitalised on external, physical contexts. One example of such applications is a mobile vocabulary application built using the library's and cafeteria's context as learning contents (K. Scott & Benlamri, 2010).

Besides the situated learning theory, quest learning approach, which adopts inquiry learning, has also contributed a lot to language education. Quest learning activities provide students with opportunities to use content-specific vocabulary in given situations (H.-Y. Chang, Wu, & Hsu, 2013). It also encourages students to take the initiative in the learning process in a collaborative environment with authentic materials (Elen & Clark, 2006). There are more research studies on quest-based activities having been conducted to examine its effect. For instance, Sadikin (2016) uses the quest-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. H.-Y. Lee (2014), studying quest-based teaching pedagogy in second and foreign language education, states that quest-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 quest approach leads to more profound and longer-lasting retention of word knowledge of the students. Furthermore, another study on the development of a quest-based vocabulary ability reveals that the quest approach helps better students vocabulary learning with satisfying outcomes (Hicks Pries & Hughes, 2012).

Backing to the profound augmented reality technology, Beder (2012) describes it as a possible step between the physical world and virtual reality. It 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 medication (Barsom, Graafland, & Schijven, 2016; Shuhaiber, 2004), to transportation (Schall Jr et al., 2013) and education (Matsutomo, Miyauchi, Noguchi, & Yamashita, 2012; W. Tarng & K.-L. Ou, 2012), not to mention entertainment field (Klopfer & Squire, 2008).

In the educational context, AR applications have enhanced outcomes, motivation and interest of learners, and provide amusing and productive learning system by shifting the concept of timing and location of language learning and mainly improve four language skills—reading, listening, speaking and writing (Safar et al., 2017). In several studies on AR applications in language teaching, the results have favourable outcomes in favour of students. Vate-U-Lan (2012) states that students' achievements increased when 3D pop-up books created by AR used to enhance the activities and provide opportunities for them [the students] to practice the language everywhere. Tsung-Yu Liu et al. (2010) suggested that Augmented Reality enhanced English learning in the skills of listening, reading, and speaking. AR boosts English teaching approach and provides high achievement results of students in learning speaking, listening, and reading.

Augmented Reality, in its nature, carries a situated learning theory, as its main feature allows teachers to overlay digital contents on real-world environment objects (Y. Fujimoto, Yamamoto, Taketomi, Miyazaki, & Kato, 2012). A situated learning

theory within AR technology can give students an authentic 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).

In the context of teaching Khmer language, the language poses no problem to Thai students as the structures of the two languages are very identical (Huffman, 1973). However, when it comes to vocabulary, Khmer vocabulary can be complicated for Thai students, which can lead to intrinsic cognitive load. As for those who are absolute beginners in Khmer language, the amount of unknown or difficult Khmer vocabulary also increases students' intrinsic cognitive load. AR application with appropriate design can reduce such a cognitive load of students and even provide students with an ultimate learning experience when it is combined with situated and quest-based learning.

The situated learning, the quest-based learning, and the augmented reality technology have their own unique potential in enhancing students' ability to remember second language vocabulary. Despite their individual uniqueness, the researcher believes that when the three are combined to develop an instruction for enhancing the ability to remember the vocabulary of students, a marvellous and satisfying learning outcome is promised. With this hypothesis, the researcher aims to develop an AR-Quest instructional design model based on the theory of situated learning for enhancing the ability to remember Khmer vocabulary of Thai undergraduate students. The AR-Quest instructional design model is the instructional steps that are designed based on the grounded principles of situated learning theory together with augmented reality principles to design vocabulary learning activities by using an AR mobile application as the primary resource.



## **1.2 Objectives of the study**

1. To develop an AR-Quest Instructional Design Model to teach Khmer vocabulary to undergraduate students at Chulalongkorn University
2. To investigate the effect of the AR-Quest Instructional Design Model on learners' remembering ability of Khmer vocabulary

## **1.3 Research questions**

1. What are the components of the AR-Quest Instructional Design Model?  
What are the learning steps in the AR-Quest Instructional Model?
2. Will the students who learn Khmer vocabulary through the AR instruction developed by the AR-Quest Instructional Design Model have a higher mean score on the posttest than that of the pretest mean score?

## **1.4 Statements of the hypotheses**

The researcher formulates hypotheses in the present study as the following:

1. The AR-Quest instructional design model consists of systematic and appropriate components for developing instruction to enhance Thai students' ability to remember Khmer vocabulary ability.
2. Students' ability to remember Khmer vocabulary will increase after the implementation of the AR-Quest instructional model developed by the AR-Quest instructional design model.

## **1.5 Scope of the study**

This study was research and development of an AR-Quest instructional design model based on situated learning to enhance the ability to remember Khmer vocabulary ability of Thai undergraduate students. According to the research objectives mentioned above, the scopes of this study were as follows:

1. This study employed research and development with four phases as follows:
  - 1.1. **Research 1:** Studying learning theories and augmented reality for the development of the AR-Quest instructional design model.
  - 1.2. **Development 1:** Developing the AR-Quest instructional design model
  - 1.3. **Research 2:** Studying the effect of the AR-Quest instructional design model
  - 1.4. **Development 2:** Revising and developing the AR-Quest instructional model
2. The population and sample of this study were:
  1. **Population:** The population of the study was divided into two groups, including 1) experts from the fields of educational technology and communications, instructional design, and language teaching and 2) Thai undergraduate students.
  2. **Sample:** The first sample group included six experts who were derived from purposive sampling. The second sample group was thirty Thai undergraduate students from different majors from Faculty of Chulalongkorn University, Thailand.
3. There were two types of variables in this study, as follows:
  1. **Independent variable:** AR-Quest instructional design model based on situated learning
  2. **Dependent variable:** the ability to remember Khmer vocabulary
4. The content of the study was basic Khmer stationery vocabulary.

5. The duration of the implementation of the AR-Quest instructional model was three sessions, with three hours each. The implementation was conducted during the second semester of the 2018 academic year.

### 1.6 Definition of terms

**Augmented Reality (AR)** is a technology used to overlay digital contents, text, pictures, audios, videos, and 3D objects to the physical environment, which can be used to enhance students' ability to remember by helping students to process information in their long-term memory.

**AR quests** refer to the designed learning activities from the AR-Quest instructional design model. The AR quest requires students to work collaboratively to solve problems by using the KHAR mobile application as the main quest exploring tool. AR quests are designed to help students improve their ability to remember Khmer vocabulary.

**Instructional model** refers to the systematic arrangement of learning activities designed based on concepts, theories, and principles derived learning theories and teaching pedagogies. Instructional model also concludes media, supplementary documents, and assessments.

**AR-Quest instructional design model** refers to instructional steps designed based on the ground principles of situated learning theory and inquiry-based learning approach together with augmented reality principles to design Khmer vocabulary learning activities requiring learners to help one another to work out problems/tasks by using KhAR mobile application. The tasks in the AR-Quest model are designed with specific learning objectives, and instruction of each task is explicit what the learners will have to do as they work their way through the AR-Quest model. The model is

structured to help them improve their ability to remember Khmer vocabulary by introducing to the AR-Quest learning activities that are able to provide them with a unique learning experience that, in turn, help them to assimilate new learned vocabulary and gradually accommodate it into their long-term memory.

**Situated learning** refers to a learning environment where AR technology is integrated, and authentic learning activities are promoted in order to provide learners with the authentic learning experience and to make learning more meaningful.

**Ability to remember vocabulary** refers to the ability that allows students to retrieve Khmer words that they have learned through the AR-Quest activities multiple times to use in an assigned task. The ability to remember Khmer vocabulary ability can come in the form of reception when students recognise the words when they hear them or see them in a written text, or in the form of production when they can retrieve the learned Khmer words in speaking or writing. Such an ability can be evaluated by the Khmer vocabulary ability test.

### **1.7 Significance of the study**

The results of the study may prove that the AR-Quest instructional design model can be used as a generic instructional design model to design and develop an effective instruction for enhancing the ability to remember second language vocabulary, specifically Khmer language. It is also believed that the findings of the study will contribute to the innovation in language teaching and learning and yield some insights into a sound pedagogical use of technology-based instruction. This research study is expected to be beneficial to language teachers who wish to employ the AR-Quest instructional design model to develop effective instruction to help enhance students' other language skills and language skills in other languages.

### **1.7.1 Theoretical contribution**

The study demonstrates the importance and benefits of situated learning theory and inquiry-based instructional approach and augmented reality in vocabulary instruction. It also provides teachers with instructional guidelines of how such theories and technology can be applied in classroom practice in order to improve students' ability to remember vocabulary and promote students' learning engagement.

### **1.7.2 Practical contribution**

1. This study will provide language teachers, particularly Khmer language teachers, with instructional guidelines in enhancing students' ability to remember vocabulary, together with the level of student engagement with the use of an AR-Quest instructional model developed from the AR-Quest instructional design model.

2. This study will provide language teachers, particularly Khmer language teachers, with insights into how to apply the integration of AR-Quest instruction to other foreign language education contexts as well as how AR-Quest activities should be employed to develop students' language skills of other foreign languages.

## CHAPTER 2

### LITERATURE REVIEW

In this chapter, the researcher presents the related literature in order to review, analyse, and synthesise fundamental concepts of the dependent variable [ability to remember Khmer vocabulary] and the independent variable [AR-Quest Instructional Design Model] of the study.

#### 2.1 Situated Learning

McLellan (1996) states that a situated learning approach underlines the effective instruction where learning contents are made to associate with its context. Researchers with expertise in situated learning have proposed major assumptions of such theory as that understanding of a new knowledge is continuously under construction; knowledge has to be learned in an authentic context of where and how it might be used; and knowledge is also built when there are interactions between individuals (Bodner & Orgill, 2007). The way knowledge is looked at which is based on situated learning principle has implications for our understanding of learning and teaching. Situated learning underlines that learning through authentic activities provides part of the notional explanation for inquiry-based approaches to learning and teaching of science course (P. Scott, Asoko, & Leach, 2013). Situated learning theory indicates that when teachers put technology to use in the context of teaching and learning, they will get a lot more benefits from technology integration for classroom instruction (R. L. Bell, Maeng, & Binns, 2013); as when technology is not used in a decontextualised manner, knowledge is believed to be constructed when students interact with their surrounding environment to achieve a goal (Bodner & Orgill, 2007).

McLellan (1996) proposes an instructional framework developed from the situated learning theory. This framework raises a practical guideline for designing and developing an instruction based on situated learning theory and place a solid emphasis on social interaction during the learning process. The main components of the model are (1) cognitive apprenticeship and coaching, (2) opportunities for various practices, (3) collaboration, and (4) reflection. Every single component is to occur in a real context.

Cognitive apprenticeship is crucial in the situated learning model because it places the importance of the knowledge generalisation that can be used in a different context (Collins & Kapur, 2014). Teachers, during a cognitive apprenticeship, bring authentic problems to the classroom in order for students to work on and then allow them to make use of the knowledge and skills they have learned from the authentic problems in the classroom to solve similar/related problems in different situations, often with the expansion of task complexity. To successfully design tasks in cognitive apprenticeship manner, Norman (1993) suggests some design guidelines such as (1) encouraging feedback and interaction, (2) determine instructional objectives and practices, (3) offering challenges, (4) promoting direct engagement by allowing students to work directly on the test, (5) supporting with learning materials for students to solve the tasks, and (6) reducing any distraction that can affect students' work.

Coaching is crucial in situated learning and cognitive apprenticeship (McLellan, 1996). Coaching refers to a process of learning where teachers do not directly tell students what they need to learn. Instead, teachers provide scaffolding for learning and guide them to achieve the set knowledge and skills. In the coaching process, students

are provided with opportunities to work on what they are learning and improve competence.

The collaboration heavily values the knowledge that is formed from social interaction. For instance, collaboration happens when students actively participate in discussions with teachers and other students to make sense of a subject matter. To ensure successful collaboration, Brown, Collins, and Duguid (1989) propose the following approaches: working on a common problem, working different roles, dealing with misunderstanding, and displaying collaborative energy.

Reflection is another crucial element of situated learning. There are a variety of forms of reflection. It is advised that teachers give students sufficient time to reflect on what they are learning. Students may be asked to make assumptions, anticipate, and bring out inferences of what they are experiencing.

(Capobianco, 2007; Holmes et al., 2002) suggest that incorporating one or more of McLellan's critical components into a curriculum is helpful and promoting the use of technology for classroom teaching and learning. Holmes et al. (2002) present findings from a teacher professional development program where situated learning is employed in real classroom practise where elementary teachers work directly with a coach to learn how to apply technology in their instruction. The findings show the growth of confidence and knowledge of using the computer in their classroom teaching and learning. Furthermore, teachers can include more teaching approaches to enhance their teaching.



### 2.1.1 Situated Cognition

Situated learning, also known as situated cognition, since it was first introduced by Brown, Collins, and Duguid, has been making a significant influence on education since it was first expounded. They state that

“‘Situated cognition and the culture of learning’ which appeared in the Educational Researcher in 1989. Based on the work of some of the great educational thinkers—credits include Vygotsky, Leontiev, and Dewey—the authors also expressed a deep indebtedness to Jean Lave, whose work has been instrumental in providing the research base for the theory.”

In situated learning, ‘bridging apprenticeships’ is to be developed to fill the gap between the use of knowledge in a real-world environment and the theoretical learning in the classroom instruction (Herrington & Oliver, 1995). Such an idea had aroused the visions of many educational researchers at that time. In 1989, Brown et al. (1989) proposed an instruction model using the idea of bridging apprenticeships for classroom practice. The model gained its fame as there was an increasing successful learning outcome observed by researchers. They, then, set out to find compelling learning examples in any culture or context and to analyse the core characteristics of such models. As a result, school subjects such as maths and literature can be taught with the effective ways of applying situated learning theory (Brown et al., 1989). Moreover, similar outcomes had also been found in the teaching of snow skiing. With all the learnings and contexts analysed, the characteristics that bring success for any instructional model consist of apprenticeship, collaboration, reflection, coaching, practice and articulation (McLellan, 1996).

Brown et al. (1989), in presenting their paradigm of situated learning, claim that that effective learning can occur when it is incorporated in both physical and social sense where knowledge may be used. They continue that traditional instruction is different from authentic learning activities. Many of the tasks introduced to students in a formal classroom are not encountered in everyday work. Brown et al. (1989) proposed that in order to ensure authentic learning experience, any situated instructional approach should be designed to lead students into authentic practices by instructing authentic activities integrated with social interaction. A vital characteristic of situated learning is the concept of the community of practice. Resulted from the growth of learning and involvement in culture, researchers shift from a passive observer to an active operating mediator. Legitimate peripheral involvement helps students to slowly integrate the group's culture and what it means to be a part of the group. Lave and Wenger (1991) state that being able to get involved in legitimate peripheral indicates that novices are able to access mature practice in a significant way.

While the theories supporting the concepts of situated learning are expounded relatively straightforward, the implementation of these ideas in teaching and learning environment may bring out specific problems. When educators try to create a learning environment using the principles and elements proposed by the situated learning theory, there are questions asked in terms of the nature and form of the instruction.

## **2.2 Inquiry Learning**

Inquiry learning comes to existence when it is believed that learning rather about understanding and implementing scientific concept rather than memorising facts and information (T. Bell, Urhahne, Schanze, & Ploetzner, 2010). Ulrich Hoppe and Werneburg (2019) define inquiry learning as a learning approach involving the process

of investigating problems, asking questions, making hypotheses, and carefully examining those hypotheses in order to form new knowledge. Inquiry learning allows students to explore and produce information by enabling them to reconstruct the scheme of knowledge (Mayer, 2004). In inquiry learning, students are encouraged to be independent and work collaboratively using authentic materials in the learning process (de Jong, 2006).

Inquiry learning typically comes with a principle of collaboration, where students work with one another to achieve shared goals (Dillenbourg, 1999). Many arguments have been argued why learners' collaboration with their peers is helpful for inquiry-based learning. Based on socio-constructivist learning theories, Duit and Treagust (2003) emphasise that knowledge emerges when a collaborative search of problem solutions in communities with distributed information from its members exists. T. Bell et al. (2010), stated the magnitude of social interaction, which is the cause for the emergence of cognitive conflicts. Vygotsky (1980) idea of the "zone of proximal development" has helped us understand the effects of collaborative experiences. Crook (1991) puts a step further to study and develop the ideas of capturing the entire context formed by teachers, peers, and learning materials of where learning occurs. The study illustrates the favourable learning outcomes achieved from student collaboration.

Although the value of inquiry learning is widely acknowledged, no one has been able to give a universal definition to it (Cuevas, Lee, Hart, & Deaktor, 2005). The inquiry principles vary according to several dimensions; two of which are discussed here. First, when various problems are examined, different interpretations of inquiry learning happen. From the viewpoint of science education, Quintana, Eng, Carra, Wu, and Soloway (1999) give a definition of inquiry learning as the process of asking questions

and examining them with practical information, either by explicitly modifying variables through experiments or by creating correlation with existing data. Second,

With the growing development of technology, inquiry learning has become even more effective learning. Inquiry learning parallels with authentic inquiry as the two are interrelated and share the same constitutive cognitive processes including studying problems (orientation), generating hypothesis, experimenting the hypothesis (switching around variables, formulate possibilities, and generating outcomes), concluding outcomes, evaluating process, planning time and activities, and managing inquiry process (de Jong, 2006).

Unrealistic classroom contexts produced by traditional teaching approach has been criticised as such unrealistic contexts disconnect students from learning activities and problems they may encounter in a real-life situation (R. Miller, 2012). Authentic learning advocates call for more realistic learning scenarios to be developed. Authentic learning requires that the learning contexts should reflect real-world problems and requires specific competencies and skills to solve such problems.

Edelson, Gordin, and Pea (1999) proved that providing students with the inquiry experience is useful for students to form knowledge in science content. In recent years, in the field of nursing education, there is seen the increasing use of inquiry-based learning (Daniels, Fakude, Linda, & Marie Modeste, 2015). Moreover, in social science, there has also been the present of Inquiry-based learning (Shih, Chuang, & Hwang, 2010b). For instance, such application is seen in the study of Lakkala, Lallimo, and Hakkarainen (2005) who used the inquiry-based approach with their combined history classes of elementary and junior high schools; and a study by Shih et al. (2010b) who use mobile devices to teach their students about cultural contents using inquiry-

based approach. Another study by I. J. Chen and Yen (2013) also used inquiry learning principles to integrate with augmented reality technology to teach students science content.

### **2.2.1 Types of inquiry**

Inquiry signifies learning processes that educational researchers commonly employ in their researches and use as a way to help students learn new learning content. The inquiry is just one of the numerous educational methods that teachers put into action in their classrooms. Inquiry learning is considered to be a student-centred approach where teachers allow students to formulate their own problems and independently investigate in the problems for solutions (Singer, Marx, Krajcik, & Clay Chambers, 2000).

Tafoya, Sunal, and Knecht (1980) propose four types of inquiry teaching approaches. These approaches are varied based on types of learning tasks, whether they are teacher-based, student-based, or teacher-and-student based. The four inquiry teaching approaches are described as:

- Confirmation Inquiry: This type of inquiry approach put forward an investigation for students to examine and confirm a principle or theory. Students have to understand what the outcome of these activities ought to be. In simple words, students are given a problem or question and are explained how to look for solutions or answers. All of the actions in the experiment or research are provided by teachers, which makes it a teacher-centred inquiry approach. Inquiry activities carried out by students are not received through discussions or ignited by students but rather by teachers or textbooks. This approach is considered as level zero.

- **Structured Inquiry:** In this structured inquiry approach, a problem is given to students, and the students do not know the possible results of tasks. Teachers in this structured inquiry activities act as an organiser, giving students detailed research steps and determining activities, materials, and tools to perform their [the students'] discovery using the inquiry approach. This is to assist students in discovering the consequences of the inquiry activities so as to generalise to form new knowledge. This structured approach is described as level two (Carin & Bass, 2001).

- **Guided Inquiry:** In the guided inquiry approach, when necessary, students are guided by teachers to perform inquiry activities. Like the previous two inquiry approaches, in guided inquiry, teachers raise problems for students; but the difference is that students, not the teachers, determine the techniques to resolve the issue. Students will get the results of the inquiry activities from the inquiry pursuits that have been carried out. In these activities, even though students have the authority to determine their own way to resolve the problem, teachers still scaffold them to hold out inquiry tasks correctly. This is done in order to prevent any students' disappointment got if they cannot get the answer to the problem. Moreover, teachers' guidance also aims to ensure that the activities do not get off track from its original objectives. Teachers can also be responsible for providing information and resources for students in order to help them reach the outcomes. Teachers may ask students several leading questions, but will not give specific answers (Carin & Bass, 2001). This guided inquiry approach is considered as level two by Carin and Bass (2001).

- **Open Inquiry:** Unlike the previous three inquiry approaches where teachers are the ones who put forward problems and questions for students, in the open inquiry approach, students themselves determine the issue, methods of solving the issue, and

obtain results based on evidence received through the conducted inquiry activities. These activities offer opportunities for students to perform inquiry tests that require several skills. This open inquiry approach challenge students to develop their communication skills, creative and critical thinking skills, manipulative skills, and methods in carrying out investigations. This approach is considered as level 3 by Carin and Bass (2001).

### **2.2.2 Attitudes towards inquiry learning**

Since attitude is described as “a behaviour to respond positively or negatively to ideas, place, event, people, or things” (Simpson, Koballa, Oliver, & Crawley, 1994), Simpson et al. (1994) state that the answer to success in education is often determined by how students feel toward home, themselves, and school.

Researches conducted by educational psychologists reveal that inquiry skills of students are not fixed; they rely on a selection of both affective and cognitive factors. These factors consist of interest and motivation in science, epistemological comprehension of the scientific process and its value (C. L. Smith, Maclin, Houghton, & Hennessey, 2000), experience with the field of the context of the learning tasks (Germann, Aram, & Burke, 1996), inquiry’s activities support in learning environment (Greeno, 2002) and communication skills (Germann et al., 1996). Eilam (2002) claims that students show self-independence in making decisions, self-regulation, and opportunities in working on tasks that they find interesting, which results in enhancing students’ motivation. Other studies have revealed that students’ attitudes are stirred by their confidence in being able to achieve their goals, the relevance of content students learn and, the pleasure of performing inquiry work (V. E. Lee & Burkam, 1996). Likewise, Hofstein, Levy Nahum, and Shore (2001) indicate students’ great excitement

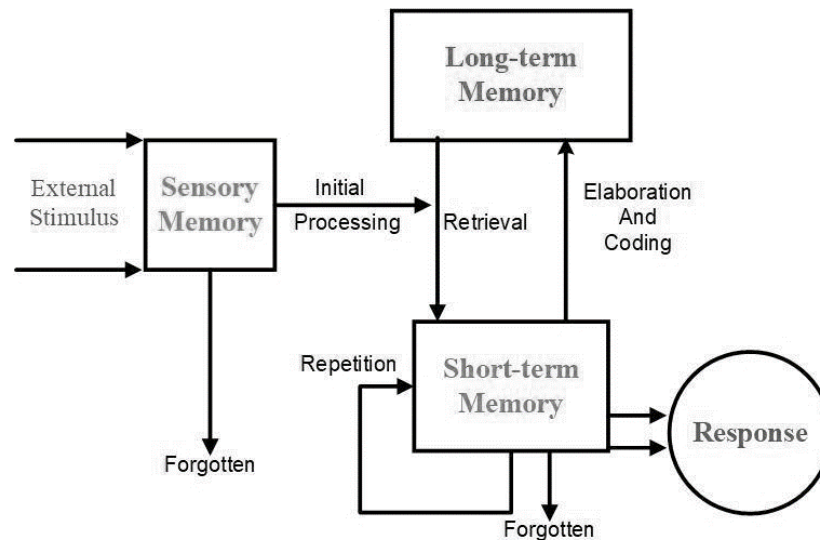
when the students are provided inquiry learning tasks. Students' mindset towards their inquiry learning experience may suggest whether they are prepared for typical tasks of guided inquiry learning or more challenging tasks of open inquiry (H.-L. Tuan, Chin, Tsai, & Cheng, 2005).

### **2.3 Information Processing Theory**

Student working memory is a crucial area of learning that has drawn the attention of researchers. Camina and Güell (2017) mention that a memory system is defined based on its brain structure, the type of information it handles, and the principles of its functions. They continue that memory is a combination of all mental experiences, that needs to be assessed in some particular way to effectually remember information (Dzulkifli & Mustafar, 2013). Eliasmith (2001) describes memory as the ability that allows us to explain the world of perception in order to prepare responses that happen in the world.

Atkinson and Shiffrin (1968) work on to develop a model explaining memory stages, which is now the most widely used model of information processing. This model suggests that memory and learning are views learning and memory as intermittent and multi-staged. Atkinson and Shiffrin (1968) suggest that information is processed before it is accumulated into memory. In the model developed by Atkinson and Shiffrin (1968) about memory stages, there are three stages of memory processing, which are 1) sensory memory, short-term memory, and long-term memory.





**Figure 1** Stage model of memory processing

Klausmeier (1988) states that the human brain works similarly to computer processing, where they both have a three-stage process as follows:

1. Input (through receptor/receiver)
2. Encoding (based on software)
3. Output (through equipment)

Based on information processing theory, information travels to memory via five senses. Such memory is called sensory memory that lasts only for a short time of a few seconds since it only gives importance to what is essential and ignores what is not. People respond to a stimulus using attention and recognition, and they record the information and stimulus into their short-term memory. From this point, people can transfer the information or stimulus from short-term memory to long-term memory by memorising or using rote-learning and elaborative operation process. This process is called encoding. In their long-term memory, there are two types—semantic (language remembering) and episodic (situation remembering). Episodic, additionally, has two types, namely motoric memory and affective memory.

To reuse the information storing in the long-term memory (Klausmeier, 1988), people need to decode it from their motoric memory or active memory and illustrate the information out into the environment. When a person is aware of how to control, manage, and use the information, of their thinking process and of using various methods – commitment, motivation, or hope –, the process “metacognition” or “self-awareness” (Eggen, Kauchak, Winitzky, Jensen, & Hadden, 1997). For example, when a student is aware that he/she learns well if he/she pays attention to what is being taught, the student will control himself/herself using their metacognition.

According to Oh-Lee, Szymkowicz, Smith, and Otani (2012), “Metacognition Executive Process describes how knowledge gained from paying attention, recognising information, encoding information, storing information and retrieving information can be used to reach learning objectives. Metacognition consists of knowledge regarding people, activities, and strategies. A person is comprised of the knowledge or conviction related to intra-individual differences, inter-individual differences, and universals of cognition. 2) The activities are constituted with task-related knowledge, task limitation, conditions, and task characteristics. 3) The strategy consists of the knowledge related to specific and general method/strategy/technique, including its benefits of each task.

Similarly, Paris and Myers (1981) divided metacognitive knowledge into three types, namely declarative knowledge, procedural knowledge, and conditional knowledge.

1. Declarative knowledge: knowledge of various factors influencing tasks
2. Procedural knowledge: knowledge of various processes and strategies in performing tasks

3. Conditional knowledge: knowledge of situations, task conditions, rationales for using various strategies/methods and performing tasks

### **2.3.1 The application of Information Process Theory (Teaching Principles)**

Khemmani (2015) has established six guidelines from his theory to give insight for teachers to apply them in their teaching practice.

1. Introduce to students the learning contents that are related to their previous experience, so the students find the learning exciting and pay their attention to it. This is done in order to connect the students' schema with new learning content and gain their interest in the topic.
2. Teachers can attract the attention of students so as to help them record information into their short-term memory by organising learning content (information) to associate with the students' personal experience and interests.
3. Psychologists state that students' short-term memory only lasts for less than half an hour, which makes researchers propose strategies to enhance students' short-term memory to last longer. One of the proposed strategies is classifying information.
4. To remember information longer, such information needs to travel through the process of information encoding from short-term memory to long-term memory. The encoding techniques can be reviewing, memorising, or elaborating process in-store new information.
5. The brain effector helps students to make use of their motor and vocal response generator. When students find the information to be useful and

meaningful for them, they somehow can record information into their short-term and long-term memory. This means that if students think that the information presenting is not beneficial and essential to them, they are likely to forget it.

6. Executive control of human memory processing is much like computer processing unity. It is stated that if a student can make use of the executive control of their brain, they are likely to be more successful in their learning. For instance, if a student knows that he or she is terrible in a course, or he or she does not like their course teacher, they will eventually find a way to get rid of this problem by experimenting different techniques or generating self-motivation.

#### **2.4 Cognitive Load Theory (Schema Assimilation)**

Human working memory is limited, and numerous researches have been conducted to explain such limitations (Paas, Renkl, & Sweller, 2003; Paas, Tuovinen, Tabbers, & Van Gerven, 2003; van Merriënboer & Sweller, 2005). Baddeley and Hitch (1974) develop a working memory model in order to illustrate an in-depth process of short-term memory. Another study on human working conducted by Cowan in 1998 proposes an integrated framework of attention and memory (Cowan, 1998). G. A. Miller (1956) who also work on information processing, suggests the capacity working memory is limited. Even though there are several studies on the limitation of human working memory alone, it is not enough to illuminate how learning occurs.

The only theory which can explain the relationship between learning and human working memory is the one from Sweller (1994) called Cognitive Load Theory (CLT). Cognitive Load Theory is believed to be a guideline for researchers to predict learning

outcomes as it suggests them [the researchers] to focus on the limitation and capabilities of human working memory (Plass, Moreno, & Brünken, 2010). CLT classifies cognitive load into three different types, namely extraneous, intrinsic, and germane (Sweller, van Merriënboer, & Paas, 1998). Extraneous cognitive load is generally caused by bad design of instructional materials; the intrinsic cognitive load results from the difficulty of learning materials, and lastly, germane cognitive load is from the too-much mental effort put into learning materials (Plass et al., 2010).

Augmented Reality (AR) is known for its unique features and abilities such as those of how to deliver information tangibly; it is believed to have the potential to better learning materials and be able to lower all the cognitive load regardless extraneous cognitive load, intrinsic cognitive load or germane cognitive load.

#### **2.4.1 Schema Assimilation and Accommodation**

Y. Lin (2015) stresses the significance of students playing the roles of meaning-makers and problem solvers in their classroom. This suggests that students should be the centre in any classroom instruction. It is essential that teachers stress the crucial roles that allow students to interact with and experience the surrounding learning environment. Below are Constructivism theorists who are enthralled about vocabulary acquisition and propose a cognitive approach to help improve students' ability to remember vocabulary. Each cognitive approach is closely connected. When one approach is used, the other is incorporated into it.

Piaget, who worked on human information processing theory, explained the process of information accommodation and assimilation (Piaget, 1983). He stated that students form new knowledge by combining their previous schema with new learning content and experiences. While this is an internal process, over the decades much

research effort has gone into exploring ways to assist learners with it. The approach used by AR mobile application is to expose students to the interconnections between vocabulary items, and statistical information about individual items. Explicitly showing items related by meaning and pronunciation allows the students to see an already-adapted framework that incorporates an individual item and serves as an example for the learner.

## 2.5 WebQuest

WebQuest has become very important in many fields of educations and has increased interest among educators since Dodge first introduced it in 1997 (Sadikin, 2016). Bernie Dodge, an educational technologist, has worked on developing a learning environment where there is an integration of technology to enhance teaching practice in a variety of levels of education. One of his remarkable achievement is WebQuest, which has been adopted in many fields of educations and been recognised as a useful and practical internet-based instructional model (Sadikin, 2016). The model gives a strong emphasis on online learning experience, which challenges, motivates, and engages learners. Dodge (2001) in his article, defines a WebQuest as online learning activities using the inquiry approach. He continues that WebQuest activities are designed for students to explore information and critically make use those information to solve the quests.

WebQuest is used only for content learning but also for researching an authentic problem-solving environment (Dodge, 2001). The essential components of WebQuest consist of an introduction, tasks, resources, the process which learners would take to accomplish the tasks, criteria for evaluating learning, and finally, a conclusion. WebQuest is categorised into two different categories: ones with various duration and

ones with a depth of treatment of the material. WebQuest, which varies in duration, are short-term WebQuest with two or three lessons and gives a focus on knowledge acquisition and integrating some specific skills. The other type of WebQuest is long-term ones, which generally takes one month to three months (a term) and aims to extend students' existing knowledge and improve students critical thinking skills by providing more challenging activities for them to analyse, synthesise, develop, and generate solutions (Ikpeze & Boyd, 2007). These two different types of WebQuest will be reviewed in greater detail later in this chapter.

With WebQuest, teachers can design activities to provide learners with more opportunities for various knowledge representations and various perspectives so that they can apply the learned knowledge within the real world (Ikpeze & Boyd, 2007). With various knowledge representations, learners can experience the same content in different situations with different activities. This is to ensure that they can flexibly use their learned knowledge in real-world contexts.

### **2.5.1 Theoretical Background of WebQuest**

WebQuest model comes to life with the combination of cooperative learning, problem-based learning, and constructivism (Dodge, 2002b, as cited in (Fiedler & Allen, 2002)). C. H. Yang, Tzuo, and Komara (2011) states that WebQuest is a new thing. It is the effective use of the web with integrated learning strategies.

Fiedler and Allen (2002) study the WebQuest model and compares it to Robert Gagné's Nine Events of Instruction". Gagné believes that learners should be informed about the objectives. Similarly, the principle of a typical WebQuest is the introduction of learning objectives. Besides, advance organisers are suggested to enhance verbal

information learning. This similar thing is also seen in WebQuest, usually in the process section (Gökalp, 2011).

Below is a table constructed by Fiedler and Allen (2002), representing the nine events of Gagne, which correspond with learners' internal processes and WebQuest Components.

**Table 1** Gagne's nine instructional events with corresponding internal processes and WebQuest components

Instructional Event	LEARNERS' INTERNAL PROCESS L	WEBQUEST COMPONENT
Gaining attention	Reception	Introduction
Informing learners of the objectives	Expectancy	Task
Stimulating recall of prior learning	Retrieval to working memory	Introduction and task
Presenting the stimulus	Selective perception	Task
Providing learning guidance	Semantic encoding	Process and scaffolding
Eliciting performance	Responding	Process
Providing feedback	Reinforcement	Process and collaboration
Assessing performance	Retrieval and reinforcement	Evaluation
Enhancing retention and transfer	Retrieval and generalisation	Conclusion

Source: Fiedler and Allen (2002)

WebQuest makes it possible for teachers to conduct a thriving cooperative learning environment (Fiedler & Allen, 2002). Group work is the need in most WebQuest tasks so that instructors can make use of it for encouraging cooperative learning. In Fiedler's study on selecting appropriate learning theories to use with



WebQuest, she, too, examines the WebQuest model with Vygotsky's theory and scaffolding Fiedler and Allen (2002). In Vygotsky's theory, social interaction is essential to engage students in authentic, collaborative activities within a relevant and meaningful cultural context. Similarly, in most tasks of WebQuest, there is a need for group work and interaction among peers in the group (Fiedler & Allen, 2002).

### **2.5.2 Types of WebQuest**

Dodge (1997) classifies WebQuest into two different types concerning duration and learning outcomes. The two are short-term WebQuest and long-term WebQuest. Short-term WebQuests, which require only a few sessions of learning, are designed to provide students with activities to help them learn a particular amount of lesson contents and make meaning to it. On the other hand, long-term WebQuests are designed to cover up learning contents, of course, that last for more than one month. Teachers employ long-term WebQuest to help students learn more about the course learning content and refine the learned knowledge. Given this, once the students complete long-term WebQuest activities, they are expected to earn the knowledge in analysing presented lesson content critically and demonstrating their understanding that is stated in the learning objectives (Dodge, 1997).

### **2.5.3 WebQuest's Elements**

Despite the long term or short term, WebQuest is intentionally designed to use learners' time effectively. In a typical WebQuest, there is always a guideline for learners to follow. The followings are the six core elements of a WebQuest.

- **Introduction**

The first element of the WebQuest is an introduction which aims to attract student attention and motivate them. The introduction also gives background

information on the topic (Irafahmi, 2016). Typically, the introduction is a short paragraph explaining why learners complete the WebQuest (Chatel & Nodell, 2002).

- **Task:**

WebQuest tasks are presented in this stage. This gives greater detail of the expected outcome (Irafahmi, 2016). Tasks have to be doable and exciting.

- **Process:**

This process stage is to give learners guidelines on how to complete each task of the WebQuest. WebQuest designers may give tips on how to effectively manage time and college data. Chatel and Nodell (2002) state that clear direction should also be listed in this session.

- **Resource:**

In this session, teachers provide students with the required sources used to solve the WebQuest activities. This helps learners to best make use of their time without wasting time on surfing irrelevant sites (Chatel & Nodell, 2002). The sources can come in the form of online documents and webpages available on the internet. Noticeably, the sources are not necessarily online (Vidoni & Maddux, 2002). They can also be books, worksheets, and other materials that students can use to complete the quests (Dodge, 2001). Despite the various types of sources for WebQuest activities, the focus is on the accuracy and applicable rates of the provided sources.

- **Evaluation:**

This session provides present learners evaluation tools so that they [the learners] can see how their work will be evaluated (Chatel & Nodell, 2002).

- **Conclusion:**

There is a brief closure paragraph presented in this session. What learners have learned through the WebQuest are included. This part also aims to encourage learners to extend the experience into other domains (Chatel & Nodell, 2002).

#### **2.5.4 Educational Value of WebQuest and Its Limitation**

Using WebQuest is one way of bringing the Internet into education. It allows teachers to help students to the best use of their time and to promote high levels of reasoning (Dodge, 1997). However, when it is simply used as other educational resources, it will not be able to minimise educational problems. Given this, WebQuest's educational value depends on not only its characteristics but also on the way they are used and the aims for which they are used (Leite, Vieira, Silva, & Neves, 2007).

WebQuest is designed to bring about several instructional practices together, some important of which are technology integration, critical thinking, authentic assessment, cooperative learning, scaffolding, schema theory, and constructivism (Dodge, 1997). In a typical WebQuest, one will see several embedded strategies, the namely authentic task to be completed, resources either digital or physical or both to be used to compete for the tasks, collaborative work and authentic assessment to increase to student participation and motivation (Tsung-Yu Liu et al., 2010). A WebQuest also promotes student creativity and critical-thinking skills by having them analyse information for the best use for tasks (Alshumaimeri & Almasri, 2012). From a well-designed WebQuest, one can expect effectively use of digital resources and high motivation of students (Renau & Pesudo, 2016).

Many pieces of research prove that WebQuest unlocks and improve student higher-order thinking skills (Crawford & Brown, 2002; Dodge, 1997; Ebadi & Rahimi, 2018; Shamisi & Saeed, 2012). Scaffolding is adapted in WebQuest that resources are

provided, which helps learners fill the gap between real-world experiences and classroom environment (Alshumaimeri & Almasri, 2012). L. T. Tuan (2011) states that teachers use WebQuest approach to teach students learning content not just to promote their problem-solving and decision-making skills, but also to enhance their information technology and literacy skills.

Leite et al. (2007) examine the advantages WebQuest brings about to learners. WebQuest has motivational power, promotes reasoning abilities, and also offers cooperative learning opportunities. Students indeed enjoy browsing the Internet. However, the Internet browsing to be effective and become worthwhile they [the students] need to learn how to use, relate and integrate information coming from different sources (Leite et al., 2007). With the use of WebQuest, students learn to develop the competence of valuing the information you find and simultaneously develop interpersonal and communication skills.

Not only students who get benefits form WebQuest; so do teachers. WebQuest is easy to handle, even by those with limited knowledge of technology (Watson, 1999). Once it [a WebQuest] is uploaded to a server, anyone can access it anywhere at any time they want (Crawford & Brown, 2002). Furthermore, a typical WebQuest provides both teachers and students with a handful of guided processes (Dodge, 2001).

Even though WebQuest presents several benefits for both students and teachers, there, on the other hand, are challenges for teachers. According to Hardy (1999), successful technology adoption is only possible when there are careful planning and enough time. Therefore, if teachers want to integrate a WebQuest to their teaching strategies, they need to plan and find time to work on it carefully. The followings are

what teachers find challenging when employing WebQuest approach (Halat & Jakubowski, 2001).

- The possibility of a lack of access to the Internet via a fast and reliable connection
- The time needed by teachers to develop a WebQuest not always available
- Finding reliable links for resources for the WebQuest

### **2.5.5 Creating a WebQuest**

Dodge (2001) suggests that teachers need to determine the learning objectives carefully before designing WebQuest. He continues that if teachers want students to improve their critical thinking skills by using WebQuest activities, such design of WebQuest should contain such verbs as design, decide, create, analyse and predict. Dodge (2001) proposed a bloom taxonomy for WebQuest tasks. He states that a WebQuest task is not necessary to stick to one level of taxonomy; in some cases, the task design can contain more than one level.

Dodge (2001) has studied available WebQuests and identified five guiding principles to help anyone, particularly teachers, to create an effective WebQuest. Those five principles come in an acronym 'FOCUS' coming from:

#### **Find great sites**

Using good sites weighs the success of a WebQuest as a good quality WebQuest is one of those that employ sources from useful websites. There, then, comes the question, 'what is a good website to be used in a WebQuest?' The answer varies based on the age of targeted students, the WebQuest topic, and the learning outcomes teachers want to focus on. However, there are some generally essential characteristics of a good website, which are readable, attractive to the learners, up-to-date, and accurate.

### **Orchestrate learners and resources**

When wanting to get the most out of something, one has to manage resources carefully. Similarly, a great WebQuest is one of those that make use of every available computer well, and everyone has something meaningful to do every moment.

### **Challenge learners to think**

Design of a WebQuest should give a strong focus, not just memorising facts. There should be tasks to engage the learner in problem-solving, creative thinking, and judgment process.

### **Use the medium**

WebQuest does not limit to a particular source of information. WebQuest designer can propose as many useful sources as she/he has to. There can be activities such as peer discussion or ask experts, not just having them [the students] browse the provided sites alone.

### **Scaffolding high expectations**

Unleashing student ability to complete big tasks, scaffolding is needed to be included in a WebQuest. Dodge (2001) proposes three different types of scaffolding to be integrated into WebQuest. They are reception, transformation, and production.

- *Reception.* A reception scaffolding provides learners with learning guidance from a given resource and retains what was learned.
- *Transformation.* This happens when learners are asked to transform what they have read and learned into something new. Mostly, learners are not familiar with such things. Thus, with help in the form of comparing and contrasting, distinguish similarities and differences of several similar objects and inductive reasoning, may they benefit.

- *Production.* Production scaffolding is when teachers provide written guidelines or templates for learners. This is done with the expectation that learners will be able to produce some higher than what they are to do alone.

## 2.6 Augmented Reality

Rabbi and Ullah (2013) describe Augmented Reality (AR) as one of the possible steps between the real world and entirely virtual reality. AR allows us to overlay virtual objects onto the real world by capturing camera images in real-time to produce a new layer to the environment with which we can interact. AR history dated back when it was able to be used only with head-mounted displays and large processing units. However, with the advancement of technology, AR has moved a big step forward to be used in personal devices, which courts for mobile phones. Many smartphones, such as those from Apple and Samsung, are built with higher computing power, hardware for environmental interaction. Their fully functional operating systems, too, have allowed the implementation of AR in more compact size solutions. Consequently, there comes the term “Mobile Augmented Reality (MAR). MAR, as defined by Doswell, Blake, and Butcher-Green (2006), is a device that can carry out AR and is typically small and easy to carry (e.g., a smartphone or a tablet). As the technology of augmented reality is becoming increasingly mature, its appliance has been introduced in many different fields, counting from transportation to medicine and entertainment (Chicchi Giglioli, Pallavicini, Pedrolì, Serino, & Riva, 2015). A smartphone with AR application installed can be used to navigate from point A to B, to find local attractions, to present users with extra information, just by looking at the world through its display. With AR technology, users can even play games taking place in the real world or try out virtual clothes without the need to go shopping.

### 2.6.1 Augmented Reality in Education

Augmented Reality (AR), an advanced technology, is used to overlay digital information such as images, sounds, videos, or 3D objects onto an object in the real environment (Azuma, 1997). AR has found its way to be applied in education as its possible benefits in teaching and learning have been recognised (Radu, 2014). However, not many types of research have worked on AR's benefits to learning (Di Serio, Ibáñez, & Kloos, 2013).

Researches working on the advantages of AR to education have proved that it (AR) is inseparably linked with cognition (T.-L. Huang & Liao, 2015; Küçük, Kapakin, & Göktaş, 2016) and interactivity (Di Serio et al., 2013). AR allows us to interact with information in a whole new as it can be used to present the relationship of digital (virtual) contents to real-world objects (Scholz & Smith, 2016). For instance, some of the AR applications in educations are from Matsutomo et al. (2012), who used AR to display virtual magnetic contents on real magnets and from W. Tarn and K. Ou (2012) who used AR technology show a butterfly virtually on a physical plant.

Besides being able to enhance real-world objects with digital information, AR is also found to be a benefit to students as it helps enhance students' memory to remember better when learning content are added up with digital information to make learning more meaningful (Y. Fujimoto et al., 2012). AR, too, has been proved to be applicable in ubiquitous learning in authentic learning 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, especially smartphones, are equipped with built-in cameras, fast processor power, larger screen,



and other sensors, which can be used to provide AR learning experience (Billinghurst & Duenser, 2012).

As AR can help learners with memorisation, it is considered to be a good match for teaching culture and languages (P.-H. E. Liu & Tsai, 2013; T.-Y. Liu, 2009). Presently, AR is used to trigger labels and symbols which are overlaid with videos, which makes it easy to understand location-related information such as name and distance of a particular place such as buildings, hotels, restaurants, and many others (Y. Fujimoto et al., 2012). In this sense, AR can genuinely be used to enhance situated vocabulary learning as words or animations are displayed in relevance to the objects found within the real environment.

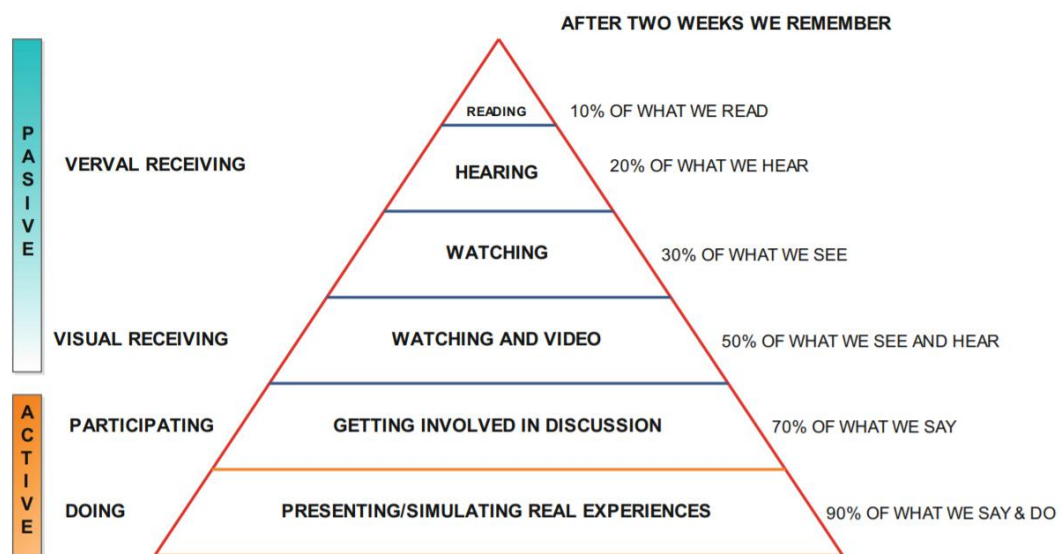
AR technology which works on handheld devices such smartphones and tablets have received an increase in attention in the field of educational technology for its usefulness in ubiquitous learning (Dede, 2011), situated cognition (Specht, Ternier, & Greller, 2011) and collaboration (Lukosch, Billinghurst, Alem, & Kiyokawa, 2015). Recently, the whole concept of using AR in facilitating learning and improving learning quality seems to attract more attention in the academic world. One of the areas that receive much attention is AR language teaching.

Throughout years of researches, Augmented Reality (AR) is claimed to have the potential for learning as it can engage, motivate and stimulate students,

### **2.6.2 Cone of learning**

Engaging students' interest to learn new knowledge is carried out more effectively during the beginning period of the instruction process (Darling-Hammond, Flook, Cook-Harvey, Barron, & Osher, 2019). To do so, several approaches must be employed in the classroom to empower the teacher to drive learning through personal

life experiences on students' personal experiences. The approach with a more substantial application is detailed on Edgar Dale's "Cone of Learning" (Masters, 2013). This reveals the various levels through which students experience the instruction process. It also illustrates the achievements to be reached on each level according to the teacher's stimuli.



**Figure 2** Learning Pyramid (source: Masters (2013))

Levels shown on the cone integrate the instruction process. On top, verbal and visual activities are placed, where students' participation is passive since they only receive information, while at the bottom, experiential activities are displayed. Student involve in the learning process and utilise the activities from which he intends to learn. This contributes to the student's significant learning (Masters, 2013).

Teaching materials are part of the teaching and learning process when life experiences and classroom practices take place (Hansen, 2000). They add to building abilities as well as capabilities for students' cognitive progress, for example, motricity and body language, logical-mathematical relations, communication, and expression,

among others. Thereby, augmented reality applications are believed to be an educational resource because they enable individuals to adopt all levels of methods shown on the Cone of Learning in a productive manner toward the student (Masters, 2013).

AR breaks the paradigms of traditional education since it makes it easier for students to develop skills associated with tasks such as: exploring, communicating, analysing, interpreting, and problem-solving (Wojciechowski & Cellary, 2013). Ternier, Klemke, Kalz, Van Ulzen, and Specht (2012) state that the objective of AR applications is to offer an immersive experience to students. They help change the classroom into a laboratory, into the bottom of a sea, or transport students to any time in history, thus, creating experiences, which are physically impossible in the real world (B. E. Shelton, 2002). This intends to increase the participation of all teachers, educational centres, and institutions on the implementation of AR environment since a 100% open mind to embrace a new framework in which the educational system adopts experiential practices and takes advantage of new technological opportunities to service teaching and learning, is necessary (Ternier et al., 2012)

### **2.6.3 Augmented Reality in Vocabulary learning**

There are four skills in any foreign language learning. They consist of listening, reading, speaking, and writing. Noticeably, mastering such skills depends heavily on vocabulary ability (F. O. Yang, 2012). Given this, throughout the years, educators have developed many creative approaches to support vocabulary learning. Some of which include hypertext annotations in e-learning (I. J. Chen & Yen, 2013), collaborative multimedia (Cai, Chiang, Sun, Lin, & Lee, 2017), word games (C. Lin et al., 2008), virtual environments (Pala et al., 2011), augmented reality (Santos et al., 2016) and

interaction with robots (Wu et al., 2008). Notably, there is found similarity in these instructional designs on three key strategies, which are repetition, engagement, and context. Indy, Yu-Ju, Chia-Ling, and Ping (2017) states that an effective way to learn new vocabulary is to expose those words to learners repeatedly. Throughout time, to exposes new words to students, teachers use different strategies, namely memory rehearsal and spaced exposures (Sedita, 2005; van den Hoorn, 2017). Memory rehearsal is when students are asked to read the words out or write them down several times. Spaced exposures are when students are placed to encounter the learned words on different occasions in listening or reading materials and conversations.

## **2.7 Vocabulary learning**

Today, being able to speak a foreign language is considered to be an indicator of our knowledge. The more languages one can speak, the more attractive they are for employment and the more opportunities they have in life. In the ASEAN context, languages of each nation are important as borders are open for people to travel and work across countries.

As knowing foreign languages is essential, so is the process of learning. Language learning has caught the interest and attention of researchers. Many researchers have broken down the language learning process into its dependent components as syntax and phonetic. If one can make sentences in a given language, the next most crucial thing is the comprehension of vocabulary. The more words one possesses, the more comfortable they can communicate with others.

Vocabulary learning is often considered as a separate part of language learning. Starting with simple noting of learned words with their meaning going through mnemonics to other advanced learning methods. There are many ways to improve one's

vocabulary. Mobile augmented reality is a new potential way that allows learners to learn the vocabulary of a foreign language in a more exciting way. Augmented Reality can engage learners into important senses of learning, such as seeing and hearing and interacting within the augmented world.

### **2.7.1 Importance of vocabulary**

Vocabulary is an essential element of language acquisition. To communicate well in a language, one must have a sufficient number of vocabularies in the language. For example, students are often reported difficulty they have encountered in both receptive and productive language use results from an inadequate vocabulary (Alqahtani, 2015). Besides, to support that vocabulary is essential in language learning, Nation has added that all language teaching approaches deal with vocabulary in own way or another.

### **2.7.2 Vocabulary ability**

Vocabulary is a crucial component of any language; thus, vocabulary knowledge is essential for foreign language learners (Alqahtani, 2015). In various research studies, researchers often use the terms “vocabulary knowledge” and “vocabulary ability” when meaning the same thing (Tipayasuparat, 2010). In fact, throughout the literature and within individual work, the two terms are used interchangeably.

Wiig and Secord (1992) state:

“word and concept knowledge are essential aspects in the model of cognition, intelligence, and verbal reasoning. Word and concept knowledge is essential for academic achievement, and that level of word knowledge has been identified as the best predictor of reading comprehension” (p.2).

Other researchers have also agreed on the terms ‘minimal, partial, and full concept knowledge’ to categorise and describe “breadth and depth” of acquired vocabulary (Schmitt, 2014). Using these criteria, students whose vocabulary concept knowledge level is at the lowest can associate new words to one specific definition or context. Students whose concept knowledge is at a supreme level can critically use words in various contexts; they know all definitions of words whose meanings are more than one, and they can interpret the meaning of a word in similar terms. Moreover, students whose conceptual knowledge is somewhere in between can use newly learned words in similar contexts and situated as the words were introduced.

A vocabulary teaching approach that students favour and get the most out of it is when learning activities are designed to give them more opportunities to engage in creating meaning more efficiently than just memorising meanings and synonym of the introduced vocabularies (C. B. Smith, 1997). Students are considered to have a comprehensive knowledge of vocabulary that they must know when they demonstrate the ability in both written and oral language with fluency and understanding (Ouellette & Shaw, 2014).

### **2.7.3 Level of vocabulary ability**

Vocabulary comprehension has been conceptualised in different ways. These alternative conceptualisations include stage-like word knowledge, dimensional word knowledge, decontextualised and contextualised word knowledge, continuum-based word knowledge, and comprehensive and partial word knowledge. Even though word knowledge is evaluated in a non-contextual manner, It, theoretically, is suggested that knowledge of a word cannot be assessed so simplistically (Lonigan, 2007).

Dale (1965) devised one of the earliest conceptualisations of word knowledge which addresses the extent of a person's understanding of a word:

Stage 1: never saw it before.

Stage 2: heard it but did not know what it means.

Stage 3: recognises it in the context as having something to do with it.

Stage 4: know it well.

These four stages of vocabulary comprehension distinguish that the meaning of a word can be both contextually based and partial. Isabel L. Beck, McKeown, and Omanson (1987) suggest that vocabulary knowledge level can be embodied on a continuum:

1. No knowledge
2. General sense such as knowing unreliable contains a harmful meaning
3. Narrow, context-bound knowledge, such as understanding that a beaming doctor is charming and happy, but that in a different context, cannot explain that individual as beaming
4. Knowing a word but cannot quickly remember it and use it wrong situations
5. Rich in the comprehension of vocabulary contextual meaning and understand its connection to other terms and its extension to metaphorical applications such as knowing what somebody does when they are demolishing a book

Anderson and Ortony (1975) examine suggestions for word sense and partial word knowledge. They state that one word can have more than one meaning according to the sentence it is used. For example, the word *piano*, if it is used in a sentence whose imply music context, the meaning of the word is defined as a musical instrument.

However, when looking at the use of the same word “piano” but with a switch in the context of household items, the meaning of piano will change from a musical instrument to a very weighty, and significant piece of furniture. When it comes to a sense of the word, such a thing cannot be found in a dictionary meaning. It is something from experiences that allow us to differentiate the meaning of the words. Undoubtedly, word comprehension is not as dichotomous and decontextualised as we see.

#### **2.7.4 Cooperative language learning (CLL)**

In language learning classroom, students are the centre of the class and they are required to active in order to well acquire language skills, especially vocabulary ability. Cooperative language learning (CLL) is designed just for that [encouraging active learning activities]. Richards and Rodgers (2014) claim that the achievement of any learning goal heavily depends on students’ interaction and cooperative work through group or peer work that aims to provide students with more meaningful and effective learning experience. Cooperative language learning is defined as a learning approach where the relationship among students’ is the focus and students are required to possess individual responsibility, a strong sense of interdependence, a sense of sinking or floating together, interpersonal skills like teamwork, confidence, management, conflict-resolution, and decision-making, group engagement, and ability to reflect on how the works and how to help it work better (Roger & Johnson, 1994). Although the students’ interactions are the main focus of the CLL, the way teachers and students work does not become oblivious. it does not ignore the way in which teachers and students work. Students in a classroom where CLL is employed are frequently urged to have an interdependence that enables them to work together rather than to compete senselessly in L2 (Larsen-Freeman & Anderson, 2013). The working memory methods used in this



research study can in turn foster teamwork between students, as they depend on the cooperative commitment of each member for their performance.

## **2.8 Instructional System Design**

Instructional System Design is instructional guidelines that teachers can follow the proposed steps in order to design and develop lesson activities for their class (Richards & Lockhart, 1994). Instructional system design is considered to be systematic as it consists of logical and chronological steps of design procedures that include planning, designing, developing, implementing and evaluating instructions to guarantee the effectiveness and efficiency in any instructional situation. The instructional design system needs to be practical and appealing to students. Moreover, Gustafson and Branch (2002) also state that an instructional design with systematical designing steps can propose a more reliable, appropriate and well-organised to instruction.

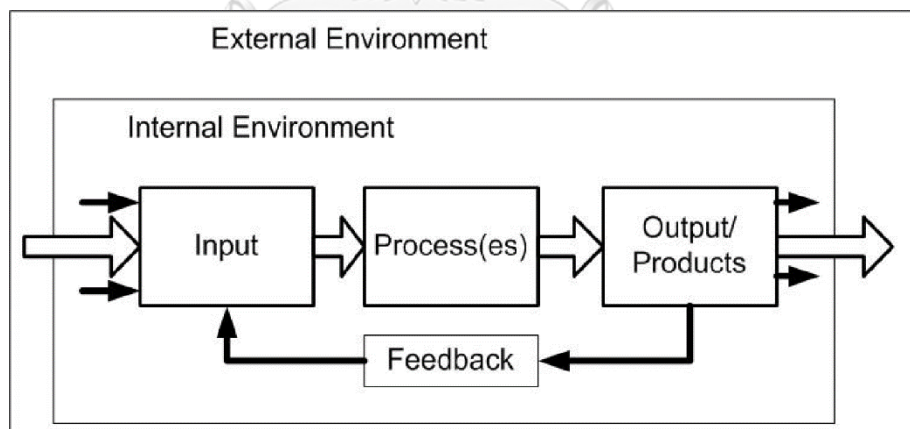
Today there are many instructional design models developed for different instructional environments. The reason behind this increasing number of proposed instructional design model is due to the prime functions of the instructional system design. Numerous instructional have been developed; some are simple; some are complex. Despite its level of complexity, every instructional design model provides teachers with chronological steps as guidelines to assist them to design and develop the best instruction that suits their classroom practice (Suksan, 2005). In this study, the researcher reviewed popular instructional design models used in educational contexts. They include the universal systems model, the ADDIE Model, Dick and Carey Model, and Kemp Model, as follows.

### 2.8.1 The universal systems model

C. E. Beck and Schornack (2004) exhibit a universal instructional system design model that comprise four focal mechanisms as follows:

1. Inputs (information or data)
2. A process (converting input information or data) into outputs or product
3. The outputs of the products
4. Feedback mechanisms and the environments they operate

The source of the inputs of this model can either be within or without the system. The design using this model, therefore, analyses the sources of the inputs (people, knowledge, materials, energy, finance, etc.), the processes (identifying the needs, resources, delivery mechanisms, interactions, navigations, structuring, etc.) that produce desired outputs (learning materials, resources, experiences, environments, etc.).



**Figure 3** The universal system model (Source: C. E. Beck and Schornack (2004))

As shown in Table 2 below, the model assumes a universal, rational agent, which in the process of design instructions maximises the use of other values.

**Table 2** Instructional components of a universal model

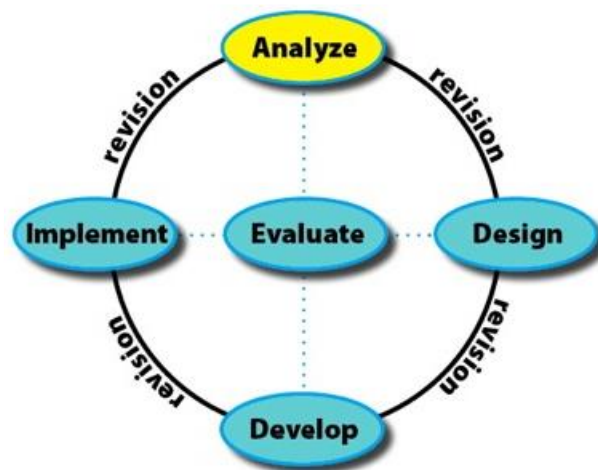
Input	Processes	Outputs
Objective element of resources and the subjective element of educationally philosophy resources include the technology, library access, and instructor resources	Educational integration – preparing and delivering the content. This is the focus on pedagogy and educational constructs – the process of designing instructional materials	Experiences: - the stimulating learning/educational materials are arising from or as a consequence of the instructional design process outcomes: - what the students acquire or can demonstrate mastery of after going through the educational/learning materials. Usually measured through assessment and more currently using the number (and type) of messages the learner's post in the discussion forums.

Source: C. E. Beck and Schornack (2004)

### 2.8.2 The ADDIE Model

When talking about instructional system design model, one most basic and applicable model always first comes to the mind of educators. It is the ADDIE Model, a conventional and systematic instructional systems design model. The ADDIE Model consists of five main components stated in each letter of its name. They are A: Analysis, D: Design, D: Development, I: implementation, and E: Evaluation, used to design and develop instructions (Sugie, 2012 as cited in (Linh & Suppasetsee, 2016)). Kruse (2002) report that there exists more than a hundred proposed instructional systems development model developed using the ADDIE Model. According to Molenda (2003), however, the unique reference of the ADDIE Model is imperceptible and he is confident

with his assumption that the ADDIE Model is simply a guideline to describe a structured approach in designing and developing instruction. The ADDIE Model is considered to be a paragon concept for a family of models with a standard fundamental structure.



**Figure 4** The elements of Instructional Design (ADDIE) (Gustafson & Branch, 2002)

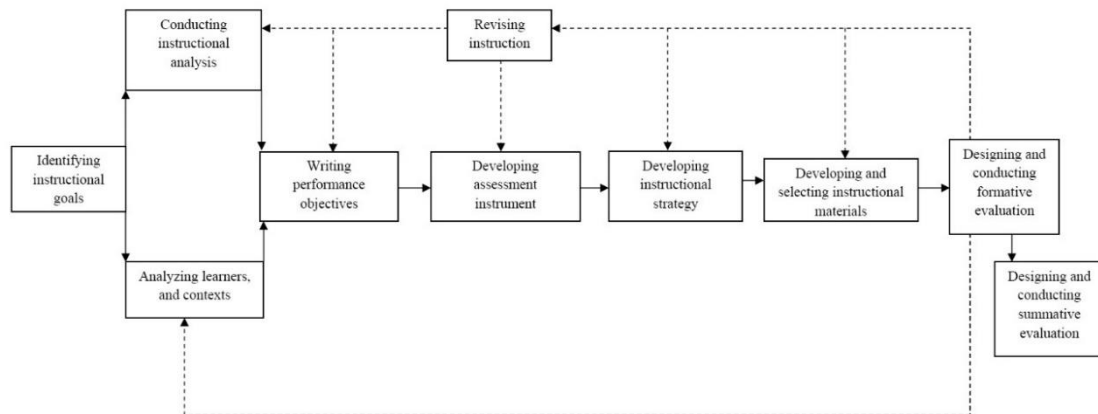
The followings are a detailed description of the five fundamental components of the ADDIE Model:

1. **Analysis.** This phase is a foundation for all other phases of instructional design. Its purpose is to identify the probable causes for a performance gap. It usually involves validating the performance gap, determining instructional goals, analysing learners, auditing available resources, recommending potential delivery system, determining if the instruction will close the performance gap, proposing degree to which instruction will close the performance gap, proposing degree to which instruction will close the gap and recommending strategies to close the performance gap based on empirical evidence about the potential for success.

2. Design. The outputs from the Analysis phase will be used to specify learning objectives, plan with assessment instruments, content, lesson planning, media selection, and the strategy that learners are expected to follow to achieve a specific task. The instructional design should be specific and systematic.
3. Develop. The content and learning materials are created and assembled in this phase. The instructional strategy needs to be clearly and appropriately identified and instruction developed to link to learning objectives and match learners' needs and characteristics.
4. Implementation. The instruction and materials are delivered to learners. The course curriculum, learning outcomes, method of delivery, and testing procedures will be implemented in this phase.
5. Evaluation.

### **2.8.3 Dick and Carey Model**

Apart from the generic model, the ADDIE, Dick and Carey Model is another popular, influential and well-known instructional design model. Dick, Carey, and Carey (2005) develop this model as a systematic approach since it demonstrates a systematic process within the components that promote and promise the success of students' learning. The characteristics of the Dick and Carey Model consist of teachers, students, teaching materials, and learning environment. Remarkably, in each element of the model [Dick and Carey Model], there is the presence of both inputs and outputs.



**Figure 5** Dick and Carey Model (Dick et al., 2005)

This model is a procedural system that consists of ten major process components as below.

1. Assess needs to identify the goal(s)

This very first step of the Dick and Carey Model is for teachers to assess needs for student academic performance in order to generate goals. In order to determine what skills students should acquire after the lesson, teachers need to find student gap. To do so, teachers can study the goal statement describes a skill, knowledge, or attitude. The instructional goals may be developed from a list of goals, a needs analysis, a students' performance analysis, and their practical experience and requirements.

2. Conduct instructional analysis

Teachers need to conduct instructional analysis in order to determine what is best for their students. This step is essential that it does not only help teachers to choose the right content and level for their students, but also to identify knowledge, skills, and attitude for students.

### 3. Analyse learners and contexts

The next important step is to analyse students of the course and the contexts. This analysis includes students' level, interest, and approaches towards the available context of the instructional setting. The information obtained from this analysis step is essential because it will help teachers outline practical learning steps and teaching approaches for the students.

### 4. Write performance objectives

When teachers have all the necessary information counting from student needs to instructional goals, the next crucial step is to list down performance objective. Teachers need to write down particular knowledge and skills the students will be able to perform after the end of the instruction. This is done in order to classify learning approaches that best suit the learning contents to promise successful student performance, as stated in the instructional goals.

### 5. Develop assessment instruments

With the list of performance objectives in hand, teachers need to design and develop learning activities, together with assessment tools used to evaluate student performance as stated in the objectives of the previous step.

### 6. Develop an instructional strategy

This step allows teachers to identify teaching approaches they will use in order to reach the instructional objectives. Some recommended teaching approaches teachers can use are pre-learning tasks, lesson content presentation, student engagement, assessment, and follow-up activities. It is

advisable that if any teaching approach is selected, teachers should study in-depth the trend and method of application from recent researches.

7. Develop and select instructional materials

Instructional materials are necessary to lead students to reach instructional objectives. Thus, it is critical that teachers select and develop teaching and learning materials required by teaching approached they have chosen in the previous step. Such materials may include learning tools, tutorials, and assessment tests.

8. Design and conduct a formative evaluation of instruction

Teachers may consider possible evaluation methods to gather information and issues to detect improving points in order to revise and improve instruction. For a formative evaluation, teachers think of one-to-one assessment, a small group assessment, and field assessment. With either assessment teachers use, it provides information to improve teaching in future practice.

9. Revise instruction

With the information obtained from assessment down in the eighth step, teachers need to analyse to find any difficulties the students experienced in reaching instructional objective stated in the early steps of the instruction design. This also suggests that teachers analyse students' behaviours and characteristics they demonstrate during the teaching and learning process. This is meant to introduce a more practical instruction used the information to revise and review teaching strategies and learning activities.

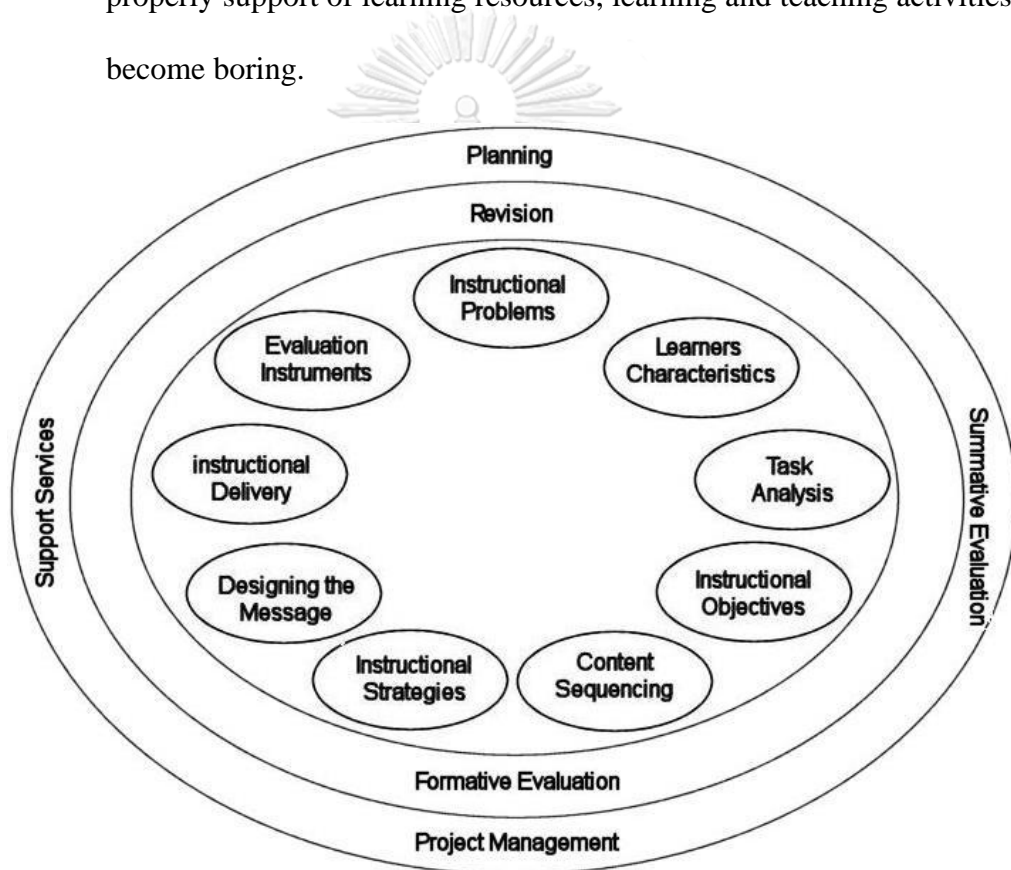


#### 2.8.4 Kemp Model

Besides the generic ADDIE Model and the influential Dick and Carey Model, Kemp Model is another dominant instructional design model. This model provides teachers with an integrated approach that is used to design and develop instruction by taking account of all environmental factors. Unlike other instructional design models, Kemp Model is extraordinarily flexible and give importance to the analysis of lesson content. According to Morrison, Ross, Morrison, and Kalman (2019), this model has nine fundamental rudiments of instructional design.

1. Teachers need to find the academic gap between instructional goals and student performance so as to design and develop instruction for filling the gap.
2. It is crucial to analyse students of the course. This can be done by taking into account their personal characteristics.
3. Once the instructional goals and student background information are already acquired, teachers need to determine learning content and tasks to fulfil the goals of the instruction.
4. Teachers need to state clearly the objectives of the instruction for their students.
5. When choosing or designing learning content, teachers need to make sure the selected contents are presented in sequence for logical learning.
6. Different students learn differently. Thus, it is suggested that teachers identify teaching approaches that can give the best out of the lesson for the students.

7. As the teaching approaches have already been decided, teachers need to organise the learning contents in ways that can attract student attention.
8. In any instructional design model, assessing students in order to evaluate the instruction is the need. Teachers are to design an assessment to see if the instructional objectives are fulfilled.
9. It does not matter how well the instruction is planned deliver, without properly support of learning resources, learning and teaching activities will become boring.



**Figure 6** The Elements of Kemp Model (Morrison et al., 2019)

### 2.8.5 Instructional models

An instructional model refers to instructional guidelines for teachers to design and develop instruction by examining and studying learning theories and making relation to the learning context. The main emphasis of an instructional model is about

selecting and determining what is necessary and vital for students and introducing to them [the students] in a prepared manner to help them form new knowledge stated in the instruction objectives. Moreover, the instructional design model, too, guides teachers to consider on creating a productive learning environment that is best suited for the students and optimising their learning ability.

Joyce, Weil, and Calhoun (2003) emphasise that an instructional model cannot be solid in one particular state; it has to be flexible as in instructional settings, there are several learning styles that students demonstrate, which needs various teaching approach. Gagne, Wager, Golas, Keller, and Russell (2005) propose nine essential components in designing learning steps as follows: 1) attract students' attention, 2) state clearly the learning objectives for students, 3) connect students previous knowledge (schema), 4) introduce the learning materials to the students, 5) provide students scaffolding when necessary, 6) provoke students' performance, 7) provide feedback for student improvement, 8) assess students' performance, and 9) confirm students' knowledge retention.

In Gagne's model, teachers control all the components, which provided no choice for students. However, many other studies suggest that students possess different learning styles and motivations, that teachers must put into consideration in their instructional practice. Joyce and Weil categorise different teaching models into four critical categories including behaviour, society, individual, and information-processing. The behavioural models consider the student ability and prior achievement in adjusting the pace and complexity of tasks for the student. The social models address the interaction of students' personalities and miscellaneous mind in designing instruction. The personal family is regarded to be student distinctiveness and can be used to help

the student take responsibility for their own development. In the meantime, the information-processing family takes into account cognitive development and preferences of the students to appropriately modify instruction (Gagne et al., 2005).

## **2.9 Situated learning in an instructional model**

The literature exposes several case studies and researches that support the contention that the situated learning approach can be used successfully as a model of instruction (e.g., (Chester, Stephen, Tosti, & Addison, 2016; G.-J. Hwang & Wang, 2016; Kucuk, 2018; Santos et al., 2016; Woolley & Jarvis, 2007); Young (1993). Computer-based applications are a further step removed from real-life work situations and criticisms. For example, Hummel (1993) emphasises that teachers who think they integrate the theory of situated learning with technological tools to enhance their instruction are actually a critical step away from the theory itself as students will not be able to experience authentic learning because the learning matter becomes the learning environment. Nevertheless, computer-based instruction still stipulates a vigorous and practical medium for the core features of the contextual classroom learning process. As proved by a research done by Harley (1993) who employs hypermedia and virtual reality in this instruction, with the results weighting the potentials of educational technology. Reeves (1992) states well-designed immersive multimedia for classroom setting gives teachers many advantages; one of which students get the opportunities to experience learning contents that are impossible in real-world practice. Collins and Brown (1988) claim that educational technology such as handheld devices and computers give us tremendous power to set up the learning environment to be situated, where students can reflect the learning activities, either in writing, reading, since, math or social studies.

Many academic scholars and educators who have sought to integrate situated learning theory into their classroom practice have acknowledged that technology can be used to provide students with a substitution to the real-life environment without losing and that such technology can be used without sacrificing the authentic context, which is such a critical element of the model (McLellan, 1996). McLellan (1996) concludes the principles of situated learning that students learn best when they are introduced to learning contents in authentic contexts. Such contexts vary based on lesson contents; they may either be actual work environment, or digital work setting, or a visual/interactive system structure.

Brown, Collins, and Duguid claim teachers can use their reformed model that has been through in-depth revision to design and develop instruction with practical and applicable steps (Brown et al., 1989; Collins & Brown, 1988). In their original paper, they introduced a new learning approach to situated learning. From the onset, they stated that their model was an attempt to propose instructional guidelines for teachers to produce instruction for fruitful learning.

Since situated learning has been proved to provide fruitful results, researchers continue to do further researches how to develop generic characteristics that can be transformed into instructional approaches. To help teachers be able to make use of situated learning in their classroom practices, McLellan (1996) encapsulates the main features of the situated learning model with the components of preparation, cooperation, contemplation, training, and manifold practices. Despite the encapsulation, other educational researchers of the field, together with the original model developer, have broadened and improved the concepts for designing learning environment to reach social context in a further comprehensive level.

### **2.9.1 Situated learning crucial characteristics for instructional design**

With many augments of researchers and theorists towards situated learning practice, Herrington and Oliver (1995) sum up crucial characteristics for instructional design. Such characteristics have contributed to the emerging theory of situated learning and have found their ways to distinguish their characteristics that convinced many researchers and teachers that best instructional approach for classroom instruction exists when it meets the following characteristics (Herrington & Oliver, 1995): 1) providing learning activities where students are equipped with authentic context so they can reflect and make use of the learned knowledge confidently in real life, 2) designing authentic learning activities, 3) giving students opportunities to perform and take over learning processes, 4) assigning students multiple roles so they can learn from different perspectives, 5) giving students more opportunities to work with their peer to learn lesson content, 6) providing students supports when necessary, 7) encouraging students to make lesson reflection, 8) encouraging students to express their thoughts and make clear of knowledge learned, and 9) providing assessments so the students can see their progress and improve what they are poor at.

## 2.10 Conceptual Framework

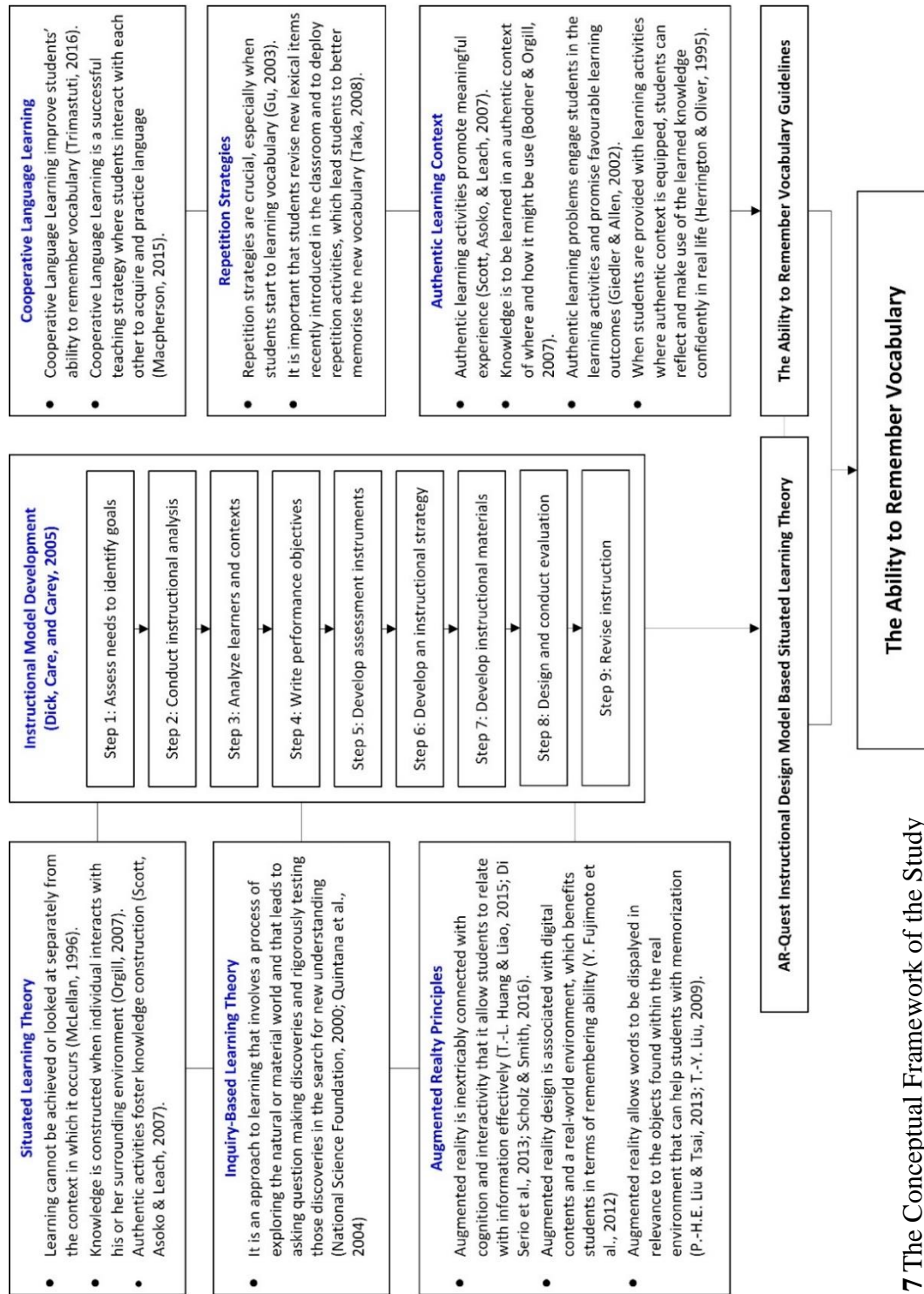


Figure 7 The Conceptual Framework of the Study

## CHAPTER 3

### RESEARCH METHODOLOGY

#### 3.1 Introduction

This chapter explains the research methodology used in this present study. The central objectives of the study are (1) to develop the AR-Quest Instructional Design Model to enhance the ability to remember Khmer vocabulary of Thai undergraduate students and (2) to investigate the effect of the AR-Quest instructional model on improving students' ability to remember Khmer vocabulary. In this chapter, the researcher covers the research design, participants, and research instruments for each stage of the research, together with methods of data collection and data analysis.

The present study was designed to answer two main research questions:

- 1) What are the components of the AR-Quest Instructional Model? What are the learning steps in the AR-Quest Instructional Model?
- 2) Will the student who learn Khmer vocabulary through the AR-Quest instruction developed by the AR-Quest Instructional Design Model have a higher mean score on the posttest than that of the pretest mean score?

#### 3.2 Research design

This study employed research and development, and it was divided into four dependent phases as follows:

##### **Phase 1: (Research 1) Studying learning theories, augmented reality for the development of the AR-Quest instructional design model**

- 1.1 Studying the significance of Khmer language necessity in Thailand
- 1.2 Studying, analysing, and synthesising learning theories for the development of the AR-Quest instructional design model



1.2.1 Situated learning for the AR-Quest instructional design model

1.2.2 Inquiry learning for the AR-Quest instructional design model

**Phase 2: (Development 1) Developing the AR-Quest instructional design model based on situated learning**

2.1 Synthesising learning principles for the AR-Quest instructional design model

2.2 Putting across the AR-Quest instructional design model's objectives

2.3 Proposing instructional parameters for the AR-Quest instructional design model

2.4 Putting forward learning steps of the AR-Quest instructional design model

2.5 Assessing and evaluating the AR-Quest instructional design model

2.6 Developing the AR-package for the AR-Quest learning activities

**Phase 3: (Research 2) Studying the effect of the AR-Quest instructional design model based on situated learning**

3.1 Preparing for the implementation of the AR-Quest instructional model

3.1.1 Determining research design

3.1.2 Specifying population and samples

3.1.3 Developing research instruments

3.2 Validating the research instruments for the AR-Quest instructional model

3.2.1 Validating by experts

3.3. Revising the research instrument for the AR-Quest instructional model

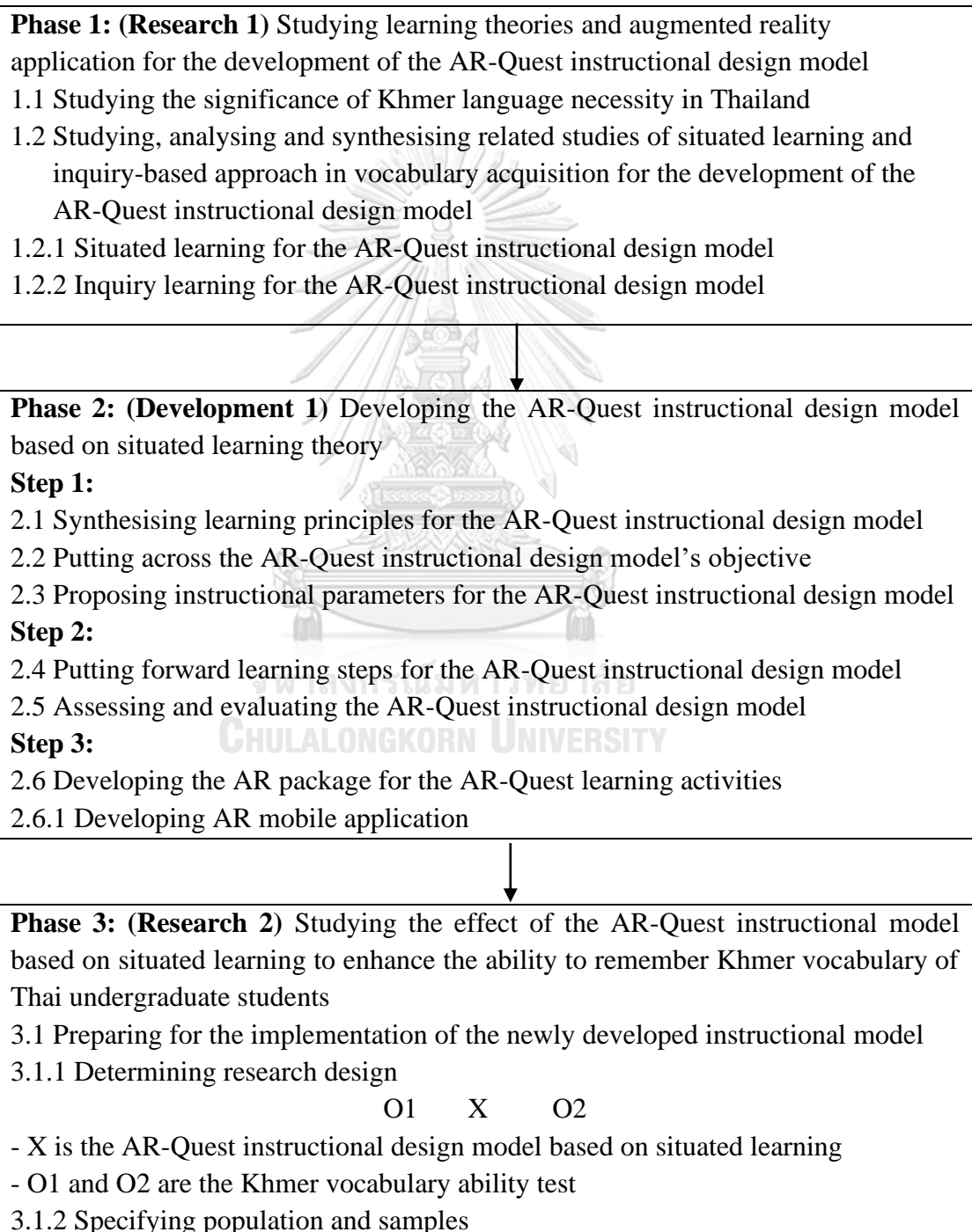
3.4 Implementing the AR-Quest instructional model in an authentic classroom

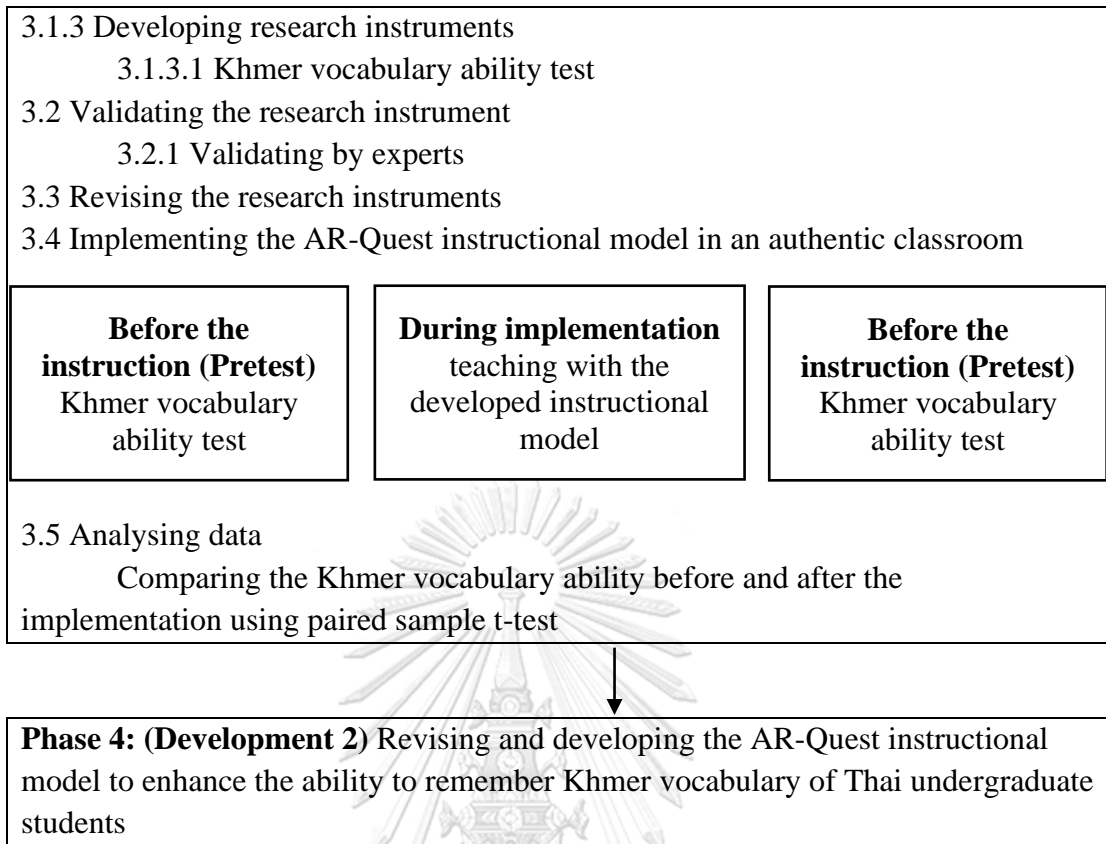
3.5 Analysing data

#### **Phase 4: (Development 2) Revising and developing the instructional model**

Analysing students' achievement regarding the ability to remember vocabulary from both the pretest and the posttest

Figure 8 below explains the research process of the development of the AR-Quest instructional design model.





**Figure 8** Research process of developing the AR-Quest instructional design model based on situated learning theory

## **Phase 1: (Research 1) Studying problems, learning theories, augmented reality for the development of the AR-Quest instructional model**

### **1.1 Studying the significance of Khmer language necessity in Thailand**

The researcher studied documents from the International Labour Organisation and Office of Foreign Workers Administration, Department of Employment, Ministry of Labour, Thailand, about Cambodian migrants coming to working in Thailand (ILO, 2016). The results of the document studied showed that there is a massive Cambodia labour flow, more than half a million, coming to Thailand in 2016, which consequently making the Khmer language to be a must-learn language for Thai people.

## **1.2 Studying, analysing, and synthesising learning theories for the development of the AR-Quest instructional design model**

The researcher studied and analysed the situated learning and inquiring learning together with other grounded theories from various sources, namely documents, textbooks, journal articles, and academic researches.

### **1.2.1 Situated learning for the AR-Quest instructional design model**

The theory of situated learning has gained interest from educators and has found its way in language education. Situated learning theory emphasises 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).

### **1.2.2 Inquiry learning for the AR-Quest instructional design model**

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 are also to take the initiative in the

learning process in a collaborative environment with authentic material (Elen & Clark, 2006).

The principles of situated learning and inquiry learning are summarised as follows:

1. Students learn well when they are introduced to group activities. This they can help one another to build skills.

2. Learning quest activities that can maximise student engagement and outcomes need to follow the six quest principles that are introduction, task, process, resources, evaluation, and conclusion.

3. Appropriate authentic learning activities and materials can determine whether learning is meaningful. Thus, it is crucial to select and organise learning resources in the instructional design carefully.

## **Phase 2: (Development 1) Developing of the AR-Quest instructional design model based on situated learning**

The researcher developed the instructional model by integrating situated learning theory and inquiry-based approach in corresponding with the problems in this research, the ability to remember the Khmer vocabulary of Thai undergraduate students.

The processes of developing the instructional model based situated learning and inquiry learning approach are shown as follows:

### **2.1 Synthesising learning principles for the AR-Quest instructional design model**

The researcher analysed the fine details of the principle of situated learning theory and inquiry-based approach. The details of the instructional model principles are shown as follows:

1. Meaningful learning occurs when students learn in an authentic context of where and how the lessons might be used.

2. When students are placed with authentic activities, they tend to remember the lesson content well.

3. Students construct knowledge when they are challenged to make their own discovery by solving learning quests.

4. Learning will be more effective when the students work collaboratively for co-constructing knowledge and are scaffolded by peers or teachers.

## **2.2 Putting across the AR-Quest instructional design model's objectives**

The researcher studied the pedagogical principles of the instructional model to determine the learning objectives of the AR-Quest instructional design model based on situated learning theory to enhance the ability to remember Khmer vocabulary of Thai undergraduate students. The objectives of the instructional model were to enhance the ability to remember Khmer vocabulary of Thai undergraduate students.

## **2.3 Proposing instructional parameters for the AR-Quest instructional design model**

The researcher synthesised the learning principles of the AR-Quest instructional model based on situated learning for the details of the instructional parameters of the instructional model. The instructional parameters of the instructional model were as follows:

1. Teachers connect students' schemas by generating questions related to what they are going to learn as their previous knowledge is used as learning stimuli for further inquiry about the topic.

2. Teachers create a productive learning environment by the question-and-answer technique, small group discussion, brainstorming, or game. Teachers, then, introduce inquiry activities to students.

3. Teachers provide students with explicit instruction of the prepared learning quests designed for students to explore the set vocabulary before assigning quests to them. This includes providing details about the resigned quest and related tasks to the students. Teachers also need to

4. Teachers give students the opportunities to collaborate in a small group together to find information, reflect learning tasks, share experiences, and develop skills for future activities.

5. Teachers need to ensure that students keep focusing on what they are experiencing in order to become more aware of the learning for the upcoming quests.

6. Students are the heart the classroom and should give more opportunities for them to work with one another. Teachers need to be ready to scaffold them when necessary.

#### **2.4 Putting forward learning steps for the AR-Quest instructional design model**

The researcher used the instructional parameters of the AR-Quest instructional model based on situated learning to design the learning steps of the model.

There are five steps in the newly developed instructional model: 1) linking students' personal experience, 2) assigning AR quests to students, 3) processing the AR quests, 4) reflecting on the AR quests, and 5) ending the AR quests. The objective, teacher's roles, and students' roles of each learning step are shown as follows:

Step 1. Linking students' personal experience	
The main objectives of this step are 1) to attract the students' attention to the topic and 2) to stimulate students' previous knowledge to link with the topic.	
<b>1. Topic instruction</b>	
This is the process of starting a new lesson by telling students about what they are going to learn and the expected learning outcome that they are going to achieve by the end of the lesson.	
<b>1.1 Teacher's roles</b>	<b>1.2 Students' roles</b>
The teacher gives students an overall image of what the students are going to be presented to.	The students pay attention to the teacher introducing the topic and the learning outcomes they will get after the lesson.
<b>2. Previous knowledge simulation</b>	
<b>2.1 Teacher's roles</b>	<b>2.2 Students' roles</b>
The teacher asks students questions to seek their experience and their point of view of the topic.	Students raise questions and answer the teacher's questions. They then share their knowledge and experience with the whole class.
Step 2. Assigning AR quests	
This second step consists of two primary objectives as the followings 1) to introduce students learning quests they are going to complete and 2) to guide and scaffold the students to explore the prepared learning quests.	
<b>1. Quest Introduction</b>	
<b>1.1 Teacher's roles</b>	<b>1.2 Students' roles</b>
The teacher introduces the learning quest, together with other necessary guidance and tips to the students.	Missing the information leads to the mistake of completing the quest. The students are to listen carefully to what the teacher is explaining.
<b>2. Schema stimulation</b>	
Students' previous knowledge is vital as it creates a productive learning atmosphere that helps students with the tasks and presents the overload of information.	
<b>2.1 Teacher's roles</b>	<b>2.2 Students' roles</b>



The teacher can guide and give the students some hints where necessary.	The students gather and note down the information and tips that they can use to solve the quest.
<b>Step 3. Processing the AR quests</b>	
The only main objective of this step is to provide students with the authentic learning experience, exploring and solving the quest, in order to introduce new vocabulary to them.	
<b>1. The exploration and evaluation</b>	
This procedure is to provide the students to work with peers in order to solve the assigned quest.	
<b>1.1 Teacher's roles</b> The teacher, in this step, acts as a class monitor to control the class, students' learning activities, and help the students when necessary.	<b>1.2 Students' roles</b> The students can work in a small group of three, where they can divide the task responsibility.
<b>2. Presentation</b>	
<b>1.1 Teacher's roles</b> The teacher asks a student from each group in order to share their discovery with the class. At this point, the teacher may encourage discussion about the shared answers.	<b>1.2 Students' roles</b> A student from each group needs to present their discovery to the whole class.
<b>Step 4. Reflecting on the AR quests</b>	
The objective of this step is to let the students reflect their own discovery of the quest they have just solved. This is to help them see what they need to improve in order to achieve a better result in the next learning quests.	
<b>2.1 Teacher's roles</b> The teacher plays a role as a controller of the class and oversees the ongoing	<b>2.2 Students' roles</b> The students discuss their previous work with peers in the group and see what they

discussion between students and students in the class.	need to and improve in order to do better in the next learning quest.
<b>Step 5. Ending the AR quests</b>	
The last step, step 5, aims to general new knowledge for the students and to summarise the entire processes of the learning quest the students have done	
<b>2.1 Teacher's roles</b> The teacher gives students some time to summarise what they have learned from the learning quest they have done.	<b>2.2 Students' roles</b> The students work both individually and, in a group, to refine their new knowledge they have learned from the learning quest.

## 2.5 Assessing and evaluating the AR-Quest instructional design model

The newly developed instructional process used before- and after- evaluation. Before the teaching procedure based on the developed model, Khmer vocabulary ability test was administrated to the students as a pretest. The test covered word matching, word translation, and appreciate choices. After the treatment, the same test was administered to the same group again. Then, the scores of the pretest and posttest were compared.

## 2.6 Developing the AR package for the AR-Quest learning activities

The AR package for learning quest activities includes KhAR mobile application [android version] and AR Khmer vocabulary cards. They were designed and developed to respond to the objective of the model of enhancing Thai undergraduate students' ability to remember Khmer vocabulary ability by AR quests. The development was based on pedagogic foundations of vocabulary learning theory while balancing technological qualities. It was a challenging task to balance vocabulary content with the

features of AR technology. The researcher, however, expected a perfect AR application developed based on the integration of vocabulary acquisition principles and AR technology principles to answer the objective of the AR-Quest model.

### **2.6.1 Developing AR mobile application**

The first phase involves the analysis of the vocabulary acquisition theories and vocabulary selection to help shape the KhAR mobile application.

#### **2.6.1.1 Vocabulary acquisition theories:**

In attempting to find a theoretical grounding for the app, this study was guided by situated learning theory. Bodner and Orgill (2007) emphasise that when the situated learning theory is applied in the AR technology to be used in vocabulary instruction in a contextualised manner, students' vocabulary knowledge is constructed as the students interact with their surrounding environment to achieve learning goals. Moreover, AR integrated with the situated learning theory can offer students to learn lesson contents within an authentic context of where and who they [the lessons] might be used, which makes the learning meaningful and enhances students' ability to remember vocabulary. Situated learning theory suggests that teachers get more benefits from AR technology integration for vocabulary instruction when it [the theory] emerges (R. L. Bell et al., 2013).

#### **2.6.1.2 Vocabulary selection:**

The need to give principal attention to the selection of the vocabulary for learning quests has been long recognised. Since teachers cannot usually teach all words that a student should know in a foreign language, it is necessary to find some basis for selecting words (Worthington & Nation). Harmer (1991) and Worthington and Nation

(1996) point out that one of the problems of vocabulary teaching is how to select which words to teach.

(Johnston, n.d.) suggests the following criteria for selecting vocabulary for teaching.

### **Importance**

With their teaching experience, teachers have to evaluate word lists presented in the learning content and value the words, whether they are essential for the student to learn (Flanigan & Greenwood, 2007). Teachers need to bear in mind if words are familiar by the students, or the context of the content can support the students to understand more about the words. They [words] are excellent choices for students to learn.

### **Transferability**

The frequency of words appearing in the learning content is another way to select words for the students. Teachers can select vocabulary which is used often in the content and/or in other academic studies. It is unwise that teachers waste instructional time teaching words that are rarely used.

### **Usefulness for generative studies**

Root words that lead to other related words are another choice that teachers also consider choosing for their students.

The above three ways of choosing learning vocabulary for students can help teachers who teach a course content where no vocabulary learning list is available. Be noticed that, it does not matter if teachers can meet the three criteria. It, however, is advisable that teachers should at least choose words that meet two of the three criteria mentioned above.

### 2.6.1.3 Steps in developing the KhAR mobile application

#### Step 1: Selecting vocabulary

Based on the vocabulary selection criteria presented earlier, the researcher selected fifteen nouns (for the KhAR mobile application) with an additional ten verbs. The theme of the words is about stationery and some common verbs used in the classroom. These fifteen words were grouped into three different categories so as to minimise students' cognitive disruption.

Besides the fifteen common words of the stationery, there are another ten verbs that are also always used in the classroom.

N	Khmer words	Thai Romanisation	Meaning in English	Meaning in Thai
<b>Category A: Words with a similar sound and the same meaning</b>				
1	ក្រដាស	กรอ-ดะห์	Paper	กระดาษ
2	គ្រឿងគិតលេខ	เครื่องคิดเลข	Calculator	เครื่องคิดเลข
3	ឯកសារ	เอกกะซา	Document	เอกสาร
4	កន្ត្រៃ	กรอนไตร์	Scissor	กรรไกร
5	នាឡិកា	เนยลิกกา	Watch	นาฬิกา
<b>Category B: Words with language relation with Thai words</b>				
1	ខ្មៅដៃ	ขมาวด	Pencil	ดินสอดำ
2	ក្តាខៀន	กะดาเขียน	Blackboard	กระดานดำ
3	ក្របួបស្ពាយ	กรอโบบสะเปีย	Backpack	กระเป๋าสะพาย
4	ជ័រលុប	จอ-ลบ	Eraser	ยางลบ
5	ខ្មៅដៃពណ៌	ขมาวดโป	Color pencil	ดินสอสี
<b>Category C: Words with different sound and meaning</b>				
1	ប៊ិច	เบ็กห์	Pen	ปากกา
2	សៀវភៅ	เซียวเพิว	Book	หนังสือ
3	ដង្កៀបក្រដាស	ดองเกียบ-กรอ-ดะห์	Paper clips	คลิปหนีบกระดาษ

N	Khmer words	Thai Romanisation	Meaning in English	Meaning in Thai
4	ដៃកកឹប	ไตเกีบ	Stapler	เครื่องเย็บกระดาษ
5	ប្រដាប់ខ្លួងខ្មៅ ដៃ	ปรอดับควง-ขมาวไต	Sharpener	กบเหลาดินสอ
Extra words (verbs)				
1	រៀន	เรียน	Study	เรียน
2	អាន	อ่าน	Read	อ่าน
3	សរសេរ	ชอเซ	Write	เขียน
4	និយាយ	นิเยีย	Speak	พูด
5	ស្តាប់	สตับ	Listen	ฟัง
6	សួរ	ซัว	Ask	ถาม
7	ប្រកប	ปรอ-กอบ	Spell	สะกด
8	គិត	เก็ด	Think	คิด
9	ប្រើ	เปรอ	Use	ใช้
10	មើល	เมิลล์	Watch	ดู

### Step 2: Planning

The app was developed with the help of OpenAR Laboratory. The researcher decided to develop the KhAR mobile application for Android smartphones. Such decision was made based on the following reasonings: 1) according to Joorabchi, Mesbah, and Kruchten (2013), there are currently almost two million apps with Android taking 52% of the market share; Apple taking 38% of market share and AppWorld and Windows with 6% and 3% respectively. These percentages were compared to Peruzal's website, in which they stated the Android OS was the most widely used, with 84% of app users operating on it (Peruzal.com, 2016). For developing the app, Unity 3D Version 2017.2.0f3 and Vuforia-unity-6-2-10 were employed because it is a

comprehensive platform containing all the tools and frameworks needed for developing an augmented reality app.

### Step 3. Sketching wireframe

After planning and developing a platform, the researcher drew the KhAR mobile application wireframe using draw.io to resemble what the app should look like on the phone screen. The following sketches were created on draw.io.

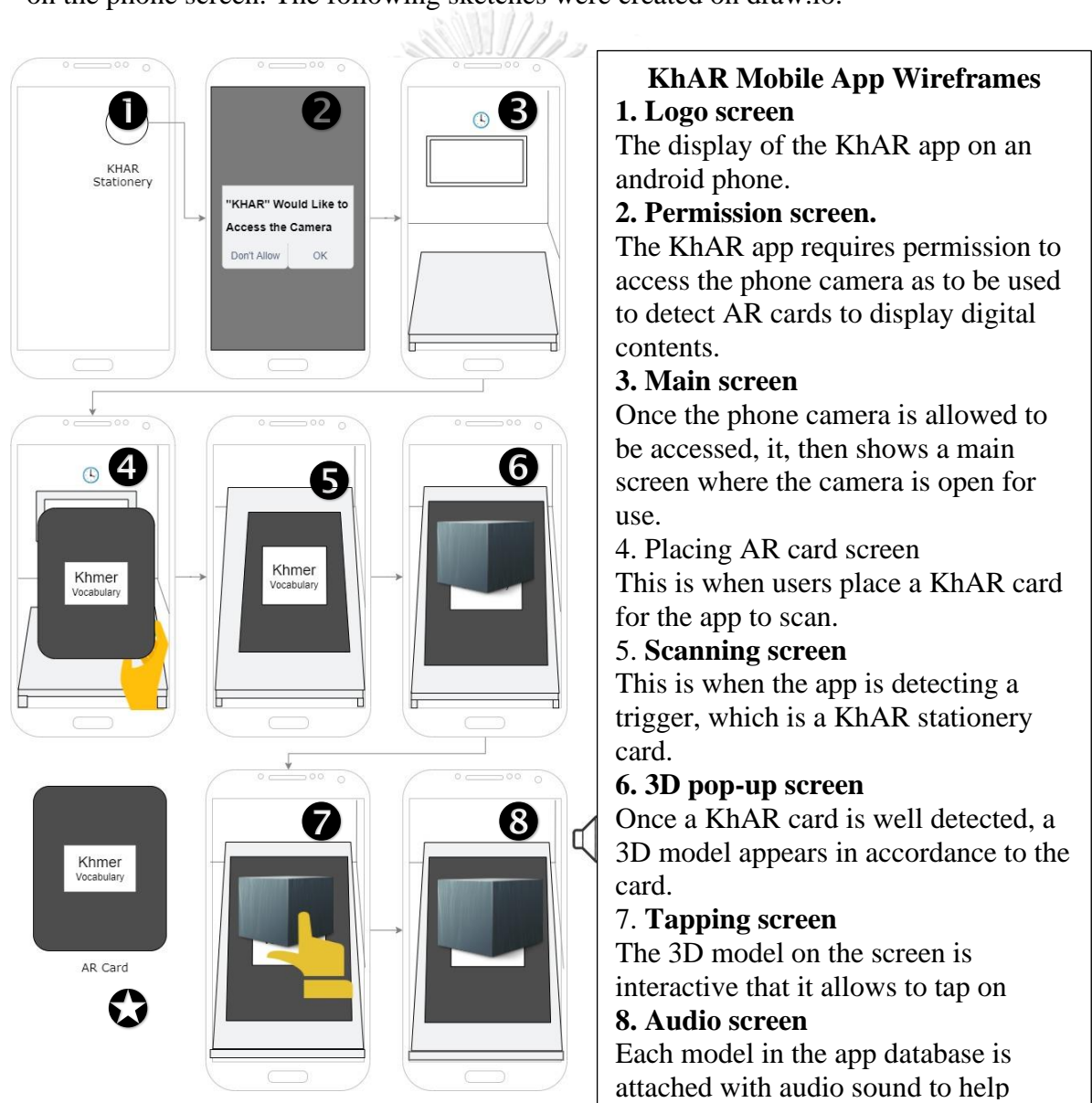


Figure 9 KhAR mobile application wireframe

#### **Step 4: Joining App development workshop**

To develop the KhAR app, the research joined an app development workshop that lasted for two days, from 8.00 in the morning to 16.00 in the afternoon. The training was intensive, with two professional trainers and five trainees. The stages of development were guided by the principles of incremental development, which indicates that one starts with the essential features of the app and gradually adds to it, according to feedback and revisions (Gargenta & Nakamura, 2014). The development steps are as follows:

**1. Setting up the environment for Android development:** the following programs were downloaded in preparing the computer for developing the app.

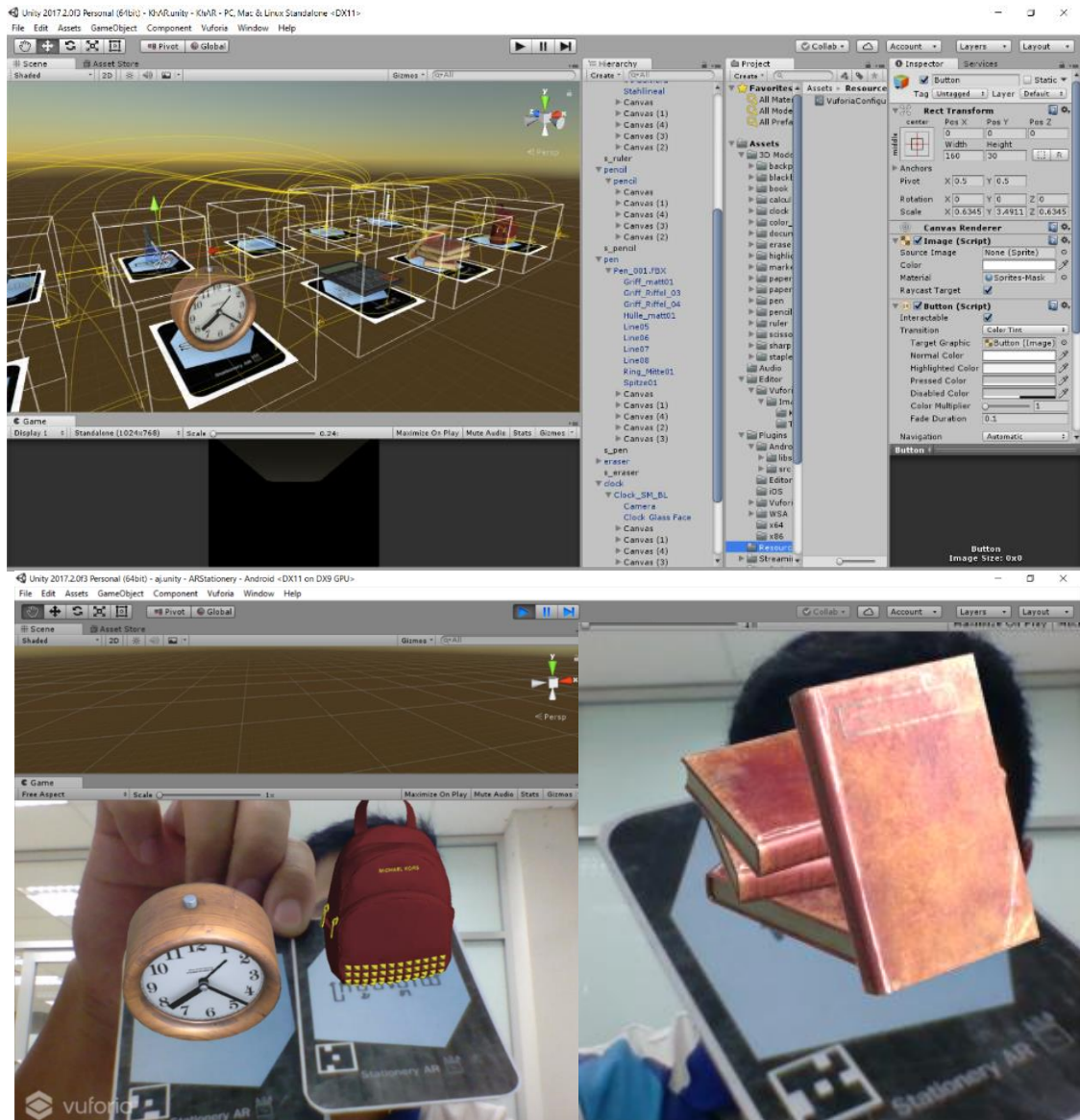
- Unity 3D version 2017.2.0f3: a cross-platform engine with build-in IDE was used to create the KhAR mobile application; it was where all the codes for instructions and sources were stored. This is the home for the KhAR mobile application.
- Java Development Kit: this was to enable the computer to understand and speak the language of the KhAR mobile app.
- Android SDK: is for compatibility with the KhAR mobile app.
- Vuforia version 6-2-10: is the heart of the KhAR mobile app that requires a database to store triggers or markers, valuable information in using the application.

#### **2. Design and Coding the KhAR mobile application**

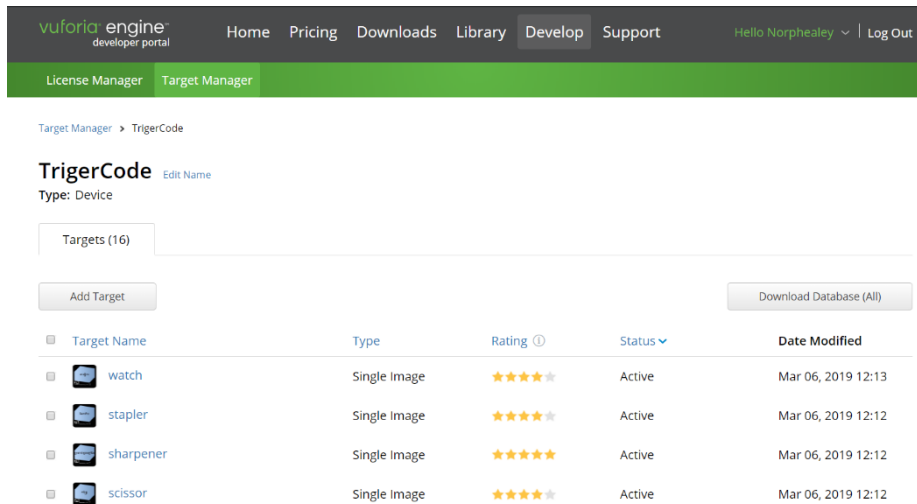
The KhAR mobile app was designed by using Unity 3D with built-in IDE, where C sharp (C#) programming was used. Digital KhAR cards, 3D objects, audios and other sources used to build the application were stored in Unity 3D.



The followings illustrate the working environment for developing the KhAR mobile application.



**Figure 10** Unity 3D workspace of KhAR application



**Figure 11** Vuforia database for KhAR application

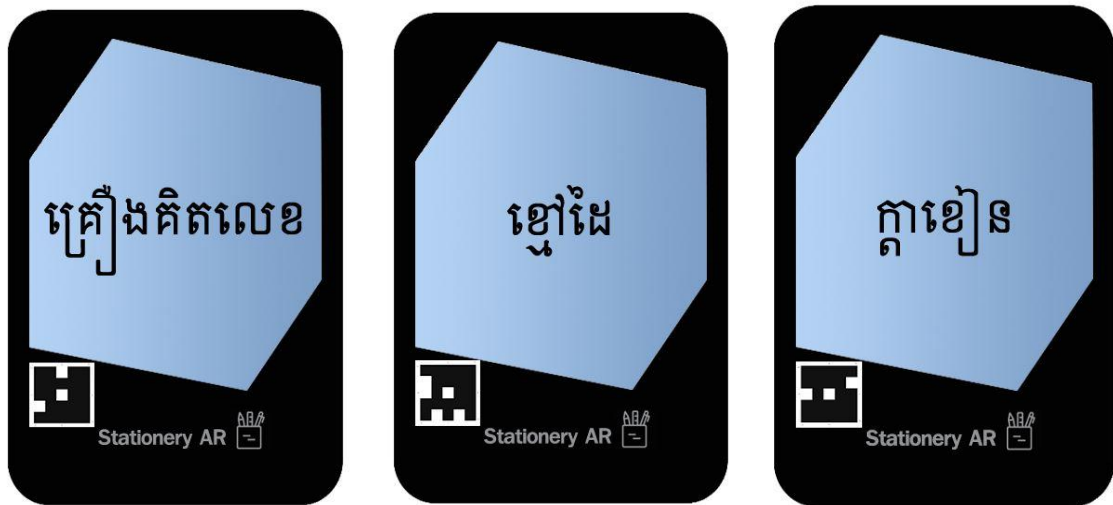
### **Step 5: Building and testing KhAR app**

Once the KhAR app was working fine with the laptop's camera. The researcher built the app for the android system. To do this, Android Studio was needed to generate the app apk file for Android smartphones carrying minimum API level Android 5.1 'Lollipop' (API level 22). The KhAR app was then tested by colleagues; feedback was received on the technical aspects of the app, including ease of use and the content such as 3D models and audios. The researcher used the comments to revise the app and sent it back for testing. It was essential to remind the testers to uninstall previous versions before installing the new version as it could be merged with errors of the previous one.

### **Step 6: Developing AR cards for KhAR app**

KhAR stationery cards are physical paper cards with a size of 5.5 x 8.5 cm. They were designed to be used with the KhAR mobile application for AR-quest activities. The KhAR cards were designed with the following characteristics:

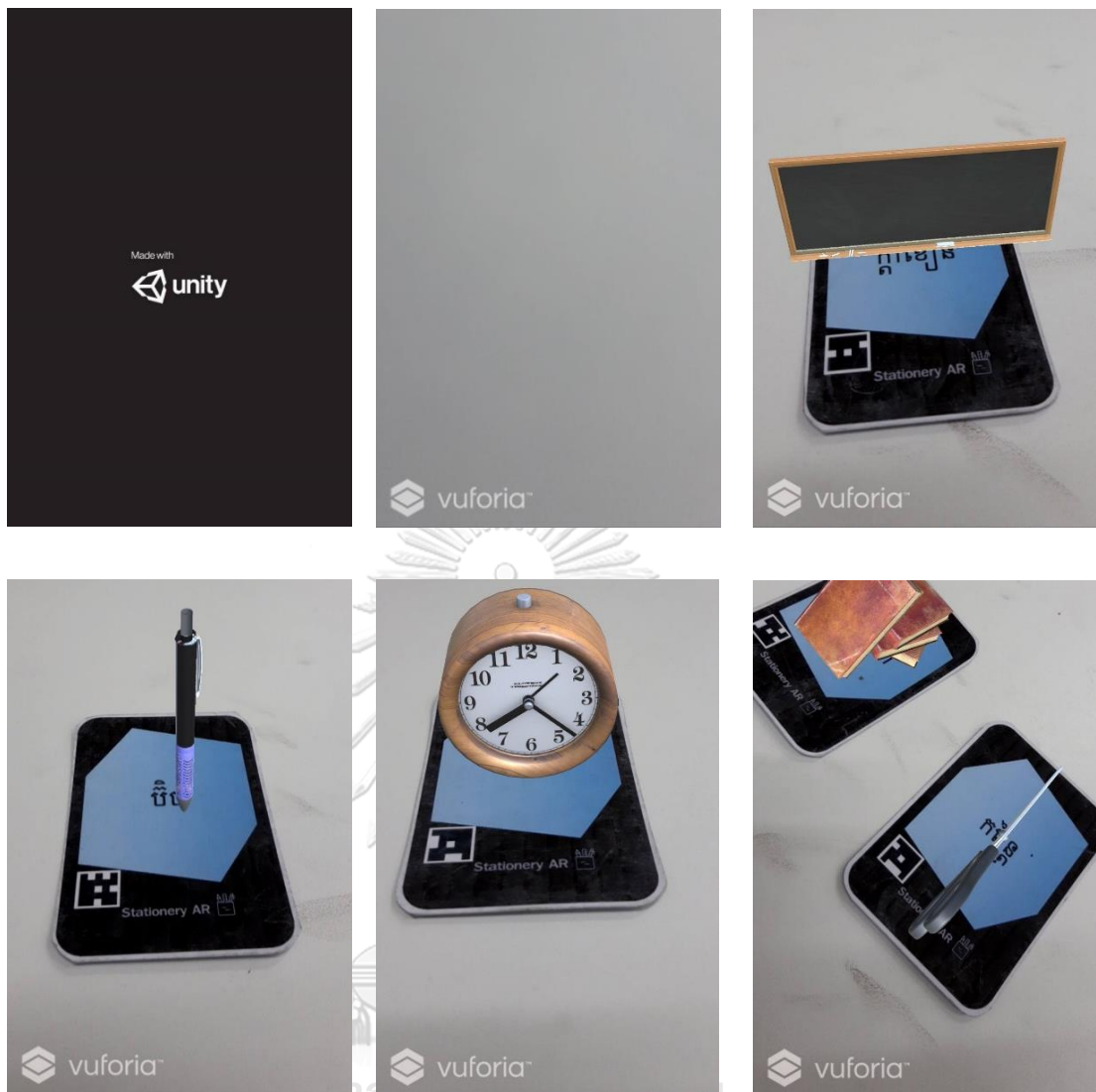
- Size: the researcher designed the size to be as big as general cards, such as national ID cards, student ID cards, and bank cards that the students use and encounter every day. The size of the cards is 5.5 cm x 8.5 cm, which is the size of the handgrip. The design makes it convenient as the cards are neither not too small nor too big for carrying around to use with the KhAR mobile application (Gusarova et al., 2015).
- Colour: the researcher designed the card using black and blue as blue reduces excitement, which helps students to concentrate (Mehta & Zhu, 2009). The researcher, as a result, used the blue colour in the middle of the background of the KhAR cards. This design was also influenced by pop-up 3D models, making it have a contrast colour for students to learn the objects with any distraction.
- Letter: the letters on the cards are Khmer stationery words. Khmer characters were used to make the trigger more unique to avoid bad detection of the KhAR application (Godwin-Jones, 2016).
- 5- or 4-star rate: AR cards are suggested to design providing with unique appearance among another. It is recommended that each AR cards to be uploaded to Vuforia database for the use in the AR application should obtain at least a 4-star rating in terms of uniqueness in appearance. This is important because when they act as triggers for the AR app, the app can detect the cards well and provide accurate digital content as set in the Unity 3D.



**Figure 12** Samples of KhAR Stationery Cards

### *KhAR app overview*

The app, KhAR Stationery, is an offline AR app. It contains fifteen basic Khmer vocabulary related to stationery. It is used to allow students to AR stationery cards (the triggers), so the students understand the words from the popup 3D of each card. The KhAR app also allows students to learn to pronounce the words as it integrated an audio feature where the students tap on the model to hear how the word is pronounced.



**Figure 13** KhAR app screenshots

### **Step 7: Tying out the AR application**

To evaluate the KhAR stationery app, it was tried out with a small classroom with five students. This was done to determine whether the app could be smoothly used in AR learning quests as an intervention for vocabulary development. Therefore, the focus fell on the quality of the KhAR stationery's design and how it facilitated vocabulary learning when used in AR learning quests. According to Parsons and Ryu

(2006), quality in a mobile learning system can be assessed both in terms of product quality and the quality of the learning experience.

**Phase 3: (Research 2) Study the effect of the AR-Quest instructional model based on situated learning to enhance the ability to remember Khmer vocabulary of Thai undergraduate students**

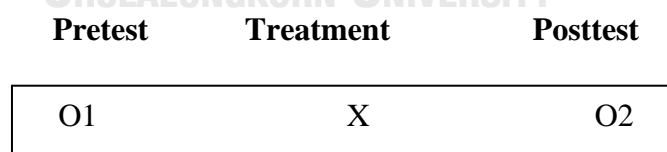
In this phase, in order to study the effect of the AR-Quest instructional model, the researcher planned to put into practice the model in a real classroom. The processes in this phase are shown as follows:

**3.1 Preparing for the implementation of the AR-Quest instructional model**

To prepare for the implementation of the developed AR-Quest instructional model, the researcher regulated the research design of this study and selected the samples for the data collection process. The following are detailed information of each process for the implementation of the AR-Quest instructional design model.

**3.1.1 Determining research design**

The researcher determined the research design for the implementation by choosing a pre-experiment design with a one-group pretest-posttest study.



**Figure 14** One-group pretest-posttest research design

From Figure 13. O1 indicates the experimental group (assessed using the pretest) before the introduction of the intervention. X is the experimental treatment, the AR-Quest Instruction developed from the AR-Quest Instructional Design Model. Finally, O2 refers to the same experimental group; but this is after they are introduced

to the treatment and are assessed by the posttest to determine whether there is a significant difference.

### **3.1.2 Specifying population and samples**

#### **Population**

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

#### **Samples**

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

### **3.1.3 Developing research Instruments**

#### **3.1.3.1 Khmer vocabulary ability test**

The researcher developed research instruments to investigate the effect of the newly developed instructional model. It was the Khmer vocabulary ability test.

The Khmer vocabulary ability test covered three items 1) word matching, 2) word translation and 3) appropriate choices. The details of the Khmer vocabulary ability test were as follows:

1. The core objective of the Khmer vocabulary ability test was to test the students' ability to remember basic Khmer vocabulary related to stationery vocabulary.

2. The time allowed for the Khmer vocabulary ability test was 25 minutes.

3. The test was categorised into three parts:

- 3.1 In the first part, students are to match Thai words to Khmer words correctly. There are ten words in this part.

- 3.2 The second part is the translation test. Five words are provided in Khmer language with Khmer romanisation. Students are to translate those five words into Thai language.

- 3.3 The final part of the test is multiple-choice statements. There are ten multiple-choice statements, and each statement comes with four choices. Students are to choose the most appropriate choice for the statements.

### **3.2 Validating the research instrument**

#### **3.2.1 Validating by experts**

The Khmer vocabulary ability test was validated by three experts in the language teaching field for the indexes of items-objective congruence (IOC). The evaluations form covered:

1. the test consistency with its objectives
2. the validity of the test content
3. the appropriateness of the number of the test items
4. the clarity of the language used in the test



##### 5. the appropriateness of the time given

The results of the evaluation by three experts were:

1. Evaluation of the test items consisted of 3-scale of appropriateness, +1 for appropriate, 0 for not sure, and -1 for not appropriate. For not appropriate items, additional comments are highly appreciated.

### **3.3 Revising the research instruments**

The overall result of IOC from the expert was at 0.8, which was considered to be good and appropriate for developing instruction to enhance students' ability to remember. One test received 0.4, which needed a revision. One expert provided constructive comments on changing the language used to pronounce the learned Khmer words from English to Thai. One expert mentioned the time allowed, which was only fifteen minutes, for the Khmer vocabulary test. The expert further suggested that the researcher should provide more time for the test since the sample are those whose Khmer language ability is the complete beginner. Thus, research revised the Khmer vocabulary ability test and change the time allowed of the test to twenty-five minutes according to the expert's comment.

Another expert mentioned using only one test for both pretest and posttest within a short time, in which the reliability of the instrument was very low. In this response to the expert's concern, the researcher made some revisions of the language and exchanged test items to make it look different, yet it covered the same content.

### **3.4 Implementing the AR-Quest instructional model in an authentic classroom**

The experiment was carried out with 30 second-year 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.

The processes of implementing the AR-Quest instructional design model based on situated learning were as follows:

1. In the first session of the implementation of the model, the Khmer vocabulary ability test was administered to the sample group as a pretest.
2. In the second session of the implementation of the model, the researcher provided orientation about the process of the implementation of the instructional design model.
3. In the third session, the sample interacted with two AR-quest learning activities.
4. In the last session, the Khmer vocabulary ability was administered to the students again as a posttest.

### 3.5 Analysing data

The research analysed the result from the data collection according to the research objective. The guidelines for data analysis were in the Table below.

**Table 3** Guideline for data analysis in this study

Research objective	Data analyses	Instrument
To study the effect of the AR-Quest instructional model based on situated learning to enhance the ability to remember Khmer vocabulary of Thai undergraduate students by comparing the students' Khmer vocabulary ability before and after learning with the model	Comparing the students' Khmer vocabulary ability before and after implementing the instructional model using paired sample t-test.	The Khmer vocabulary ability test was used in both pretest and posttest.

#### **Phase 4: (Development 2) Revising and developing the instructional model**

In this step, after the implementation, the AR-Quest instructional model was revised for better future practices. The followings are revised points revised under the information from the implementation.

1. In the learning step 1, linking students' personal experience, the introduction of basic Khmer grammar was cut short due to the need of time and the core objective of AR learning quests.

2. In Learning Step 2, assigning AR quests to students, which requires students to use android devices, quest activities were redesigned to be group learning activities so they can share their android devices with one another.

3. In learning step 3, processing the AR quests, individual learning activities were omitted the limited resources of Android smart devices. Plus, group work was also been proved to be effective in inquiry learning activities.

4. In step 4, reflecting on the AR quests, two learning sub-steps were combined together for students to have more time reflecting on the learning quests.

For greater detail of the research results, please see Chapter 4.

## CHAPTER 4

### RESULTS

The research entitled “The `Development of an AR-Quest Instructional Design Model based on Situated Learning Theory to Enhance the Ability to Remember Khmer Vocabulary of Thai Undergraduate Students” consists of two main objectives, which are:

- 1) To develop an AR-Quest Instructional Design Model to teach Khmer vocabulary to undergraduate students
- 2) To investigate the effect of the AR-Quest Instructional Design Model on the students’ ability to remember Khmer vocabulary

With the above two objectives, the researcher formulated two research questions. They consisted of:

- 1) What are the components of an AR-Quest Instructional Design Model?  
What are the learning steps in the AR-Quest instructional design model?
- 2) Will the students who learn vocabulary through the instruction developed by the AR-Quest Instructional Model have a higher mean score on the post-test than that of the pre-test mean score?

To answer the research questions, the researcher divided the research findings into two sections as follows:

Section 1. The results of the development of the AR-Quest instructional design model based on situated learning theory to enhance the ability to remember Khmer vocabulary of Thai undergraduate students

Section 2. The result of the effect of the AR-Quest instructional design model based on situated learning theory to enhance the ability to remember Khmer vocabulary of Thai undergraduate students

**Section 1. The results of the development of the AR-Quest instructional design model based on situated learning theory to enhance the ability to remember Khmer vocabulary of Thai undergraduate students**

Section 1 consists of two phases, which are Phase 1: studying learning theories and augmented reality in education, together with other grounded theories and principles for the development of the AR-Quest instructional design model and Phase 2: developing the AR-Quest instructional design model based on situated learning, which also includes the validating and revising the instructional model.

After the extensive work on the two critical phases of reviewing and synthesising from related literature and comments from experts of the related fields, the AR-Quest instructional design model comes to existence. The AR-Quest instructional design model is designed as a linear instructional design model used to enhance the ability to remember Khmer vocabulary of the students. The model is crucially based on situated learning theory and inquiry learning theory. The two [learning theories] are used as guidance for the instructional medium. The characteristics of the AR-Quest ID model are learner-centred, and flexible and authentic context is introduced to students so that they [the students] can make use of the knowledge they have learned in real-life.

The experts of related fields evaluated the AR-Quest instructional design model. They approved that the model was valid and appropriate for Khmer language instruction as the model comes with systematic components and logical steps. The AR-

Quest instructional design model is developed with four significant steps. The entire process of the AR-Quest instructional design model is illustrated as follow:

#### 4.1 Components of the AR-Quest Instructional Design Model

1. Analysis
<p><b>1.1 Analysing objectives</b></p> <p>Objectives keep teachers on the right track. Studying learning objectives is the first step of the AR-Quest Instructional Design Model. Teachers can analyse learning objectives by studying existing curriculums or course syllabus. More importantly, it is advisable that teachers determine the situation that can go along with the objectives. This gives teachers insights about crucial factors that might positively or negatively affect instruction.</p> <p><b>1.2 Analysing content</b></p> <p>Analysing 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.</p> <p>To analyse learning content for students, teachers may consider existing textbook of the course. With the objectives in hand, teachers divide the content into structures, orders, and scopes in great details. This allows teachers to see changes in content and be able to choose what really fulfil the learning objectives.</p> <p><b>1.3 Analysing learners</b></p> <p>Teachers need to determine students of the course. This sub-step is helpful as teachers know the ability of the students. It also helps teachers to understand the starting level of the course and to choose appropriate strategies to deliver the course effectively.</p> <p>To analyse students of the course, teachers may consider the following guidelines:</p> <ul style="list-style-type: none"> <li>- Students' pre-existing knowledge that relate to learning goals</li> <li>- Students' attitude towards learning</li> <li>- Students' academic motivation</li> </ul>

- Students' general preferences

In order to gather students' information, teachers can:

- interview students' previous teachers, and the students themselves
- use the self-report form to let students reflect their aptitude, interest, motivation, and attitude towards learning
- observe the work of students in various learning contexts
- administrate an ability test before instruction takes place

#### 1.4 Analysing 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 the authentic learning environment. For instance, required devices such as computers, smartphones, tablets, and other smart handheld devices must be kept in mind.

The simplest way to get such information is to observe real condition by visiting the classroom.

## 2. AR Quest Development

### 2.1 Designing AR quests

#### 2.1.1 Analysing 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.

#### 2.1.2 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.

The followings are AR-Quest characteristics:

- **Inquiry-based:** Quest activities are engaged students, both socially and physically.
- **Semi-structured approach:** Students are responsible for their learning process, but with the teacher's support where necessary.

- **Authentic learning experience:** Quest activities are to be designed to link with situations, and students learn by experiencing them.
- **Students' own discovery:** Students are challenged to make their own discovery of the learning quests.
- **Collaborative learning:** Students are provided with opportunities to work collaboratively with peers.
- **Students' reflection:** Students reflect on their learning progress after every AR quest.
- **Teacher's scaffolding:** Teachers need to be ready to provide support to students when needed.
- **Technology ability:** Both teachers and students need to be familiar and have the necessary skills in utilising information technology.

Teachers, too, need to consider the time needed, the locations, and the quest closure.

There are several types of quests teachers can consider. The followings are recommended quests for teachers (Bell, Smetana, & Binns, 2005):

- **Confirmation quests:** Teachers develop a quest based on a topic that has already been covered in a previous class. Students are then led through an activity that requires them to collect, record and present information. Rather than discover something new, the main aim is to confirm and deepen prior knowledge.
- **Discovery quests:** This type of quest involves presenting students with some sort of task, often in the form of a problem or question, that challenges students to develop the skills or knowledge used in the course. In simple words, teachers provide problems, and students design an experiment to find the answer.
- **Gather quests**, also known as **collection quests:** The quests are designed for students to collect a number of items in order to complete the quests.



Two samples of learning quests, a gather quest and a confirmation quest for AR-Quest instruction are presented to give a better picture of how teachers should design quests for their AR-Quest instruction. Please see the quest samples.

### **2.1.3 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.

## **2.2 Developing AR quests**

### **2.2.1 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 core medium of instruction of the AR-Quest Instructional Design Model. The two learning theories promise favourable learning outcomes when they are carefully applied in the AR learning quests.

### **2.2.2 Breaking AR quest process**

It is advisable to break down the scripted AR quests by:

- **Introduction**

In this first element of the AR quest, teachers need to give an introduction to attract students' attention and motivate them. It is essential to recollect that the introduction also provides background information on the topic

- **Task**

The task element of the AR quest is where learning tasks are presented. This gives greater detail of the expected outcome.

- **Process**

This process stage is to provide students with the guideline of how to complete each task of the AR quest. Teachers may give tips on how the student can effectively manage time and college data. Teachers need to list clear directions in this session.

- **Resource**

The resource section provides students with materials that are needed to get through learning quests. They can be worksheets, an AR application, and AR cards.

- **Evaluation**

Evaluation tools are to be presented in this session for students to see how their work will be evaluated.

- **Conclusion**

There is a brief closure paragraph presented in this section. What students have learned through the AR quest are included. This part also aims to encourage students to extend their experience.

### 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.

## 3. AR Package Development

### 3.1 Designing the AR package

#### 3.1.1 Selecting vocabulary

Vocabulary is the core content on which the AR-Quest instructional design works. Thus, teachers must select vocabulary carefully. Since teachers cannot usually teach all words that a student should know in a foreign language, it is necessary to find some basis for selecting words (Worthington & Nation). Harmer (1991) and Worthington and Nation (1996) point out that one of the problems of vocabulary teaching is how to select which words to teach.

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 essential for students to learn (Flanigan & Greenwood, 2007). Teachers need to bear in mind if words are familiar by the students, or the context of the content can support the students to understand more about the words. They [words] are excellent choices for students to learn.

### **Transferability**

The frequency of words appearing in the learning content is another way to select words for the students. Teachers can select vocabulary which is used often in the content and/or in other academic studies. It is unwise that teachers waste instructional time teaching words that are rarely used.

### **Usefulness for generative studies**

Root words that lead to other related words are another choice that teachers also consider choosing for their students.

The above three ways of choosing learning vocabulary for students can help teachers who teach a course content where no vocabulary learning list is available. Be noticed that, it does not matter if teachers can meet the three criteria. It, however, is advisable that teachers should at least choose words that meet two of the three criteria mentioned above.

### **3.1.2 Designing AR cards**

AR cards are physical paper cards needed to be designed to use with AR mobile application for AR-quest activities.

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).

**Colour:** The colour of the cards should be black and blue as blue reduces excitement, which helps students to concentrate (Mehta & Zhu, 2009). The design may also be influenced by pop-up 3D models, as the teacher needs to ensure the cards have a contrast colour from 3D models in order to allow students to learn the objects with any distraction.

**Letter:** As they are vocabulary cards of Khmer language, Khmer letters representing Khmer words should be included in the cards. It also helps make the cards more unique for the AR app to detect well (Godwin-Jones, 2016).

### **3.1.3 Sketching wireframe**

Teachers can draw AR mobile application wireframes using draw.io to resemble what the app should look like on the phone screen.

## **3.2. Developing AR package**

### **3.2.1 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

When creating an AR quest for students, the interactive design has to be put into consideration as it is what engages students. There are several techniques applied to enhance interactive AR experience that promotes an authentic learning environment. One of which is 3D technology, which allows teachers to present learning objects in a way that students can interact, observe, and explore (R. Chang & Yu, 2017). Another technique is the realistic association between digital content and real-world object. As for Tosti, Stephen, and Gwo-Jen (2014), they applied AR technology to teaching experiments to simulate the reactions and changes of different materials under different conditions.

Through the features of AR, interactive quests that can be used to promote an authentic learning experience can be developed in an instant, so that students can explore and make their discovery.

### **3.2.2 Building AR app**

Teachers can use Unity with built-in IDE and C sharp (C#) programming to develop the app. It is advisable always to consult programming experts when you want to build an AR app.

### **3.2.3 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 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.

## 4. Instruction Development

### 4.1 Designing instructional material

#### 4.1.1 Designing learning activities

Teachers need to come up with ideas of learning activities to attract students' attention. To design AR tasks that promise authentic and meaningful learning experience, teachers have to think of situations where students are challenged to solve the tasks by using problem-solving skills, self-discovery, and self-reflection that help them form new knowledge. Teachers may also 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.

The followings are three processes that help teachers designing learning activities.

#### **1. Plan:**

Everything starts with a plan. 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 the quest. Besides the resources, teachers have to work and determine the characteristics of the tasks, the time needed, the locations, the task closure, and the task assessments.

#### **2. Prepare:**

Once everything is noted down, teachers need to prepare resources and make sure that everything is in place and is ready to be used before the tasks begin.

The teachers also need to identify the roles of themselves and students before designing learning activities to get along with AR quest activities. The teachers may follow the followings:

#### **Teacher's roles**

- The teacher explains the purpose of experiential learning to students.
- The teacher is less dominant in the AR activities classroom.
- The teacher positively promotes authentic learning experiences.
- The teacher provides a situation or an experience that attracts students' attention.
- The teacher links learning objectives with authentic situations or experiences.
- The teacher provides students with any helpful resources to help students solve the AR quests.
- The teacher allows students to work collaboratively.
- The teacher allows students to explore, investigate, and uncover answers on their own.

#### **Students' roles**

- Students have their hands on practically authentic problems.
- Students are involved in different and challenging tasks while exploring the AR quests.
- Students are given freedom in the whole learning process if they make positive progress.
- Students do self-evaluation on their learning progress.
- Students learn from challenging tasks and become willing to change.
- Students form new knowledge from the learning AR quests.

#### **3. Design:**

After finishing with the preparation [ideas and materials], teachers script the learning activities that promise authentic learning experiences.

#### **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 as 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 effect 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 employ for AR-Quest instruction.

##### **Step 1: Linking students' personal experience**

- 1.1 Introducing topic:
- 1.2 Simulating students' previous knowledge

##### **Step 2: Assigning AR quests to students**

- 2.1 Introducing AR quests
- 2.2 Simulating students' schema

##### **Step 3: Processing the AR quests**

3.1 Exploring the AR quests

3.2 Presenting results

**Step 4: Reflecting on the AR quests**

**Step 5: Ending the AR quests**

#### **4.3 Studying the effect of the AR instruction**

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.

##### **Step 1. Linking students' personal experience**

Before leading students to the prepared AR-Quests, the teacher needs to attract the students' attention to the topic and stimulate students' previous knowledge to link with the topic. To do so, the teacher can follow the following steps:

###### *1.1 Introducing topic:*

To introduce the topic to the students, the teacher needs to give the students an overall image of what they are going to learn. Moreover, the teacher also needs to tell the students about the expected learning outcomes.

###### *1.2 Simulating students' previous knowledge*

To link the students' previous knowledge, the teacher can ask the students questions to seek their experience and their opinion towards the topic. This can let the teacher know the students' level of knowledge. So, the teacher can best adjust the learning process to suit the class.

##### **Step 2. Assigning AR Quest to students**

After introducing the students, the topic, and the learning outcomes of the lesson, the teacher, then, introduce the students learning quests they are going to complete. At the same time, the teacher may be ready to guide and scaffold the students to explore the quests.

###### *2.1 Introducing AR quests*



The teacher brings about the AR quests together with other necessary guidance and tips for the students. During the time, the teacher should encourage the students to ask questions to clear out their doubts over the upcoming AR quests.

### *2.2 Simulating students' schema*

The quest is designed based on the students' previous knowledge and level. Therefore, it is expected that the students use knowledge to help them go through the AR quests to seek a solution. It is believed that as the students can connect their knowledge to what they are doing, they automatically turn the whole classroom's learning environment to be enjoyable, and this helps prevent overload of the students' cognitive process.

### **Step 3. Processing the AR quests**

After explaining the AR quests to the students, the teacher provides them with authentic learning experience as the teacher scaffolding them during the process of solving the AR quests in order to help them acquire new Khmer vocabulary.

#### *3.1 Exploring 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 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 quest exploration, the teacher has a student from each team to share their answers with the whole class. It is considered that the classroom presentation is the most effective way to let students share with the whole class their answers to the assigned AR quests. Then, the students can discuss the finding with the teacher and peers.

### **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. This is to help them see what they need to improve in order to achieve a better result in the next learning quests.

To do this, the students can discuss their previous work with their peers in the group and see what they need to improve in order to do better in the next learning quests.

### **5. Ending the AR quests**

To end an AR quest, the teacher can help the students generalise new knowledge. This can be done by having the students to summarise the entire process of the learning quest that the students have done. It helps assimilate their new discovery with their previous knowledge in order to form a new one.

### **4.4 Assessing the AR instruction**

It is necessary to assess students' learning processes and outcomes. If the instructional goals cannot be achieved, the developed instruction is not complete. From assessment results, teachers can improve the learning process and check if students achieve the goals. To evaluate the model, teachers may study the pretest and posttest results to determine the effect of the model.

Please note 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.

## **Samples of AR Quest Activities**

### **Quest 1: Helping Joe to get ready for his first day of school**

A gather quest: students help gather learning materials as presented in the list for Joe

#### **Introduction:**

Do you remember when you were a kid and started your first day of school? Who helped you prepare your learning materials such as pencils, erasers, notebooks, etc.? Today you are going to help our Little Joe to prepare his learning materials. Joe is too little to manage his stuff on his own. Thus, he needs helps. You may need to work in a group of three and each person will have a specific job to do.

Are you ready to help Joe? Are you ready to explore what Joe needs for his first day of school? Are you ready? Let us begin!

#### **Task:**

You will go to all the available learning materials (AR cards) and gather the ones which are stated in the list given to you. You will have to use the KhAR mobile application to find the right learning materials needed for Joe, as presented in the handout.

You are also to jot down the materials that are in Khmer language with Thai translation as you are to present the materials you prepare for the class.

With the learning materials you will have gathered, your group is to write a short paragraph advising Joe how he should take care of his school stuff. You may use Thai language, but you have to use Khmer romanisation for the materials you have learned.

### **Process:**

#### 1. Choosing

- Choose a material list to prepare for Joe.
- Choose a group name.
- Choose a member of the group to be:
  - The seekers – is responsible for seeking the entire available learning materials using KhAR mobile application.
  - The data recorder – notes now the correct learning materials the seek has found.

#### 2. Exploring

- There are sheets provided for recording the learning materials you collect.
- Learning materials are placed around the classroom. You need to use the KhAR mobile application to scan them AR cards and learn what they are pronounced in Khmer language.

#### 3. Reviewing

- Have you finished seeking all the materials?
- Do you have the necessary materials for Joe for his first day of class?
- Are you ready to move on?

#### 4. Presenting

- As a group, you need to work together to help advice Joe how to use and take care of his learning materials.

- You may choose a representative for your group and tell the class the materials you have prepared for Joe and tell how Joe should take care of this stuff.
- The finished products should contain:
  - A list of learning materials in Khmer romanisation with Thai translation
  - A short paragraph of your advice to Joe of how he should take care of his learning materials – noted that the learning material words are to be sated in Khmer romanisation.

#### **Resource:**

Resources used to complete this AR quest are available in the classroom. They include learning material lists, KhAR mobile application, and AR cards. The AR cards contain digital learning media that require KhAR application to pull out the contents. The AR cards were embedded with three-dimension objects and corresponding Khmer audios.

#### **Evaluation:**

The students' discovery will be evaluated in the sharing session when they present their findings with the whole class.

#### **Conclusion:**

Joe is now ready for his school. With your help and advice, he will have a great time.

The words you have learned with this AR quest are a gate for you to discover more about Khmer language. As you have noticed, not just the language structures that are similar, so are a large number of words.

After the lesson, you all are encouraged to explore more about Khmer language. Then you will realise not only the language but also the culture that we share.

#### **Sample of Worksheet**

##### Let us help **Joe!**

Please help **Joe** to pack his learning materials he may need for his first class.

The stuff he needs includes:

①

- กรอโบบสะปี้เคี้ย
- เซียวเพิว
- ขมาวได
- จอ-ลบ
- บอนตอด

Name:

Please write down the learning materials you have gathered in Thai in the table provided below. You may add any distinctive mark as you need to help you remember Khmer vocabulary better.

N	Khmer romanization	Thai translation	Your mark
1	กรอโบบสะปี้เคี้ย		
2	เซียวเพิว		
3	ขมาวได		
4	จอ-ลบ		
5	บอนตอด		

\*Please see Appendix for more worksheets.

### Samples of AR Quest Activities

#### Quest 2: Putting them in the same family

Confirmation quest: with three categories of words, students are to determine the right categories for each word

**Introduction:**

Khmer language and Thai language are so related to one another. For Thai learners, it is possible to communicate with Cambodian people in Khmer language if they have a good knowledge of Khmer vocabulary. To learn Khmer to communicate with local people, Thai learners do not need to extensively learn Khmer grammar since the grammar of the two languages is very similar.

Not just the grammar that is similar, so are a significant number of vocabularies. Once you get to know Khmer language, you will notice Khmer and Thai words have relations with each other.

This AR is designed to introduce you some Khmer vocabulary, which 1) are pronounced similarly and have the same meaning, 2) have language relations, and 3) are different in both pronunciations and meanings.

**Task:**

There are Khmer vocabulary AR cards. You will group the cards into three different categories as follows:

- 1) Vocabularies that are pronounced similarly and convey the same meaning as Thai vocabularies
- 2) Vocabularies that have relations with Thai words (word construction)
- 3) Vocabularies that are different in both pronunciation and meaning and do not have any word relations with Thai vocabularies

**Process:**

## 1. Choosing

- Form a group of three.
- Assign each member role:
  - The navigator – is responsible for going through all the Khmer vocabulary AR cards by scanning them using KhAR mobile application
  - The decision-maker – discusses the found vocabulary and decide its category
  - The data recorder – is responsible for writing down the words into the correct category

## 2. Exploring

- You are provided with the category sheet used to write down words into the correct category.
- The Khmer vocabulary AR cards are made available for scanning. You need to use KhAR mobile application to scan the AR cards and learn and discuss their categories.

## 3. Reviewing

- Have you finished scanning all the materials?
- Are the words placed into the correct categories?

## 4. Ending

The finished product should contain a worksheet of the word category with Khmer words placed in the correct categories.

### **Resource:**

Resources used to complete this AR quest exist within the classroom. They include worksheets of vocabulary categories, KhAR mobile application, and AR cards. The AR cards contain digital learning media that require KhAR application to pull out the contents. The AR cards were embedded with three-dimension objects and corresponding Khmer audios.

### **Evaluation:**

The students' discovery will be evaluated in the sharing session when they present their findings with the whole class.

### **Conclusion:**

As Thai speakers, learning Khmer language for basic communication is not really difficult. This lesson gives you just a bit of a significant similarity you may find in the two languages.

Since Khmer and Thai language share a lot of similarities, starting with basic vocabularies is a very significant way to learn Khmer language.

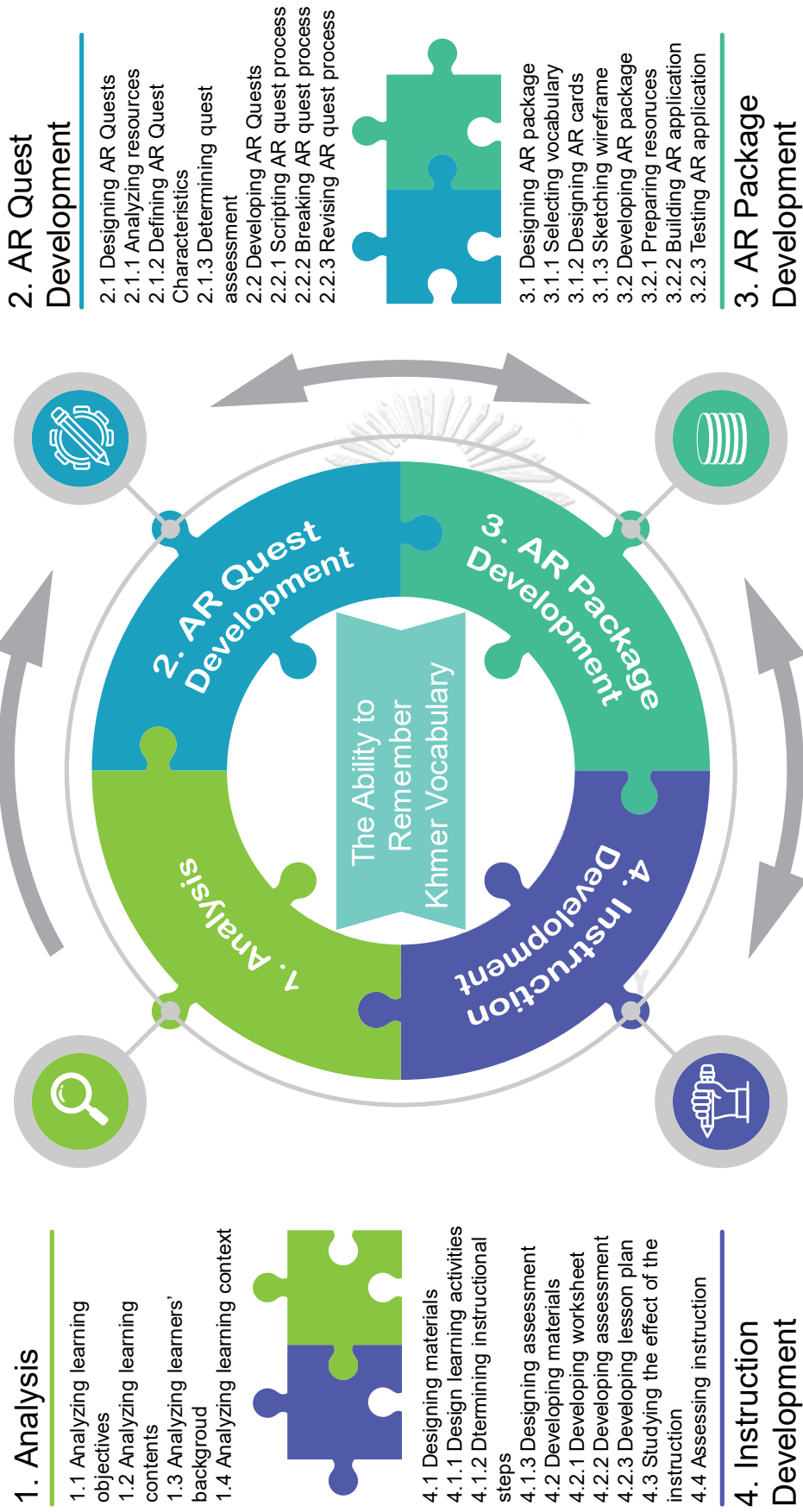
After the lesson, you all are encouraged to explore more about Khmer language. Then you will realise not only the language but also the culture that we share.

### **Sample of Worksheet**

\*Please see the worksheet in the Appendix.







**Figure 15** The AR-Quest Instructional Design Model

Table 4 gives a clearer picture of the AR-Quest Instructional Design Model as it describes the characteristics of the model.

**Table 4** The characteristics of the AR-Quest Instructional design model

Characteristics
<ul style="list-style-type: none"> <li>• Learning activities are inquiry-based.</li> <li>• Students learn together in a semi-structured approach.</li> <li>• Learning activities are linked with real situations, and students learn by experiencing them.</li> <li>• Authentic learning tasks promote both students' social and physical engagement.</li> <li>• The authentic learning experience is promised.</li> </ul>
Grounded theories
<ul style="list-style-type: none"> <li>• AR-Quest model is based on experiential learning theory.</li> </ul>
Process
<ul style="list-style-type: none"> <li>• <i>Analyse objectives</i>: objectives are what keep teachers on the right track. To analyse learning objectives, the existing curriculum and syllabus are to study.</li> <li>• <i>Analyse the context</i>: teachers determine who the students are and also identify the learning context.</li> <li>• <i>Plan</i>: teachers need to be clear with the learning objectives and determine learning resources that students will need to solve the quests.</li> <li>• <i>Prepare</i>: teachers prepare resources and other necessary tools and make sure everything is in place when needed to be used.</li> <li>• <i>Design</i>: script the learning activities based on the ideas and preparation from the previous steps.</li> <li>• <i>Facilitate</i>: teachers hold back to give students assistance to complete answers to their questions. Instead, guide students through the process of finding and determining solutions from themselves.</li> </ul>

- *Evaluate*: teachers use the assessment techniques/tools which are planned in the earlier steps. Students' learning progress can be assessed in discussion and the reflection session.

#### Resources

- Learning resources are to be well-prepared before the quest discovery.
- Primary resources for AR-Quest activities include worksheets, AR materials (AR markers), and AR mobile application.

#### Assessment

- Assessment tools for the quests of augmented reality vary to each quest's design. Students can be assessed by observation and tests.

#### Teacher's roles

- Teachers explain the purpose of experiential learning to students.
- Teachers are less dominant in the AR activities classroom.
- Teachers positively promote authentic learning experiences.
- Teachers provide a situation or an experience that attract students' interest.
- Teachers link learning objectives with authentic situations or experiences.
- Teachers provide students with any helpful resources to help students solve the AR quests.
- Teachers allow students to explore, investigate, and uncover answers on their own.

#### Students' roles

- Students have their hands on practically authentic problems.
- Students are involved in difficult and challenging tasks while exploring the AR quest.
- Students are given freedom in the whole learning process if they make positive progress.

- Students do self-evaluation on their learning progress.
- Students learn from challenging tasks and become willing to change.
- Students form new knowledge from the learning activities.

#### 4.2 Learning steps of the AR-Quest instructional model

The learning steps of the AR-Quest instructional model based on situated learning are shown in Table 5:

**Table 5** Learning steps of the AR-Quest instructional model based on situated learning

STEP 1: LINKING STUDENTS' PERSONAL EXPERIENCE	
Objectives	
	<p>The main objectives of this step are</p> <ol style="list-style-type: none"> <li>1) to attract the students' attention in the topic</li> <li>2) to stimulate students' previous knowledge to link with the topic.</li> </ol>
Description	
	<p>The teacher warms up the class by introducing the topic. At this time, the teacher uses the students' schema to lead their attention to the being-introduced topic. This step allows the teacher to check the students' level and knowledge of the topic.</p>
Learning sub-step	Learning activities
<p>1.1 Topic introduction</p> <p>To introduce the topic to the students, the teacher gives students the overall image of what the students are going to be presented to. Together, the</p>	<p>Teachers can use a variety of ways to introduce the learning topic to their students. Some common of which include</p>

	<p>teacher also tells the students of the expected learning outcomes when they complete the lesson.</p>	<p>storytelling, educational games, question-and-answer, video presentation or other visualising media.</p>
	<p>1.2. Previous knowledge simulation</p> <p>To link the students' previous knowledge, the teacher can ask students questions to seek their experience and their point of view of the topic. This activity can let the teacher know the students' level related to the topic. With this, the teacher can best adjust the learning process to best suit this class.</p>	<p>Asking students questions is one of the most effective ways the teacher can use to stimulate the students' schema of the topic. This allows students to be able to express their thought concerning the topic.</p> <p>The teacher, too, can generate interest-catching questions for the whole class discussion.</p>
<b>Teacher's tasks</b>		
	<ul style="list-style-type: none"> <li>- The teacher tells students what they are going to learn and the learning outcomes they are going to be able to do after finishing the lesson.</li> <li>- The teacher gains attention from the students by linking their previous knowledge to the present topic of the class.</li> <li>- The teacher asks the students questions in order to open classroom discussions over the topic that they will be learning.</li> </ul>	

	<ul style="list-style-type: none"> <li>- The teacher is responsible for making the class environment to be active where students are engaged to join the discussion.</li> </ul>	
<b>Students' tasks</b>		
	<ul style="list-style-type: none"> <li>- The students pay attention to the teacher introducing the topic and the learning outcomes they will get after the lesson.</li> <li>- The students raise questions and answer the teacher's questions. They then share their knowledge and experience with the whole class.</li> </ul>	
<b>STEP 2: ASSIGNING AR QUESTS TO STUDENTS</b>		
<b>Objectives</b>		
	<p>This second step consists of two primary objectives as the followings: to introduce students learning quest they are going to complete to guide and scaffold the students to explore the prepared learning quests.</p>	
<b>Description</b>		
	<p>This is where the crucial thing happens, the quest exploration. This step introduces students to the quests and other related information, which can trigger the students' schema and connect with the task. Be noticed that, the characteristics of the quest was designed to be a series of task quest where the students need to work with every single task to finish the quest. This second step set the students on foot to be ready for quest exploration in a cooperative learning environment.</p>	
	<b>Learning sub-step</b>	<b>Learning activities</b>
	2.1 Quest introduction	

	<p>The teacher introduces the learning quest, together with other necessary guidance and tips to the students. While the teacher is guiding the students, they [the students] can raise any questions they may have concerning the quest task they will be doing.</p>	<p>The teacher is the activity leader in this step as he/she takes the central role of presenting necessary information about the quest for students. Explicitly, the teachers tell the students what the quest is, what they are going to do with the quest, and other essential tips to help students go through the quest.</p> <p>Since the quest information is essential, the teacher needs to make sure his/her way of delivering the message to the students is clear and understandable. After providing students with information, the teacher can propose a question-and-answer to check the students' understanding of the presented quest.</p>
	2.2 Schema stimulation	To trigger the knowledge of the students to link with the presented

	<p>The quest is designed based on students' previous knowledge. Thus, it is expected that students use their knowledge to help them go through a series of tasks in order to solve the quest. As the students can connect their knowledge to what they are doing, they automatically turn the whole classroom's learning environment to be enjoyable, and this helps prevent overload of the students' cognitive process.</p>	<p>quest, it is suggested that the question-and-answer approach will work and plus, this promotes an interactive learning environment where the students enjoy the quest. Besides the question-and-answer approach, the teacher can also encourage the students to work in pairs or a small group of three. So, they can work together and map the ideas of the quest. Furthermore, such an approach promises better social interaction between peers.</p>
<b>Teacher's tasks</b>		
	<ul style="list-style-type: none"> <li>- The teacher introduces the quest to the student and then explains to the students what the quest is and how they are going to solve it.</li> <li>- As the quest information is essential, the teacher needs to make sure that the students understand the quest process correctly.</li> <li>- In this stage, the teacher can guide and give the students some hints where necessary.</li> <li>- It is vital that the teacher let the students ask any questions to clear out their doubts about the quest.</li> </ul>	



	<ul style="list-style-type: none"> <li>- After everything is clear, the teacher gives students authentic learning resources used to solve the quest.</li> </ul>	
<b>Students' tasks</b>		
	<ul style="list-style-type: none"> <li>- Missing the information leads to the mistake of completing the quest. The students are to listen carefully to what the teacher is explaining.</li> <li>- The students gather and note down the information and tips that they can use to solve the quest.</li> <li>- The students ask the teacher questions to clear out any doubt they have. This is important as in the next step; they are going to solve a series of tasks in order to complete the quest.</li> </ul>	
<b>STEP 3: PROCESSING THE AR QUESTS</b>		
<b>Objectives</b>		
	<p>The only main objective of this step is to provide students with the authentic learning experience, exploring and solving the quest, in order to introduce new vocabulary to them.</p>	
<b>Description</b>		
	<p>This step gives the students with the unique authentic learning experience as the quest activity was designed based on the principle of situated learning theory. The quest exploration is conducted with an organised classroom environment.</p>	
	<b>Learning sub-step</b>	<b>Learning activities</b>
	3.1 The exploration and evaluation	

	<p>The students can work in a small group of three, where they can divide the task responsibility. The peers among the group need to work collaboratively in order to complete a series of tasks so as to solve the assigned quest.</p>	<p>The quest exploration is to be conducted in a well-organised classroom environment, where the teacher has prepared all the required resources from the students to solve the quest.</p>
<p>3.2 Presentation</p>	<p>After the quest exploration, a student from each group needs to present their discovery to the whole class.</p>	<p>It is considered that the classroom presentation is the most effective way to let students share with the whole of their discovery of the assigned quest. The students, then, can discuss the finding with the teacher and peers.</p>
<b>Teacher's tasks</b>		
	<ul style="list-style-type: none"> <li>- The teacher provides the students notes and pencils so they can jot down what they will be learning while they are solving the quest.</li> <li>- The teacher, in this step, acts as a class monitor to control the class, students' learning activities, and help the students when necessary.</li> <li>- The teacher may raise hint questions for any group that seems to be stuck in the process of exploring the quest; so, they can go on.</li> <li>- After completing the assigned quest exploration, the teacher asks a student from each group in order to share their discovery with the class.</li> </ul>	

	At this point, the teacher may encourage discussion about the shared answers.	
<b>Students' tasks</b>		
	<ul style="list-style-type: none"> <li>- The students may prepare the material given by the teacher to use when they are exploring the quest.</li> <li>- The students read the quest and gather the information to solve the quest.</li> <li>- The students use the KhAR mobile application to find the answers of the quest and note them down in their note.</li> <li>- After completing the quest, one student from each group shares their answer to the class and get feedback from the teacher and the peers.</li> <li>- Then, the students are to summarise their quest discovery in the form of a short paragraph.</li> </ul>	
<b>STEP 4: REFLECTING ON THE AR QUESTS</b>		
<b>Objectives</b>		
	The objective of this step is to let the students reflect their own discovery of the quest they have just solved. This is to help them see what they need to improve in order to achieve a better result in the next learning quests.	
	<b>Learning sub-step</b>	<b>Learning activities</b>
	The students discuss their previous work with peers in the group and see what they need to improve in	Nothing would work better than the group discussed in this step. This is because the students

	order to do better in the next learning quest.	need to work and discuss with their same peers to seek for what they lack in order to improve it.
<b>Teacher's tasks</b>		
	<ul style="list-style-type: none"> <li>- Like in the previous step, students are the focus of the activity. Thus, the teacher plays a role as a controller of the class and oversee the ongoing discussion between students and students in the class.</li> <li>- The teacher may also act as a scaffolder to support the students when they encounter problems.</li> </ul>	
<b>Students' tasks</b>		
	<ul style="list-style-type: none"> <li>- The students work and discuss with the same peers in their group and reflect their individual experiences got from the previous learning quest.</li> </ul>	
<b>STEP 5: ENDING THE QUESTS</b>		
<b>Objectives</b>		
	The last step, step 5, aims to generalise new knowledge for the students and summarise the entire processes of the learning quest the students have done.	
<b>Description</b>		
	This last step summarises all the learning activities that occurred in the quest exploration and helps the students form the new knowledge as they have been through the learning quest.	
	<b>Learning sub-step</b>	<b>Learning activities</b>

	<p>In this final step, students are given some time to summarise what they have learned from the learning quest they have done. This is to assimilate their new discovery with their previous knowledge in order to form new knowledge.</p>	<p>Individual reflection and group discussion are recommended in this final step as they both promote a personalised environment and social learning environment.</p>
<b>Teachers' tasks</b>		
	<ul style="list-style-type: none"> <li>- The teacher promotes a relaxing classroom environment in order to promote a learning experience, sharing among students in the class.</li> <li>- While the students are discussing and working on their learning reflection, the teacher may support them and give feedback.</li> <li>- Once the students have formed their new knowledge they have learned, the teacher asks them to share the knowledge with the class.</li> </ul>	
<b>Students' tasks</b>		
	<ul style="list-style-type: none"> <li>- The students work both individually and in a group to refine their new knowledge they have learned from the learning quest.</li> <li>- The students, then, share with the class the newly generated knowledge to the class.</li> </ul>	

**Section 2. The result of the effect of the AR-Quest instructional model based on situated learning enhance the ability to remember Khmer vocabulary of Thai undergraduate students**

**4.3 The effect of the AR-Quest instructional model on students' ability to remember Khmer vocabulary**

After the lesson plans, 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 effect of the developed AR-Quest instructional model on the students' ability to remember Khmer vocabulary. The results of the evaluation are shown based on quantitative data as follows:

**Table 6** Compare pretest and posttest of the students' ability to remember Khmer vocabulary

Paired sample	Paired Differences (%)		Sig. (2-tailed)
	Mean	Std. Deviation	
post* - pre**	9.771	3.557	.000

\*after using AR-Quest instruction

\*\*before using AR-Quest instruction

From Table 6, a paired sample t-test indicated that the Pretest score of the students' ability to remember Khmer vocabulary was lower score than the Posttest's (mean = 9.771),  $p=.00$ . The results of the statistical analysis using the Paired Sample t-test shows that the posttest scores of the Khmer vocabulary ability test were significantly higher at the level of .05.

The results indicated that the AR-Quest instruction developed from the AR-Quest Instructional Design Model based on Situated Learning had a positive effect on

the ability to remember Khmer vocabulary of Thai undergraduate students as they demonstrated the ability to do better at a significant level in the posttest, administered after the AR-Quest instruction and activities, than in the pretest, administered before the AR-Quest instruction and activities.



## CHAPTER 5

### SUMMARY, DISCUSSION, AND RECOMMENDATIONS

The research entitled “Development of an AR-Quest instructional design model based on situated learning to enhance students’ vocabulary learning” consists of two objectives, which are:

1. To develop an AR-Quest Instructional Design Model to teach Khmer vocabulary to undergraduate students majoring in Educational Technology and Communication at Chulalongkorn University
2. To investigate the effect of the AR-Quest Instructional Design Model on learners’ ability to remember Khmer vocabulary

#### **Research processes**

The research processes of this research and development study consist of four phases, including 1) studying learning theories and augmented reality application for the development of the AR-Quest instructional design model, 2) developing the AR-Quest instructional design model, 3) studying the effect of the AR-Quest instructional model based on situated learning to enhance the ability to remember Khmer vocabulary of Thai undergraduate students, and 4) revising and developing the AR-Quest instructional model to the ability to remember Khmer vocabulary of Thai undergraduate students.

#### **Phase 1: (Research 1) Studying works of literature for the development of the AR-Quest instructional design model**

In this phase, the researcher studied related works of literature on learning theories that had significant positive effects on foreign language vocabulary acquisition. From the literature review, two major learning theories were studied



extensively. They were situated learning theory and inquiry learning theory. This included learning and teaching theories and principles. In a situated learning environment, knowledge has to be learned in an authentic context of where and how it might be used, and knowledge is also built when there are interactions between individuals (Bodner & Orgill, 2007). This principle of the authentic learning experience is well-matched with the vocabulary acquisition theory as students tend to 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). Thanks to the advancement of technology that it has the ability to enable teachers to transform a traditional learning environment into an innovative and rewarding learning environment that promise better learning outcomes (Herrington & Kervin, 2007).

On the other hand, inquiry learning encourages an active learning process where students explore the material world, and that leads to asking questions, making discoveries, and rigorously testing those discoveries in the search for new understanding (Ulrich Hoppe & Werneburg, 2019). Isabel L Beck, McKeown, and Kucan (2013) have shown that vocabulary is best learned in context when students have meaningful encounters with the words. In an inquiry context, students have more opportunities to use content-specific vocabulary in conversations about their topic. Besides the learning theories on vocabulary acquisition, the researcher also studies the booming technology, Augmented Reality, where the authentic learning environment is promised when it [AR] is applied.

The researcher, too, studies different instructional design principles and models so as to propose an effective instructional model where situated learning, inquiry learning, and augmented reality technology are the core.

## **Phase 2: (Development 1) Developing the AR-Quest instructional design model based on situated learning theory**

The development of the AR-Quest instructional design model based on situated learning to enhance the ability to remember Khmer vocabulary of Thai undergraduate students and other related documents of the model consists of three steps as follows:

**Step 1:** Designing and developing the AR-Quest ID model used the reviewed learning theories and AR technology as a core

The AR-Quest instructional model was developed based on the reviewed vocabulary acquisition theories and AR technology, which promise the improvement in students' ability to remember Khmer vocabulary. Two learning approaches, situated learning and inquiry learning are integrated in order to specify the principles, instructional parameters and learning steps of the newly developed instructional model. Augmented reality technology was used the model as the primary tool which helps enhance the authentic learning environment. The model objectives and instructional guidelines of the model were also developed.

**Step 2:** Designing and developing other related materials and documents used in the model

Related materials and documents used in the newly developed instructional model were also developed in this phase. They were the lesson plan of the model consisting of the title, duration, learning objectives, learning steps, learning activities, learning resources, and evaluation and assessment. AR mobile application was also developed to use with the designed learning activities in the lesson plan. The assessment tool, which is the pretest and posttest, are also carefully developed in this second phase.

**Step 3:** Having the newly developed AR-Quest instructional design model and other related materials and documents revised

The newly developed instructional model with the instructional materials and documents is revised and improved in accordance with comments from both advisor and external experts' validation. For construct validity, the instructional model and instructional material and documents are validated by six experts in the related field. After being revised using experts' comments, the instructional model and related materials and documents are validated again in a pilot study in a small group that shares the characteristics as the population of the study. Then, the instructional model and related documents received another revision and improvement before the authentic implementation.

**Phase 3: (Research 2) Studying the effect of the AR-Quest instruction developed from the AR-Quest instructional design model**

The pre-experiment design with one group pretest-posttest was implemented for studying the effect of the AR-Quest instructional design model based on situated learning to enhance the ability to remember Khmer vocabulary of Thai undergraduate students in a real classroom. The sample in this study was 30 second-year undergraduate students purposively selected for the Faculty of Education. The sample was in the second semester of the year 2019.

The instrument for collecting the students' ability to remember Khmer vocabulary was developed for studying the effect of the newly developed instructional model in enhancing the ability to remember Khmer vocabulary of Thai undergraduate students. The 30-minutes Khmer vocabulary ability test consisted of three main parts including 1) matching with ten items, 2) translation with five items and 3) word choices

with ten items. The test was validated for structure and content validity by six experts in the related fields. Then, the test was further revised using feedback from experts before try-out with thirty second-year undergraduate students.

The implementation processes of the AR-Quest instructional model based on situated learning were: (1) the researcher administered the Khmer vocabulary ability test, as a pretest, to the students, (2) the researcher taught the students Khmer vocabulary using the AR-Quest instruction developed from the AR-Quest instructional design model, (3) the researcher administered the Khmer vocabulary ability test, as a posttest, to the student, and (4) the researcher analysed the students' score from the two tests and determined the effect of the AR-Quest model on the students' ability to remember Khmer vocabulary by using paired sample t-test.

**Phase 4: (Development 2) Revising and developing the AR-Quest instructional model to enhance the ability to remember Khmer vocabulary of Thai undergraduate students**

After the implementation, the AR-Quest instructional model to enhance the ability to remember Khmer vocabulary of Thai undergraduate students was improved in several aspects as follows:

1. In the learning step 1, linking students' personal experience, the introduction of basic Khmer grammar was cut short due to the need of time and the core objective of AR learning quests.

2. In Learning Step 2, assigning AR quests to students, which requires students to use android devices, quest activities were redesigned to be group learning activities, so they can share their android devices with one another.

3. In learning step 3, processing the AR quests, individual learning activities were omitted the limited resources of Android smart devices. Plus, group work was also been proved to be effective in inquiry learning activities.

4. In step 4, reflecting on the AR quests, two learning sub-steps were combined together for students to have more time reflecting on the learning quests.

## **1. SUMMARY**

The summary of this study is presented into two sections:

Section 1. The results of the development of the AR-Quest instructional design model based on situated learning

Section 2. The results of the effect of the AR-Quest instructional model based on situated learning in enhancing the ability to remember Khmer vocabulary of Thai undergraduate students

### **Section 1. The results of the development of the AR-Quest instructional design model based on situated learning**

#### **1. Components of the instructional model**

##### **1.1. The objective of the instructional model**

The objective of the AR-Quest instructional design model based on situated learning is to enhance the ability to remember Khmer vocabulary of Thai undergraduate students.

##### **1.2. The AR-Quest Instructional Model Principles**

The principles of the AR-Quest instructional model based on situated learning are as follows:

1. As the understanding of a concept is continuously under construction, knowledge has to be presented and learned in an authentic context of where and who it

might be used, and knowledge is also built when there are interactions between individuals (Bodner & Orgill, 2007).

2. Teachers bring to the class the authentic problems for students to solve and then provide them with opportunities to use the learned knowledge and skills to solve similar problems in different situations, often with the increase of task complexity (Collins & Kapur, 2014). Authentic problems refer to problems that students frequently encounter in daily life (Niss, 1992).

3. Students are to actively participate in discussions with teachers and other students to make sense of a subject matter. Moreover, teachers give more time on student reflection, an essential component of situated learning, on what they are experiencing. Students can be asked to do observations, make predictions, pose inferences, and tentative theories they are learning.

4. Students are encouraged to make their own discoveries and generate knowledge by activating and reconstructing knowledge schema (Mayer, 2004). Students are also to take the initiative in the learning process in a collaborative environment with authentic material (de Jong, 2006).

### **1.3. Instructional parameters of the instructional model**

The instructional parameters of the AR-Quest instructional design model based on situated learning theory are:

1. Teachers connect students' schemas by generating questions related to what they are going to learn as their previous knowledge is used as learning stimuli for further inquiry about the topic.

2. Teachers create a productive learning environment by the question-and-answer technique, small group discussion, brainstorming, or game. Teachers, then, introduce inquiry activities to students.

3. Teachers provide students with explicit instruction of the prepared learning quests designed for students to explore the set vocabulary before assigning quests to them. This includes providing details about the resigned quest and related tasks to the students. Teachers also need to

3. The teacher provides opportunities for students to work collaboratively in a small group inquiring information, reflecting their learning activities, sharing learning experiences, and seeking for better improvement in the following assignment.

4. Students keep on reflecting on what they are doing to gain more awareness of their learning and preparing for the next quest.

5. Students should learn together, and the teacher should be ready to provide support to students when needed.

6. Both teachers and students should be familiar and have the necessary skills in utilising information technology since it is a critical tool in searching, designing and inquiring information.

#### **1.4. Learning steps of the AR-Quest instructional model**

##### **Step 1. Linking students' personal experience**

This step functions as a warm-up step where the teacher uses students' schema to create learning stimuli. The teacher also uses this step to introduce a new lesson to students. In this step, the teacher is the main key person in establishing the learning processes to attract students' attention to the topic. In the meantime, the students are

vigilant about what the teacher is presenting. The teacher will determine the students' cynicism and comprehension by analysing their learning.

### **Step 2. Assigning AR quests to students**

This step helps to prepare students for the discovery and is also an instructional step where teachers use it to assign the AR quest to the student. The students need to listen carefully to the assignment and prepare all the potential ways to find solutions. As it is essential that students understand clearly what they are going to do in the next step, teachers must ensure that the students do not misunderstand the concept and objectives of the next learning activities. To do this, teachers can seek the students' understanding by asking them quest related to AR quests information.

### **Step 3. Processing the AR quests**

In this step, teachers serve as a facilitator for direct questions and technical support in backing up the students' exploration of the KhAR mobile application used to solve the AR quests. When the search ends, the students must share their quest answer with the rest of the class. Teachers can observe the students' work while the students are presenting their quest answer. Teachers and other students can help with the complete product.

### **Step 4. Reflecting on the AR quests**

In this step, students still stay in the same group and work together to reflect what they have been through in the AR quest exploration. This gives them ideas of what they need to improve for future quests. Teachers, in this step, work as a facilitator while students take a turn sharing their learning experiences.

### **Step 5. Ending the AR quests**



In this last learning step, teachers conclude and sum up the whole learning process. Teachers wrap up what the students have been through, and the students refine and reflect on what they have learned.

### **1.5. Assessment and evaluation of the instructional model**

The AR-Quest instructional design model based on situated learning consists of two assessments and evaluations: before- and after- process, and on-process evaluation.

Before-process assessment and evaluation of ability to remember Khmer vocabulary of the students was evaluated with Khmer vocabulary ability test.

On-process assessment and evaluation, students' task performance was used to evaluate the students' ability to remember Khmer vocabulary during each learning session. The students' task performance refers to the score of the students' given handout during each lesson plan.

### **2. The AR-Quest instructional model's supplementary documents**

The AR-Quest instructional design model based on situated learning to enhance the ability to remember Khmer vocabulary of Thai undergraduate students consists of two related documents, the instructional guidelines and lesson plan.

The AR-Quest instructional guidelines of the model provide teachers with a better and brighter understanding for effective use of the AR-Quest instructional design model based on situated learning to enhance the ability to remember Khmer vocabulary of Thai undergraduate students. The instructional guidelines of the model include learning principles, objectives, learning steps, and assessment and evaluation. Lesson plans of the model comprise of title, duration, learning objectives, learning steps, learning activities, learning resources and evaluation and assessment.

Two lesson plans were developed based on the AR-Quest instructional design model. Each lesson plan was designed for ninety-minute instruction and covered all the five learning steps. Each lesson plan shared the same organisation: title, time, learning objectives, learning contents, learning activities, learning media and resources, and assessment and evaluation.

## **Section 2. The results of the AR-Quest instructional design model based on situated learning to enhance the ability to remember Khmer vocabulary of Thai undergraduate students**

To investigate the effect of the AR-Quest instructional model based on situated learning theory, the model was implanted among thirty year-two undergraduate students of the Faculty of Education. The samples were in the second semester of the academic year 2019.

The Paired Sample t-test indicated that the Pretest of the Khmer vocabulary ability test (mean rank = 1.00) was lower than the Posttest (mean rank = 9.771),  $p = .00$ . The results of the statistical analysis showed that the posttest scores of the Khmer vocabulary ability test were significantly higher at the level of .05.

## **2. DISCUSSIONS**

The discussion in this research are presented based on two aspects, as follows:

1. The development of the AR-Quest instructional design model based on situated learning to enhance the ability to remember Khmer vocabulary of Thai undergraduate students
2. The effect of the AR-Quest instructional model based on situated learning to enhance the ability to remember Khmer vocabulary of Thai undergraduate students.

## **2.1 The development of the AR-Quest instructional design model based on situated learning to enhance the ability to remember Khmer vocabulary of Thai undergraduate students**

The development of the AR-Quest instructional design model based on situated learning to enhance the ability to remember Khmer vocabulary of Thai undergraduate students was systematically developed by integrating two learning approaches, situated learning and inquiry-based learning, as well as the integration of augmented reality technology.

The theory of situated learning has gained interest from educators and has found its way in language education. Situated learning theory emphasises learning through authentic activities that promote a more meaningful learning experience (P. 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 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 tend to 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.

Learning quest activities are seen to be applied to different subjects. In recent years, there is seen the application of quest-based learning in nursing education (Akinsanya & Williams, 2004; Finn, Fensom, & Chessier-Smyth, 2010). Such learning approach is also applied in the social sciences (Barrett & Stauffer, 2009; Clandinin & Connelly, 2000; Nelson, Ketelhut, Clarke-Midura, Bowman, & Dede, 2005). Lakkala et al. (2005) practice the theory of inquiry learning in the combined history classes of the twelve elementary and junior high schools. Shih, Chuang, and Hwang (2010a) apply the quest-based approach to mobile devices intended to help students to understand the culture associated with temples. Besides, H.-Y. Chang et al. (2013) experiment the effect of the combination of mobile AR technology and pedagogical quest activities on a socio-scientific issue's context of the grade-nine students, which proves positive effects on students' understanding of the science content. Quest learning approach adapts inquiry learning and it believes 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). Quest learning activities encourage students to make their discoveries and generate knowledge by activating and reconstructing knowledge schema (Mayer, 2004). In quest learning approach, inherited from inquiry learning, students are also to take the initiative in the learning process in a collaborative environment with authentic material (Elen & Clark, 2006).

Whereas AR, not a learning theory, but 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 (W. Liu, David Cheok, Mei Ling Lim, & Leng Theng, 2007), also has contributed a lot the success of classroom instruction. W. Liu et al. (2007) did research on developing AR instructional material, which gave them positive results as that learners' attention and learning outcomes were improved. When comparing the two types of materials, it is seen that practice time, and the cost spent on the design of the AR materials are less than those of traditional stimulation materials (B. 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 easily. Different from traditional teaching methods that only use texts, AR instructional model promises a learning experience where students learn lesson content with ease. From the research of Woods et al. (2004), the advantages of AR used in classroom instruction are illustrated. They [the advantages] include (1) the favour of students towards AR materials over traditional teaching materials, (2) the ability of being able to help students learn abstract concepts better, (3) 3D virtual objects which allow learners to interact freely, which, consequently, improve students' interaction, motivation, enthusiasm, and learning outcomes.

Moreover, AR is also found to be beneficial to students remember better as 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 memorisation, it is considered to be a good match for teaching languages (P.-H. E. Liu & Tsai, 2013; T.-Y. Liu, 2009). Presently, AR is used to trigger labels and symbols which are overlaid with videos, which makes it easy to understand location-related information such as name and distance of a particular place such as

buildings, hotels, restaurants, and many others (Y. Fujimoto et al., 2012). In this sense, AR can genuinely be used to enhance situated vocabulary learning as words or animations are displayed in relevance to the objects found within the real environment.

Secondly, the researcher synthesises the learning principles from situated learning, inquiry-based learning, and principles related to augmented reality technology in order to develop the so-called AR-Quest instructional design model based on situated learning to enhance the ability to remember Khmer vocabulary of Thai undergraduate students. Based on the extensive review of related works of literature, researches reveal the positive effect of each learning theory [the situated learning and the inquiry-based learning] and the augmented reality technology in enhancing the ability to remember better second language vocabulary ability. The situated learning has the potential to make learning more meaningful by providing students with authentic learning problems that they may encounter in real life (P. Scott et al., 2007). In the context of vocabulary learning, it can be an ineffective and slow process that students learn words from definitions, and the words themselves are isolated from their context (Bora, 2013). Situated learning plays a vital role in allowing students to acquire new words in a more meaningful way and store them in long-term memory for retrieval in any learning tasks (Nikbakht & Boshraadi, 2015). Inquiry learning suggests that learning can reach its highest potential when students work collaboratively with their peers in order to devise hypotheses, gather data to experiment the hypotheses, draw a conclusion, and reflect on the original problem and the thinking processes needed to solve it. In inquiry learning, students also take the initiative in the learning process in a collaborative environment with authentic materials (Elen & Clark, 2006). Inquiry learning activities, based on the design, can allow students to repeatedly associate with targeted words,

which lead to better memory of the learned words. Augmented reality has been proved to be beneficial in a wide range of areas. There is no different in retaining vocabulary ability. AR has the ability to assist students in remembering vocabulary better by using the features of applying virtual content to overlay onto a real environment object (Yuichiro Fujimoto et al., 2012; Y. Fujimoto et al., 2012).

These three major concepts, the situated learning, the inquiry learning, and the augmented reality technology, have the potential to enhance students' ability to remember vocabulary in their own unique way. Despite their individual uniqueness, when they are combined together, there comes a marvellous teaching instruction for vocabulary learning. The researcher saw the possibility and the power of them in instruction for enhancing students' ability to remember vocabulary when they are integrated as an instructional design model. The researcher, then, systematically developed the AR-Quest instructional design model based on situated learning and had it evaluated by six experts and, then, piloted in an authentic classroom. Next, the researcher improved the instructional design 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 effect of the instructional model with thirty second-year undergraduate students, who were purposively selected from the Faculty of Education, Chulalongkorn University, Thailand.

To sum up, the AR-Quest instructional model based on situated learning aims to enhance the ability to remember Khmer vocabulary of Thai undergraduate students. This model consists of four significant steps which are 1) Analysis, 2) AR Package Development, 3) AR Quest Development, and 4) Instructional Development.

## **2.2 The effect of the AR-Quest instructional design model based on situated learning to enhance the ability to remember Khmer vocabulary of Thai undergraduate students**

As presented in the finding, the students' statistically significant improvement in their ability to remember Khmer vocabulary could be seen as an indicator of the effect of the implication of the AR-Quest instructional model. Discussion on the effect of the AR-Quest instructional model based on situated learning is presented based on 1) results of the Khmer vocabulary ability test and 2) grounded theories and learning principles of the model.

### **2.2.1 Results of the Khmer vocabulary ability test**

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. This suggests that AR-Quest instructional model does have a positive effect on the students' ability to remember Khmer vocabulary. Such positive effects may be resulted from contributory factors of the study. They are the AR-Quest instruction where AR inquiry activities were integrated, and the AR package used to work with AR inquiry activities.

The AR-Quest instruction led to the improvement of the students' ability to remember Khmer vocabulary as the students were taught with the instruction that was carefully designed and developed following the steps presented in the AR-Quest instructional design model where the theory of situated learning and inquiry-based approach were the core. The learning tasks of the instruction gave students an authentic learning experience that made students find learning more meaningful as they saw the possibility of using the learned vocabulary in their daily life, which, in turn, enhanced



their ability to remember learning contents. This corresponds with what several scholars have previously claimed. For instance, in a study of W.-Y. 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 practise 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 the 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's score increase when authentic learning materials are presented in a situated learning environment.

The positive effect of the students' ability to remember also resulted from the inquiry learning activities that were designed for the students to have opportunities to practice the introduced Khmer vocabulary many times within the AR quest learning

process. Such repetitive activities could lead the students to better memorise the new Khmer vocabulary. In this study, students worked in a group to complete two main inquiry-learning activities such as 1) to find particular words presented in the worksheet and 2) to group the words into their correct family, which led to rapid remembrance of the learned vocabulary in a limited of time. This result corresponds with the research findings of Sadikin (2016), who used an inquiry-learning approach in WebQuest to teach English vocabulary to EFL young learners, where the result indicates that there was a significant difference in students' achievement in vocabulary mastery before and after inquiry treatment. On the other hand, H.-Y. 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 a productive and meaningful learning experience. This present research also goes along with the findings of the research finding of Vintinner et al. (2015), whose results from the inquiry interactive word walls study reveal that such an integrated inquiry approach leads to more profound and longer-lasting retention of word knowledge of the students. Another study on the development of an inquiry-based vocabulary ability, inquiring into familiar objects, to introduce scientific vocabulary to students reveals that inquiry approach helps better students vocabulary learning with a satisfying outcome (Hicks Pries & Hughes, 2012).

Another crucial factor that contributed to the improvement of the ability to remember Khmer vocabulary of the students was the AR package, the core research tool of the study. The AR package to the AR-Quest instruction of this study was designed based on the proved theories to reduce the students' cognitive load as much as possible. Starting from the selection of Khmer vocabulary for the AR mobile

application, the researcher took into account the students' cognitive load. The researcher selected fifteen nouns (for the KhAR mobile application) with an additional ten verbs. These fifteen words were grouped into three different categories so as to minimise students' cognitive disruption. Cognitive load theory indicates the dynamics of such disruption and suggests ways to bring it down (Liontas, 2001). Based on cognitive load theory, students' cognitive process falls into three categories of load including intrinsic, germane, and extraneous cognitive load. Intrinsic cognitive load occurs when students are introduced with new and complex learning contents. Germane cognitive load happens when students are provided with appropriate learning activities, which helps enhance students' learning; such cognitive load is considered excellent. Extrinsic cognitive load happens when teachers bring irrelevant learning contents to students, which disrupts students learning; such cognitive load is to be reduced as much as possible.

Khmer vocabulary is complicated for foreign learners; this complexity represents intrinsic cognitive load. The amount of unknown or difficult Khmer vocabulary also falls into an intrinsic cognitive load. Thus, to reduce such cognitive load, the researcher categorised the fifteen words into three different categories. Each category consists of five common words. The characteristics of the first five Khmer words are similar to Thai words in terms of pronunciation and meaning. The second category of the words shares some language relations between the Thai language and the Khmer language. Last but not least, the third category of words are those with different both in pronunciation and meaning. 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 to reduce students' cognitive load 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 favouring the experimental group who used the AR applications, and Chester et al. (2016), who developed a situated mobile learning approach where the results were superior to the results of those taught using traditional learning methods.

In addition to the ability to reduce the students' cognitive load of the AR package, its features of displaying 3D model to the real-world objects and playing audio for pronouncing the words demonstrated the potential to help the students improve their ability to remember Khmer vocabulary ability as they [the AR package's features] could help increase cognitive engagement and retain the students' attention. In this study, the AR package gave the students an immersive vocabulary learning experience as it could create a realistic learning environment by displaying visual models in 3D format onto AR cards in order to enhance the students' ability to remember Khmer vocabulary. The results of this match with the research results of P.-H. E. Liu and Tsai (2013) who used augmented-reality-based mobile learning material in EFL English composition and the result indicated that such AR materials provide students with linguistic and content knowledge. Furthermore, researches conducted by Küçük et al. (2016) on investigating effects on student achievement and cognitive load by learning anatomy via mobile augmented reality, and Cai et al. (2017) on applying augmented reality-based natural interactive learning application in magnetic field instruction showed that AR-based applications could decrease students' cognitive load and improve students' learning outcome.

The effect of the AR-Quest instructional model on the students' ability to remember Khmer vocabulary results from three factors, namely 1) the AR-Quest instruction itself as it was carefully designed and developed in accordance with the steps presented in the AR-Quest instructional design model where the theory of situated learning and inquiry-based approach were the core, 2) the AR-Quest learning activities that were designed for the students to have opportunities to practice the introduced Khmer vocabulary multiple times within the AR quest learning process and such repetitive activities could lead the students to memorise the new Khmer vocabulary better, 3) the AR package that was designed and developed based the proved theory to reduce the students' cognitive load, and provide students with AR features that promoted an immersive vocabulary learning experience.

### **3. RECOMMENDATIONS**

The research entitled “Development of an AR-Quest instructional design model based on situated learning to enhance the ability to remember Khmer vocabulary of Thai undergraduate students” are pointed with two recommendations: pedagogical implication of the instructional model and recommendations for further research.

#### **3.1 Pedagogical implications of the instructional model**

The research findings suggest that the following implication for teachers who teach with the AR-Quest instructional design based on situated learning as follows:

1. The research findings showed that the AR-Quest instructional design based on situated learning provided an appropriate enhancement in the ability to remember Khmer vocabulary for undergraduate students. Since the design of the AR-Quest instructional model employed the KhAR mobile application and well-organised

learning activities, teachers may modify the mobile application to fit with their designed learning activities to provide the best outcomes for students.

2. Teachers must be flexible in linking students' personal experience as it is essential to attract students' attention and encourage them to be actively involved in learning activities.

3. Concerning levels of proficiency, the findings of the study suggested that the AR-Quest instructional model based on situated learning were practical absolute beginner students with Khmer as a foreign language.

4. This instructional model is designed using AR contents and KhAR mobile application as learning resources. Thus, for the high effect of the implication of this model, the teacher should conduct a preliminary study to investigate the learning differences among students in language proficiency and essential skill in using technology.

5. The majority of the learning contents in this instructional model are integrated into a mobile application. Therefore, the teacher has to study each content before using it in the class carefully. Moreover, the teacher should check for any unexpected errors in mobile applications.

6. In the AR-Quest instructional model, learning activities are designed to include inquiring information from the mobile application. Each and every step of the model has its own function and required practice time; thus, it is recommended that teachers manage time for the learning activities carefully.

7. During the instruction, particularly during the students exploring the AR quests, teachers should support students by checking each group if they need any

technical support or ask indirect questions to check their understanding. Moreover, teachers should observe students' learning behaviour during instruction.

### **3.2 Recommendations for further research**

The followings are the researcher's recommendations for further studies.

1. In this pre-experiment research, the research used only one-group only by administering the Khmer Vocabulary ability test as the research instrument. The further future study should be designed using other research designs, namely the control-group pretest-posttest design, in order to get rigid evidence of the effect of the integrated instruction.

2. The present study employed Khmer basic vocabulary about stationery. The future studies are advised to include more Khmer vocabulary in other fields such as hotels, restaurants, and airports, etc. Moreover, further studies should include more sophisticated vocabulary, phrases, and sentences.

3. The effect of the model of this research was studied immediately after the intervention. Thus, future researches wishing to study students' ability to remember vocabulary should administrate the Khmer vocabulary ability test sometime, the students are taught by using the instructional model.

4. This research focused on the effect of the AR-Quest instructional model on improving the students' ability to remember Khmer vocabulary. Further research should be carried out to explore the extent to which this model improves other language skills.

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จุฬาลงกรณ์มหาวิทยาลัย  
**CHULALONGKORN UNIVERSITY**

## **APPENDIX A**

### **LIST OF EXPERTS**

The research instruments of the research entitled “Development of an AR-Quest instructional design model based on situated learning to enhance the ability to remember Khmer vocabulary of Thai undergraduate students” were the AR-Quest instructional design model, a sample of the lesson plan, KhAR mobile application, and the Khmer vocabulary ability test.

#### **List of experts for the AR-Quest instructional design model**

1. Ajarn Dr. Chanchhaya Chhouk, University of Cambodia
2. Ajarn Saint Meansngoun, Western University
3. Ajarn Un Channary, Mahasarakham University

#### **List of experts for the research instrument**

1. Ajarn Un Channary, Mahasarakham University
2. Ajarn Phath Chamraen, Kampong Cheuteal Institute of Technology
3. Seang Hokleng, Kampong Cheuteal Institute of Technology

## **APPENDIX B**

### **INSTRUCTIONAL GUIDELINES OF THE MODEL**

These instructional guidelines designed to accompany the AR-Quest instructional model based on situated learning to enhance the ability to remember Khmer vocabulary of Thai undergraduate students aims to provide interested teachers with the needed details concerning the model. Therefore, it is advisable for the teacher to study all the necessary details in terms of the instructional model and instructional guidelines of the model.

#### **Related documents of the instructional model**

1. The AR-Quest instructional model based on situated learning to enhance the ability to remember Khmer vocabulary of undergraduate students comprises of principles, objectives, learning steps, and evaluation.
2. The instructional guidelines of the AR-Quest instructional design model based on situated learning to enhance the ability to remember Khmer vocabulary of undergraduate students comprises of learning steps, contents, and lesson plans.

#### **Things to study**

1. It is advisable for interested teachers to have a clear understanding of the AR-Quest instructional design model based on situated learning to enhance the ability to remember Khmer vocabulary of Thai undergraduate students before the implementation.
2. Before-process evaluation should be conducted before the implementation of the model. It is advisable for the teacher to use Khmer vocabulary ability

test, which contains three main parts, 25 items with 30 minutes allowed, in order to evaluate the ability to remember Khmer vocabulary of the students.

3. The teacher implements the AR-Quest instructional model based on situated learning to enhance the ability to remember Khmer vocabulary of Thai undergraduate students into the classroom using the designed lesson plans. There are two lesson plans in this instructional model. each of which lasts three hours, covering a period of two weeks. Each lesson plan is designed on the basis of the instructional model, and shares the same format, unit title, students' level, duration, objectives, learning content, and materials. It is also advisable for the teacher to be well-prepared and well-designed for content and materials as suggested so achieve the desired goal of the model.
4. After-process evaluation should be conducted in the last session of the implementation of the model. The teacher is able to administer Khmer vocabulary ability test, which contains 25 test items with 30 minutes allowed in order to evaluate ability to remember Khmer vocabulary of the students.

## APPENDIX C

### LESSON PLAN

#### Lesson plan for AR-Quest Khmer vocabulary instruction

##### Sample of Lesson Plan

- Time:** 90 minutes per week
- Subject:** Basic Khmer vocabulary
- Students:** Second-year students from the Faculty of Education
- Skill:** Remembering and constructing simple sentences
- Goals:** Students use words to construct basic sentences using stationery words.
- Objective:** On completion of this lesson, students will be able to
1. Recognise Khmer language structure
  2. Recognise Khmer vocabulary about stationery
  3. Use the learned words for constructing basic sentences correctly
- Content:**
1. Basic Khmer sentence structure
  2. Vocabulary about stationery
- Learning material:**
1. Handout about Khmer language structure
  2. ARQuest Mobile Application
  3. A set of teaching material

Vocabulary about the classroom is considered to be a fundamental skill that students should learn and be trained to be fluent in order to bring this knowledge to use in learning Khmer language. In addition, students can use the vocabulary and sentence structure to talk to Khmer people.

Time	Tasks	Purposes
10 mins	Linking students' personal experience	<p>The purposes of this step are 1) to attract the students' attention to the topic and 2) to stimulate students' previous knowledge to link the topic.</p> <p>The teacher warms up the class by introducing the topic. At this time, the teacher uses the students' schema to lead their attention to the being-introduced topic. The step allows the teacher to check the students' level and knowledge of the topic.</p>
	Teacher's Roles	
	<ul style="list-style-type: none"> <li>- The teacher tells the students Ss what they are going to learn and the learning outcomes they are going to be able to do after finishing the lesson.</li> <li>- The teacher plays a Thai song that contains Thai and Khmer words to get students' attention and to introduce Khmer language structure to Thai students. (<a href="https://youtu.be/33aHUOe9ZwE">https://youtu.be/33aHUOe9ZwE</a>)</li> <li>- The teacher asks the students whether they know any Khmer words.</li> <li>- The teacher tells the students they will learn basic Khmer vocabulary, which we use often. (Stationery)</li> <li>- The teacher introduces ARQuest application to students.</li> </ul>	
	Students' Roles	
	<ul style="list-style-type: none"> <li>- The students pay attention to the teacher when he is introducing the topic and the learning outcomes they will get after the lesson.</li> <li>- The students raise questions and answer the teacher's questions.</li> <li>- The students talk about their background and experiences about Khmer language.</li> </ul>	
Time	Tasks	Purposes
50 mins	Assigning AR quest:	
	Teacher's Roles	

	<ul style="list-style-type: none"> <li>- The teacher introduces Khmer language structure, which is similar to Thai language structure.</li> <li>- The teacher gives the students Khmer grammar handout.</li> <li>- The teacher introduces the AR quest to the students and then explains what the AR quests are and how the students are going to solve it.</li> <li>- The teacher makes sure that the students understand correctly the AR quest process.</li> <li>- The teacher lets the student ask any questions to clear out their double of the AR quest.</li> <li>- The teacher gives students authentic learning resources used to solve the AR quest.</li> </ul>	<p>The purposes of this step are 1) to introduce students AR learning quests they are going to complete, 2) to provide students with authentic learning experience [exploring and solving the AR quests], and 3) to guide and scaffold the students to explore the prepared learning quests.</p>
	<b>Students' Roles</b>	
	<ul style="list-style-type: none"> <li>- The students listen carefully to what the teacher is explaining.</li> <li>- The students gather and note down the information and tips that they can use to solve the quest.</li> <li>- The students ask the teacher questions to clear out any doubt they may have.</li> </ul>	<p>This step introduces students to the AR quests and other related information that can trigger the students' schema and connect with the task. Be noticed that, the characteristics of the quest is designed to</p>
	<b>Processing the AR quests:</b>	
	<b>Teacher's Roles</b>	<p>be a series of task</p>

	<p>(Quest 1 worksheet)</p> <ul style="list-style-type: none"> <li>- The teacher provides the students notes and pencils so they can jot down what they will be learning while they are solving the AR quests.</li> <li>- The teacher monitors the class and students' learning activities and helps them when necessary</li> <li>- The teacher may raise hint questions for any group that seems to be stuck in the process of exploring the quest; so they can go on.</li> <li>- After completing the assigned quest exploration, the teacher asks a student from each group to share their discovery with the class.</li> <li>- The teacher encourages discussion about the shared answer.</li> </ul>	<p>quest where students need to work with every single task to finish the quest.</p> <p>This step sets the students on foot to be ready for quest exploration in a cooperative learning environment.</p>
<b>Students' Role</b>		
	<ul style="list-style-type: none"> <li>- The students prepare the materials given by the teacher.</li> <li>- The students read the AR quest and then gather the information to solve the quest.</li> <li>- The students use the KhAR mobile application to find the answer to the AR quest and note them down in their note.</li> <li>- After completing the AR quest, one student from each group shares their answer to the class and get feedback from the teacher and their peers.</li> </ul>	



	- The students are to summarise their quest discovery in the form of a short paragraph.	
Time	Tasks	Purposes
10 mins	Reflecting on the AR quest:	The objective of this step is to let the students reflect their own discovery of the quest they have just solved. This is to help them see what they need to improve in order to achieve a better result in the next AR learning quests.
	Teacher's Roles	
	The teacher controls the class and oversees the ongoing discussion between students and students in the class. The teacher supports the students when they encounter problems.	
	Students' Roles	
	The students work and discuss with the same peers in their group and reflect on their individual experiences got from the learning quest.	
Time	Tasks	Purposes
20 mins	Ending the AR quests:	The last step aims to generalise new knowledge for the students and summarise the entire processes of the AR learning quests that the students have done.
	Teacher's Roles	
	The teacher promotes a relaxing classroom environment in order to promote a learning experience, sharing among students in the class. While the students are discussing and working on their learning reflection, the teacher supports them and give feedback. Once the students have formed their new knowledge they have learned, the teacher asks them to share the knowledge with the class.	
	Students' Roles	

	<p>The students work both individually and in a group to reflect on the new vocabularies they have learned from the AR learning quests.</p> <p>The students share to the class the newly formed knowledge to the class</p>	
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## HANDOUT

### Grammar handout

Note: The following grammar rules are used for informal communication by Cambodian people in their daily life.

In this handout, you may find a brief description of basic Khmer language structures used to construct simple statements, questions, and negative sentences.

You will be happy to know that Khmer grammar is very simple. The grammar usually follows a subject-verb-object sentence structure. It is precisely the same as simple Thai sentence structure.

#### Khmer Form:

ប្រធាន (Subject) + កិរិយា (verb) + (កម្មវត្ថុ) (object)

#### Thai Form:

ประธาน (Subject) + กริยา (verb) + (กรรม) (object)

You may examine the following positive statements.

<b>English</b>	I	go	to school
<b>ខ្មែរ</b>	ខ្ញុំ	ទៅ	សាលារៀន
	កូណូម	តេ	សាលារៀន
<b>ไทย</b>	ผม	ไป	โรงเรียน
	This	is	a book
	នេះ	គឺ	សៀវភៅ
	นี่	คือ	เชียวพู่
	นี่	คือ	หนังสือ
	The eraser	is	Here.

ជីវលុប	នៅ	ទីនេះ
ខ្លាច-លប	នៅ	តំបន់
យាងលប	នៅ	ទីនេះ

With the three simple sentences above, you may notice the similarity between Khmer language structure and Thai language structure.

Now let us see how we can construct questions in Khmer language. Like Thai language needing the word “ไหม” at the end of a sentence when wanting to make a simple question, Khmer language is the same. To construction a simple question in Khmer language, all you need is word “អត់ (អ៊ែត)” at the end of a sentence.

Khmer Form:

ប្រធាន (Subject) + កិរិយា (verb) + (កម្មបទ) (object) + អត់ (អ៊ែត)?

Thai Form:

ประธาน (Subject) + กริยา (verb) + (กรรม) (object) + ไหม

Let us study the following examples.

<b>English</b>	Will	you	go	to study?	
<b>ខ្មែរ</b>		អ្នក	ទៅ	រៀន	អត់?
		នើម	គេ	រៀន	អ៊ែត
<b>ไทย</b>		คุณ	ไป	เรียน	ไหม
	Are	you	hungry?		
		អ្នក	ឃ្នាន	អត់?	
		នើម	គេ	អ៊ែត	

	คุณ	หิว	ไหม	
Do	You	have	a ruler?	
	អ្នក	មាន	បន្ទាត់	អត់?
	នើយ	មើយ	បន្ទាត់	អត់
	คุณ	มี	ไม้บรรทัด	ไหม

Constructing a negative in Khmer language is also quite simple for Thai learner since the languages share the similar characteristics. In Thai language, to make a negative we need the word “ไม่” before a verb or an adjective. Khmer language is the same. Instead of the word “ไม่” we use the word “អត់ [ខ្ពែង]” before a verb or an adjective. However, Khmer negative sentences always come with the word “ទេ [ពេ]” at the end of the sentence.

**Khmer Form:**

ប្រធាន (Subject) + អត់ (ot) + កិរិយា (verb) / គុណសម្បត្តិ (adjective) + (កម្មវត្ថុ) (object) + ទេ (ពេ)

**Thai Form:**

ประธาน (Subject) + ไม่ + กริยา (verb) / คุณศัพท์ (adjective) + (กรรม) (object)

Let us study the following examples.

<b>English</b>	He	is	not	hungry.	
<b>ខ្មែរ</b>	គាត់		អត់	ឃ្នាន	ទេ
	ក្នុង		អត់	គេស្រី	ពេ
<b>ไทย</b>	เขา		ไม่	หิว	
	The	teacher	does	not	go to teach.

	ไต่	มัต	เจา	บ่ไต่	เจ
	ครู	อ็อค	เตอ	บ่องเรียน	เต
	ครู	ไม	ไป	สอน	
He	does	not	know.		
คำ		มัต	ไต่	เจ	
กวด		อ็อค	เคิง	เต	
เขา		ไม	ไป		

### QUEST 1:

#### Helping *Joe* to get ready for his first day of school

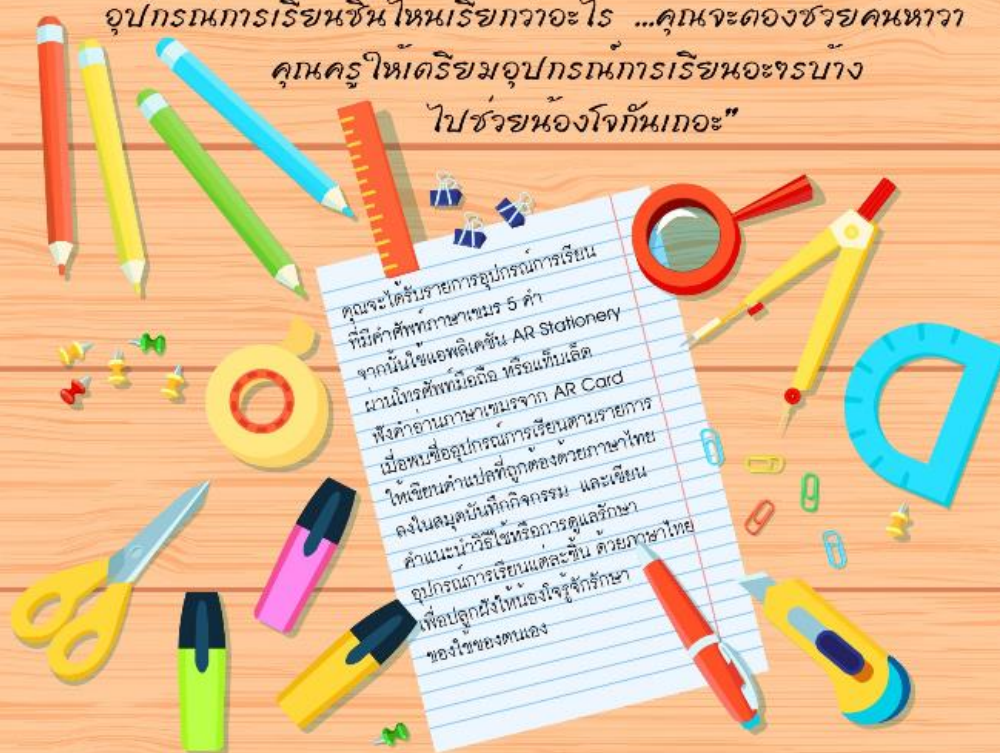
Introduction	<p>Do you remember when you were a kid and started your first day of school? Who helped you prepare your learning materials such as pencil, eraser, notebook etc.? Today you are going to help <i>Joe</i> to prepare his learning materials. Joe is a little Joe. He needs helps with his learning stuff. For this task, you may need to work in a group of three and each person will have a specific job to do.</p> <p>Are you ready to help our <i>Joe</i>? Are you ready to explore what <i>Joe</i> needs for his first day of school? Are you ready? Let us begin!</p>
Task	<p>You will go to all the available learning materials and gather the ones which are presented in the list given to you by your instructor. You will have to use the ARQuest mobile application to find the right learning materials needed for <i>Joe</i> for his first class as the given list is in Khmer romanisation. The app allows you to explore the AR cards and listen to learning materials in Khmer language.</p> <p>You are also to jot down the materials which are in Khmer language with Thai translation as you are to present the materials you prepare to the class.</p> <p>With the words gathered, your group is to write a short paragraph advising <i>Joe</i> to take care of his stuff. You may use Thai language but you have to use Khmer romanisation for the words you have learnt.</p>

# กิจกรรมที่ 1

เปิดเรียนวันแรก

มาช่วยน้องโจ เตรียมของไปโรงเรียนกันเถอะ

“วันแรกของการเปิดเทอม น้องโจ อายุ 7 ปี  
ต้องเตรียมของไปโรงเรียนตามรายการที่คุณครูให้ไว้ แต่น้องไม่รู้ว่าจะ  
อุปกรณ์การเรียนชิ้นไหนเรียกว่าอะไร ...คุณจะต้องช่วยค้นหาว่า  
คุณครูให้เตรียมอุปกรณ์การเรียนอะไรบ้าง  
ไปช่วยน้องโจกันเถอะ”





Let us help our *Joe*

Please help our *Joe* to pack his learning materials he may need for his first class.

The stuff he needs includes:

<p>①</p> <p><input type="checkbox"/> กรอบใบสะปี่เคี้ย</p> <p><input type="checkbox"/> เขี้ยวเพิว</p> <p><input type="checkbox"/> ขม่าวได</p> <p><input type="checkbox"/> จอ-ลบ</p> <p><input type="checkbox"/> บอนตอด</p>	<p>Name:</p>
---	--------------

Please write down the learning materials you have gather in Thai in the table provided below. You may any distinctive mark as you need to help you remember Khmer vocabulary better.

N	Khmer romanization	Thai translation	Your mark
1	กรอบใบสะปี่เคี้ย		
2	เขี้ยวเพิว		
3	ขม่าวได		
4	จอ-ลบ		
5	บอนตอด		

Let us help our *Joe*

Please help our *Joe* to pack his learning materials he may need for his first class.

The stuff he needs includes:

<p>②</p> <p><input type="checkbox"/> กรอบใบสะปี่เอี้ย</p> <p><input type="checkbox"/> เบ็ก</p> <p><input type="checkbox"/> ปรรอ-ดັบ-ควง-ขมาวไต</p> <p><input type="checkbox"/> กรอ-ดะห์</p> <p><input type="checkbox"/> เดกห์เก็บ</p> <p><input type="checkbox"/> ดองเตียบกรอดะห์</p>	<p style="text-align: center;">Name:</p>
---	--

Please write down the learning materials you have gather in Thai in the table provided below. You may any distinctive mark as you need to help you remember Khmer vocabulary better.

N	Khmer romanization	Thai translation	Your mark
1	กรอบใบสะปี่เอี้ย		
2	เบ็ก		
3	ปรรอ-ดັบ-ควง-ขมาวไต		
4	กรอ-ดะห์		
5	เดกห์เก็บ		
6	ดองเตียบกรอดะห์		

Let us help our *Joe*

Please help our *Joe* to pack his learning materials he may need for his first class.

The stuff he needs includes:

<p>③</p> <p><input type="checkbox"/> กรอ-ดะห์</p> <p><input type="checkbox"/> เบ็ก</p> <p><input type="checkbox"/> ขมาวได-ปอ</p> <p><input type="checkbox"/> เดกห์เก็บ</p> <p><input type="checkbox"/> ดองเดียบกรอดะห์</p>	<p>Name:</p>
--	--------------

Please write down the learning materials you have gather in Thai in the table provided below. You may any distinctive mark as you need to help you remember Khmer vocabulary better.

N	Khmer romanization	Thai translation	Your mark
1	กรอ-ดะห์		
2	เบ็ก		
3	ขมาวได-ปอ		
4	เดกห์เก็บ		
5	ดองเดียบกรอดะห์		

**QUEST 2:****Put them in the same family**

Introduction	<p>Khmer language and Thai language are so related to one another. For Thai learners, it is possible to communicate with Cambodian people in Khmer language if they have a good knowledge of Khmer vocabulary. Learning Khmer to communicate with local people, Thai learners do not need to extensively learn Khmer grammar since the grammar of the two languages is very similar.</p> <p>Not just the grammar that is similar, so are a great number of vocabularies. Once you get to know Khmer language, you will notice Khmer and Thai words have relations with each other.</p> <p>This quest is designed to introduce students some Khmer vocabularies which 1) are pronounced similarly and have the same meanings, 2) have language relations (e.g. the same word constructions) and 3) are entirely different both pronunciations and meanings and do not have an association between them.</p>
Task	<p>There are Khmer vocabulary AR cards. You will group the cards into three different categories, which are:</p> <ol style="list-style-type: none"> <li>1) vocabularies which are pronounced similarly and convey the same meaning as Thai vocabularies</li> <li>2) vocabularies which have word relations with Thai words (word construction)</li> <li>3) vocabularies which are different in pronunciations, meanings and do not have any word relations with Thai vocabularies.</li> </ol>

จากกิจกรรมที่ 1 การเรียนรู้คำศัพท์ภาษาเขมรจาก AR Card จะเห็นความสัมพันธ์ระหว่างคำศัพท์ภาษาเขมรและคำศัพท์ภาษาไทยหลายคำ เราอาจจำแนกคำศัพท์  
ภาษาเขมรตามลักษณะความสัมพันธ์กับภาษาไทย ...มาทำกิจกรรมที่ 2 จัดกลุ่ม AR Card กันเถอะ

## กิจกรรมที่ 2

จัดกลุ่มคำศัพท์ที่ได้เรียนจาก AR Card แล้วจำแนกลงในตาราง

ออกเสียงคล้ายกับคำไทย	บางพยางค์ ออกเสียงคล้ายกับคำไทย หรือ มีความหมายสัมพันธ์กับคำไทย	แตกต่างจากคำไทย

## APPENDIX E

## THE KHMER VOCABULARY ABILITY TEST

## Test elements:

- I. The vocabulary test consists of three main parts. In the first part, students are to correctly match Thai words to Khmer words. There are ten words in this part.
- II. The second part is the translation test. Five words are provided in Khmer language with Khmer romanisation. Students are to translate those five words into Thai language.
- III. The final part of the test is the multiple-choice statements. There are ten multiple-choice statements and each statement comes with four choices. Students are to choose the most appropriate choice for the statements.

**Time required:** The test time 25 minutes.

- I. Match the Thai words with the Khmer words.

เติมอักษรหน้าคำศัพท์เขมรที่ตรงกับความหมายในภาษาไทย

___	กรรไกร	កន្ត្រៃ	กรอนไตร
___	กระดานดำ	ក្ដារខៀន	กะดาเขียน
___	กระดาศ	ក្រដាស	กรอ-ดะห์
___	กระเป่าสะพาย	ក្របួបស្លាយ	กรอ-โบบ-สะปีเอี้ย
___	เขียน	ខ្មៅដៃ	ขมาวดไต
___	คลิปหนีบกระดาศ	គ្រឿងគិតលេខ	เครื่องเกิดเลข
___	เครื่องคิดเลข	ដង្កៀបក្រដាស	ดองเกียบกรอดะห์
___	เครื่องเย็บกระดาศ	ដៃកកឹប	เดกห์-เก็บ
___	ดินสอดำ	នាឡិកា	เนี้ยลิกกา
___	นาฬิกา	សរសេរ	ซอเซ







### Vocabulary list for instruction

The followings are Khmer vocabularies used for an ARQuest Instruction. The theme of the words is about stationery and some common verbs used in classroom. There are fifteen words which are grouped in three different categories. Each category consists of five common words. The characteristics of the first five Khmer words are similar to Thai words in term of pronunciation and meaning. The second category of the words shares some language relation between Thai language and Khmer language. Last but not least, the third category of words are those with different both in pronunciation and meaning.

Besides the fifteen common words of the stationary, there are another 10 verbs which are also always used in classroom.

N	Khmer words	Romanisation	Meaning in English	Meaning in Thai
Category 1: Words with similar sound and the same meaning				
1	ក្រដាស	kro-das	Paper	กระดาษ
2	បន្ទាត់	bon-tort	Ruler	ไม้บรรทัด
3	គ្រឿងគិតលេខ	krerng-kit-lek	Calculator	เครื่องคิดเลข
4	ឯកសារ	ek-kor-sar	Document	เอกสาร
5	កន្ត្រៃ	kon-trai	Scissor	กรรไกร
6	នាឡិកា	nea-likka	Watch	นาฬิกา
Category 2: Words with language relation with Thai words				
1	ខ្មៅដៃ	kh'mov-dai	Pencil	ดินสอดำ
2	ក្តារខៀន	k'da-khean	Blackboard	กระดานดำ
3	ក្របូបស្ពាយ	kro-bub-speay	Backpack	กระเป๋าสะพาย
4	ដីរលុប	jor-lob	Eraser	ยางลบ

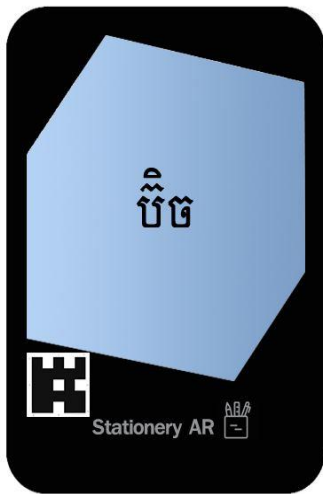
5	ខ្មៅដៃពណ៌	kh'mov-dai por	Colour pencil	ดินสอสี
Category 3: Words with different sound and meaning				
1	ប៊ិច	bej	Pen	ปากกา
2	សៀវភៅ	seav-phov	Book	หนังสือ
3	ដង្កៀបក្រដាស	dong-keab-kro-das	Paper clips	คลิปหนีบ กระดาษ
4	ដៃកកប	daek-kerb	Stapler	เครื่องเย็บ กระดาษ
5	ប្រដាប់ខ្លុងខ្មៅដៃ	bro-dab-khoung kh'mov-dai	Sharpener	กบเหลาดินสอ
Extra words (verbs)				
1	រៀន	rean	Study	เรียน
2	អាន	arn	Read	อ่าน
3	សរសេរ	sor-sae	Write	เขียน
4	និយាយ	ni-yey	Speak	พูด
5	ស្តាប់	s'dab	Listen	ฟัง
6	សួរ	Sour	Ask	ถาม
7	ប្រកប	bro-korb	Spell	สะกด
8	គិត	khert	Think	คิด
9	ប្រើ	brer	Use	ใช้
10	មើល	merl	Watch	ดู

## **AR cards for KhAR mobile application**

### **Developing AR cards for KhAR app**

KhAR stationery cards are physical paper cards with the size of 5.5 x 8.5 cm. They were designed to be used with the KhAR mobile application for AR-quest activities. The KhAR cards were designed with the following characteristics:

- Size: the researcher designed the 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 size of the cards is 5.5 cm x 8.5 cm, which is a size of the hand grip. 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).
- Colour: the researcher designed the card using black and blue as blue reduces excitement, which helps students to concentrate (Mehta & Zhu, 2009). The researcher, as a result, used the blue colour in the middle of the background of the KhAR cards. This design was also influenced by pop-up 3D models, making it to have a contrast colour for students to learn the objects with any distraction.
- Letter: the letters on the cards are Khmer stationery words. Khmer characters were used to make the trigger more unique to avoid bad detection of the KhAR application (Godwin-Jones, 2016).



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