

## The Use of Augmented Reality Direct Vocabulary Instruction Based on Cognitive Theory of Multimedia Learning to Enhance Vocabulary Knowledge of Thai University Students

Premkamon Hiranrakpattana<sup>1</sup>, Pornpimol Sukavatee<sup>2</sup>

### Abstract

The potential of augmented reality to merge the real and computer-generated world together can revolutionize the vocabulary field. This study aimed to 1) investigate the effectiveness of the use of augmented reality direct vocabulary instruction based on cognitive theory of multimedia learning to enhance vocabulary knowledge of Thai university students and 2) explore the perceptions of Thai university students towards the instruction. This study employed a one group pre-posttest research design. Twenty Thai university students from the second to fourth year at a public university in Bangkok participated in this study for 10 weeks. The instruments were lesson plans with AR flashcards, pre-posttest, questionnaire and interview. The data was analyzed using paired-sample t-test, mean, SD and thematic analysis. The results showed that 1) there was a significant improvement of students' vocabulary knowledge at  $p < 0.001$ . and 2) students had positive perceptions towards the instruction as they found it interesting and useful, agreeing to apply it outside classrooms. The augmented reality direct vocabulary instruction based on cognitive theory of multimedia learning enhances vocabulary knowledge systematically with an overlay of sound, pictures and real situations. It can also become part of students' future self-learning.

**Keywords:** Augmented Reality, Direct Vocabulary Instruction, Cognitive Theory of Multimedia Learning, Vocabulary knowledge

### Introduction

At the tertiary level in Thailand, English is still a required subject because it will support students in their academic performance and future careers. However, according to Sasum and Weeks (2018), Thai university students do not possess sufficient vocabulary, thus cannot speak English fluently. Similarly, Sinturat et al. (2022) reported that due to the lack of

---

<sup>1</sup> M.Ed. Student, Teaching English as a Foreign Language, Faculty of Education, Chulalongkorn University

<sup>2</sup> Assist. Prof. Dr. of Faculty of Education, Chulalongkorn University, Advisor

Corresponding Author E-mail : joypremkamon@gmail.com

vocabulary knowledge, Thai university students are unable to complete their thoughts while speaking. They cannot think of appropriate words that can best express themselves both in conversation and academic settings. Moreover, limited vocabulary is the primary factor contributing to anxiety in oral English classrooms (Ritthirat & Chiramanee, 2014). These demonstrate how crucial vocabulary knowledge is, and it is important that universities continue to promote it. The course in this study aims to improve vocabulary knowledge for effective communication and discussion. Nonetheless, vocabulary should not be taught through rote memorization with Thai translations. By translating the target words into the learners' first language, it typically places an emphasis on vocabulary rote memorization. Students remember the words without understanding how to use them in context. In accordance with Imamee (2016), Thai university students reported that while learning English vocabulary, the most frequently faced issue was not knowing how to apply vocabulary in a proper and authentic context. In addition, teachers should be aware of the issues with word pronunciation. To avoid communication difficulties caused by word mispronunciation, students should be provided with appropriate instruction with authentic materials (Jaiprasong & Pongpairoj, 2020). Also, Thai students also found vocabulary materials that are traditionally used in class boring and uninspiring (Thongchu & Adipat, 2022).

In the 21st century, students of this generation can utilize technology well to enhance their own learning experience. Augmented reality can facilitate students with an overlay of texts, sound, pictures and videos to support vocabulary knowledge (Binhomran & Altalhab, 2021; Fan et al., 2020). For example, students can scan an augmented reality flashcard and listen to the audio of pronunciation. Also, they can understand the definition of vocabulary more easily by making connections through multimedia i.e. pictures. Additionally, augmented reality can provide real-world scenarios on how to use words in different contexts (Palaiogeorgiou et al., 2017; Santos et al., 2016; Tyson, 2021; Weerasinghe et al., 2022). Binhomran and Altalhab (2021) found that augmented reality assists students in understanding the meaning of the new vocabulary through animated objects in the story. In line with Solak and Cakir (2016), the experimental group who learned vocabulary with 3D animation, pronunciation and use through augmented reality resulted in higher scores than the control group both in the posttest and retention test. Apart from that, augmented reality enhances motivation and student-centered learning (Hung et al., 2017; Kaenchan, 2018; Perry, 2015; Solak & Cakir, 2016; Taskiran, 2019). In this study, the use of augmented reality is

designed and supported by cognitive theory of multimedia learning (Mayer, 2005): the dual-channel assumption—learning vocabulary by linking connections between auditory and visual systems, the limited-capacity assumption—avoiding cognitive load when presenting vocabulary; and the active-processing assumption—students actively selecting, managing, and processing information to learn vocabulary.

Most importantly, despite the use of augmented reality based on the cognitive theory of multimedia learning, the gap found in many studies is that augmented reality was used in education without a clear teaching method (Parmaxi & Demetriou, 2020; Saltan & Arslan, 2016). This may reflect that researchers focus on the novelty of augmented reality rather than how its affordance is in line with pedagogical methods (Parmaxi & Demetriou, 2020). Accordingly, the direct vocabulary instruction by Archer and Hughes (2011) was integrated with augmented reality based on the cognitive theory of multimedia learning in this study. It is the most appropriate and required instruction for academic vocabulary or vocabulary in Tier 2 (Beck et. al, 2013), the target vocabulary in this study. As a result, the four steps of the augmented reality direct vocabulary instruction based on the cognitive theory of multimedia learning include 1. Introduce the word 2. Introduce the meaning of the word 3. Illustrate the word with examples 4. Check students' understanding.

In conclusion, due to Thai university students' limited vocabulary, problems with traditional instruction, the lack of motivation, and the research gap that uses technology without a clear teaching method, this study aims to 1) examine the effectiveness of the augmented reality direct vocabulary instruction based on the cognitive theory of multimedia learning to enhance vocabulary knowledge of Thai university students and 2) Thai university students' perceptions towards it. It uses a mixed-method approach both quantitative and qualitative method to get more in-depth findings.

## Objectives

1. To investigate the effectiveness of the use of augmented reality direct vocabulary instruction based on cognitive theory of multimedia learning to enhance vocabulary knowledge of Thai university students.

2. To explore the perceptions of Thai university students towards the use of augmented reality direct vocabulary instruction based on cognitive theory of multimedia learning to enhance vocabulary knowledge.

## Research Framework

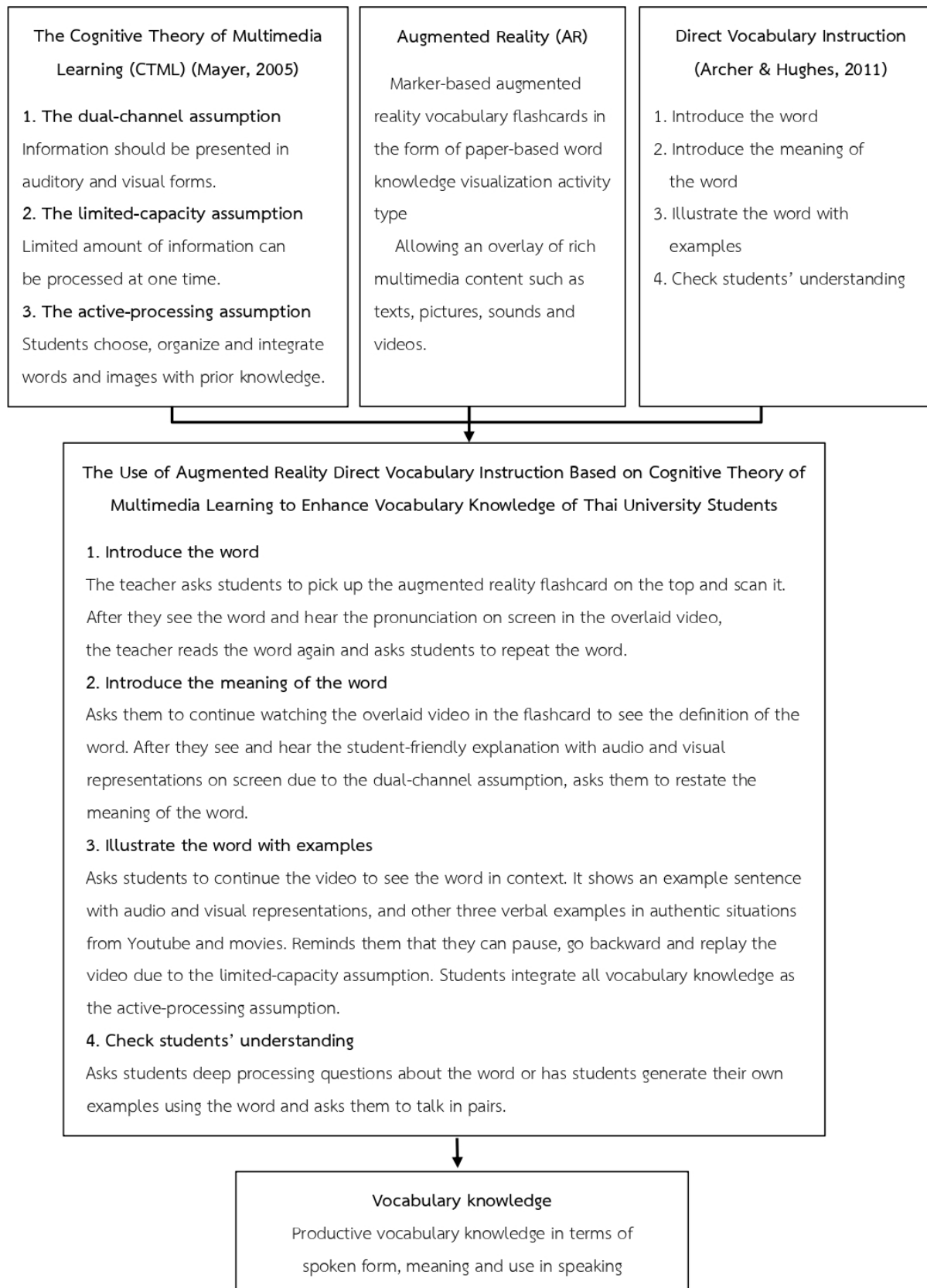


Figure 1 Research framework

## Research Methodology

### 1. Research Design

This study employed a one group quasi-experimental pretest-posttest design.

### 2. Population and Participants

The population of this study was Thai university students at a public university in Bangkok, Thailand. The participants were 20 Thai university students, non-English major students in a conversation course in the first semester of the academic year 2023. It used convenience sampling because the researcher knew their background. They were the second to fourth year students who had passed a prerequisite course in their first year before enrolling in this English elective course. Thus, their English proficiency levels were at B2-C1 CEFR levels.

### 3. Research Instruments

#### 3.1 Pretest-posttest and Rubric

Pretest and posttest in this study shared the same items. It was a productive vocabulary knowledge test to assess vocabulary knowledge in aspects of spoken form, meaning and use in speaking. It was adapted from Meaningful Sentences Test by Sharakhimov and Nurmukhamedov (2021). It contained 20 test items and took 30 minutes in total. The test was done through augmented reality. Students had to scan the test cards from Number 1-20. After scanning, they would see one word along with an associated picture. They had 20 seconds to 'Think' and then 20 seconds to 'Speak' - say a meaningful sentence using the word to describe the picture. The rubric for assessing vocabulary knowledge was also adapted from Sharakhimov and Nurmukhamedov (2021), including three criteria 1) spoken form - the target word is pronounced correctly with the right stressed syllable 2) meaning - students know the correct meaning of the word and express it in context with a detail in picture 3) use - they can choose part of speech of the word correctly and produce the word with appropriate collocations in sentence.

#### 3.2 Perception Questionnaire

The perceptions of the participants were investigated using a close-ended 4-point Likert scale questionnaire to avoid neutral responses. The questionnaire was in English due to the high proficiency level of the participants. It was developed based on three attitude components by Pickens (2005): affective component, cognitive component and behavioral component.

### 3.3 Semi-structured Interview

Semi-structured interview questions were conducted to find more in-depth perceptions towards the instruction. Six students were selected randomly based on their performance after the posttest: two high performance students, two middle performance students and two low performance students. There were six open-ended questions, for example, asking whether and how the instruction helps improve vocabulary knowledge. Students were able to freely express their opinions in Thai or English depending on their preference in order to reduce anxiety and get details about their perceptions.

All research instruments were validated by three experts using the Index of Item-Objective Congruence (IOC), yielding above 0.6 which indicated that they were appropriate for the study. The Pearson Correlation was used to find the reliability between the pretest and posttest, indicating 0.527 which was a distinct positive relationship and reliability.

## 4. Instructional Instruments

Instructional instruments in this study included lesson plans, augmented reality flashcards, slides and vocabulary exercises. The target vocabulary consisted of 40 words in Tier 2 (academic vocabulary) at B2-C2 CEFR levels. A flashcard represented one word. The words chosen were the words which had highest imageability, depending on concreteness ratings according to Brysbaert et al. (2014) to create visual representations of the word. After students scanned the card in the real world, it would show a video on the device screen. There were three parts of the video, focusing on spoken form, meaning and use. After finishing each part, a pause sign would appear to let students pause and do an activity.

All the lesson plans and materials were validated by three experts in the fields of educational technology and English language teaching using Item-Objective Congruence (IOC) and were rated 1 in all aspects, identifying that they were appropriate for the study.

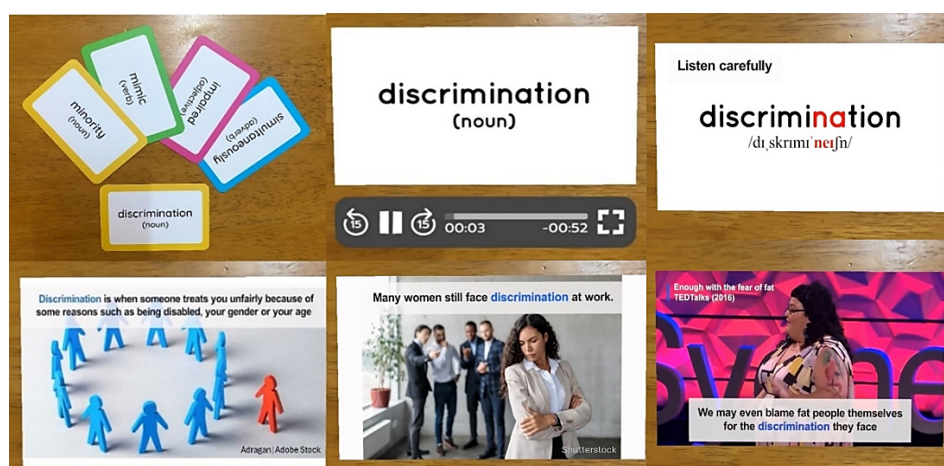


Figure 2 Example of augmented reality flashcards before and after scanning

## 5. Data Collection

This study took 10 weeks. The first week was for orientation of how to use augmented reality flashcards and pretest. After that, the augmented reality direct vocabulary instruction based on cognitive theory of multimedia learning to enhance vocabulary knowledge was conducted for 8 units for 8 weeks which the class met once every week. The time allocation for each lesson was 50 minutes per class. In the final week, the data of posttest, perception questionnaire and semi-structured interview were collected.

## 6. Data Analysis

The scores from pretest and posttest were analyzed quantitatively using the SPSS program to find mean, standard deviation and a paired-sample t-test. The 4-point Likert scale questionnaire data was analyzed by descriptive statistics, including mean, and standard deviation to evaluate the Thai university student's perception. It was interpreted into 4 levels: 1.00-1.49 means Strongly Disagree, 1.50-2.49 means Disagree, 2.50-3.49 means Agree and 3.50-4.00 means Strongly Agree. A thematic analysis was used to examine the information from the semi-structured interview and coded based on the three components: affective component, cognitive component and behavioral component.

## Research Results

**Research question 1:** To what extent will the use of augmented reality direct vocabulary instruction based on cognitive theory of multimedia learning enhance vocabulary knowledge of Thai university students?



Table 1 The results of vocabulary knowledge pretest and posttest

Vocabulary knowledge	<i>N</i>	<i>M</i>	<i>SD</i>	<i>Mean difference</i>	<i>t</i>	<i>Sig.</i>
Pretest (60)	20	36.73	8.35	15.22	9.55*	.001
Posttest (60)	20	51.95	3.73			

\* $p < .05$

The results of paired sample t-test in Table 1 reveal that university students gained a significantly higher vocabulary posttest mean score ( $M = 51.95$ ,  $SD = 3.73$ ) than vocabulary pretest mean score ( $M = 36.73$ ,  $SD = 8.35$ ) at the significance level of 0.001 ( $t = 9.55$ ,  $p < 0.05$ ). The total score was 60. The mean difference of pretest and posttest is 15.22. These results imply that university students' vocabulary knowledge enhanced significantly after learning through the augmented reality direct vocabulary instruction based on cognitive theory of multimedia learning.

**Research question 2:** What are the perceptions of Thai university students towards the use of augmented reality direct vocabulary instruction based on cognitive theory of multimedia learning to enhance vocabulary knowledge?

Their perceptions are reported based on the three components: affective component, cognitive component and behavioral component as follows.

Table 2 The results of perception questionnaire from affective component

Questionnaire items	<i>M</i>	<i>SD</i>	Meaning
1. I enjoy learning vocabulary with Augmented Reality Direct Vocabulary Instruction based on CTML.	3.45	0.51	Agree
2. Augmented Reality Direct Vocabulary Instruction based on CTML creates a good atmosphere.	3.45	0.51	Agree
3. Augmented Reality Direct Vocabulary Instruction based on CTML makes me feel more motivated to learn vocabulary.	3.35	0.59	Agree
<b>Total mean score</b>	<b>3.42</b>	<b>0.54</b>	<b>Agree</b>

The results from table 2 indicate that the participants mostly agreed they liked the instruction with the total mean score of 3.42. According to the results, item 1 and 2 gained the same score while item 3 got a slightly lower score. It means most of them enjoyed learning



vocabulary with the instruction and agreed it created a good atmosphere. In line with the qualitative data, the example excerpts were:

*“It was great, I think it is more fun than finding a vocab in dictionary.”*

*“It was very interesting and also made the learning process unique and enjoyable.”*

*“Good! I never do something like this before, so it’s a good experience.”*

*“I like this learning method, and the cards and AR are also really interesting and well made.”*

The responses suggest that most students thought that the novelty of augmented reality technology made their vocabulary learning more interesting and memorable than traditional methods. Thus, it can be concluded from the questionnaire and interview that most students had positive feelings towards the instruction.

Table 3 The results of perception questionnaire from cognitive component

Questionnaire items	M	SD	Meaning
4. The pronunciation in the video from AR flashcards and the word repeating activity help me pronounce the word correctly.	3.60	0.50	Strongly Agree
5. The student-friendly explanation with multimedia from AR flashcards and the restate meaning activity help me memorize vocabulary definitions more easily.	3.60	0.50	Strongly Agree
6. The example sentences with audio and pictures from AR flashcards help me use the vocabulary in sentence.	3.60	0.50	Strongly Agree
7. The examples in authentic situations from Youtube and movies from AR flashcards help me use the vocabulary in context in real life situations.	3.55	0.51	Strongly Agree
8. Checking understanding activities such as answering deep processing questions help me understand and remember the vocabulary better.	3.60	0.50	Strongly Agree
<b>Total mean score</b>	<b>3.59</b>	<b>0.50</b>	<b>Strongly Agree</b>

The results from table 3 indicate that the participants strongly agreed that the instruction helped improve their vocabulary knowledge with the total mean score of 3.59.

According to the results, almost all items gained the same highest score of 3.60 which can be interpreted that the participants perceived that the steps in the instruction could benefit them equally in terms of pronunciation, memorizing vocabulary definitions more easily, using the vocabulary in sentence, and understanding and remembering the vocabulary better. Although item 7 received the lowest score, its score reflected that they still strongly agreed. Furthermore, qualitative data from the interview also confirmed that they believed the instruction helped improve their vocabulary knowledge. The example excerpts were:

*“It will start the word’s pronunciation then repeat the meaning, and the example that help a lot to improve my vocabulary knowledge.”*

*“It helps me improve my vocabulary knowledge by making me learn the vocabulary step by step, making me need to pay more attention and time to every word, and give examples about how to use it in real life situation.”*

The responses suggest that the steps in the intentional direct vocabulary instruction has an important role in improving their vocabulary knowledge systematically with the affordance of augmented reality. Thus, it can be concluded from the questionnaire and interview that most students thought the instruction helped improve their vocabulary knowledge.

Table 4 The results of perception questionnaire from behavioral component

Questionnaire items	M	SD	Meaning
9. I will keep on learning vocabulary through multimedia based on the instruction in the future.	3.15	0.67	Agree
10. I will apply what I have learned from the instruction to improve my vocabulary knowledge.	3.40	0.50	Agree
<b>Total mean score</b>	<b>3.28</b>	<b>0.59</b>	<b>Agree</b>

The results from table 4 indicate that the participants agreed to keep on learning vocabulary through multimedia based on the instruction and apply what they have learned from the instruction to improve their vocabulary knowledge with the total mean score of 3.28. Some excerpts from the interview were illustrated as follows:

*“I will apply some process, for example, turning on Youtube videos involving the vocabulary to learn its context and pronunciation.”*

*“I’ll find the meaning and a picture of the vocab to help me remember it more easily.”*

The responses suggest that students intended to find various multimedia such as pictures and videos from resources to help them improve their vocabulary knowledge. Thus, it can be concluded from the questionnaire and interview that most students will follow and apply the instruction to improve their vocabulary knowledge.

## Discussion

### 1. The effectiveness of the use of augmented reality direct vocabulary instruction based on cognitive theory of multimedia learning to enhance vocabulary knowledge

According to the results from pre-posttest, it was shown that the use of augmented reality direct vocabulary instruction based on cognitive theory of multimedia learning enhanced vocabulary knowledge significantly in every aspect at  $p = 0.001$ . In the first step: Introduce the word, students were able to listen to the audio’s pronunciation and see the International Phonetic Alphabet (IPA) in augmented reality based on the dual-channel assumption, and then students followed the teaching step to repeat the word. This helps students learn the correct pronunciation through two channels: auditory (sound) and visual forms (text) and actively involve in pronunciation practice, resulting in their development of vocabulary knowledge in spoken form in the posttest. In the second step: Introduce the meaning of the word, both text and pictures of the word along with the narration audio help students remember the definition of the word more easily which is in accordance with many studies that students learn and retain vocabulary better from a combination of verbal words and pictures than from words alone (Lin & Tseng, 2012; Teng, 2023; Yawiloeng, 2020) based on the dual-channel assumption. Also, the meaning of the new vocabulary was introduced to students through student-friendly explanation based on the limited-capacity assumption rather than dictionary’s complex definitions. In the third step: Illustrate the word with examples, students were provided with videos of using the word in context in augmented reality. The overlaid video showed an example sentence with audio and visual representations, and other three authentic situations from Youtube and movies with captions based on the dual-channel assumption. They could replay, go backward or forward with the control bar based on the limited assumption. These facilitate them to learn the word at their

own pace and understand how to use the word better. Followed by the fourth step: Check students' understanding, students had the opportunity to use the word talking with their partners in the discussion activity, allowing them to use the word practically in their real life. This was consistent with Santos et al. (2016) and Faraj (2015) that when students see how vocabulary is used in context, it allows the formation of associations that facilitate later retrieval when students want to use the vocabulary in similar situations.

However, some challenges were observed due to technical problems. The application was sometimes slow and hard to use since it did not process if students held the card incorrectly. This may affect the effectiveness of the instruction because the students would fail to see some content in augmented reality and could not follow the instruction in time. The teacher must be cautious and step in to help them at once.

Moreover, the effectiveness of the instruction was assessed in the context of university students. It may be limited if it is conducted with younger students such as primary and lower secondary students because they need much more assistance with technology and get distracted easily. The steps need to be shorter and more simplified.

## **2. The perceptions of Thai university students towards the use of augmented reality direct vocabulary instruction based on cognitive theory of multimedia learning**

According to the results of the questionnaire and interview, Thai university students had positive perceptions towards the instruction in all components. For affective component, the students had positive feelings towards the instruction as they most enjoyed learning vocabulary with the instruction and agreed that it created a good atmosphere. The novelty of augmented reality technology to magically appear the digital content in the real world made their vocabulary learning more interesting and memorable than traditional methods such as finding a word in dictionary. Some of them even mentioned that they had never done anything like this before. It was in line with many studies that revealed that augmented reality has a positive impact on students' interest, engagement and motivation in comparison to conventional teaching methods (Hung et al., 2017; Kaenchan, 2018; Perry, 2015; Solak & Cakir, 2016; Taskiran, 2019). Yet, it is observed that the augmented reality is likely to lose its attractiveness as time passes. For cognitive component, they considered that the steps in the direct vocabulary instruction with augmented reality multimedia helped them improve their vocabulary knowledge, especially the most in pronouncing correctly, memorizing vocabulary definitions more easily, using the vocabulary in sentence, and understanding and remembering

the vocabulary better. In accordance with Schmitt and Schmitt (2020), direct vocabulary instruction provides effective support for learning and deep processing, which is more likely that the word will be remembered for later use. The instruction makes them focus on each word and deeply understand it through augmented reality's multimedia, so their vocabulary knowledge improves in every aspect. For behavioral component, they ensured that they would like to follow the steps and apply the instruction. For example, they will search for pronunciation, see pictures of the word, and watch examples of the word on Youtube. Also, they will try to use the word to discuss with their friends.

### **Limitations of the study**

1. The sample size is limited since this study aims to enhance vocabulary knowledge in a conversation course whose nature should have a limited number of students. Larger sample size can be explored in further study.
2. A delayed posttest was not conducted in this study due to limited time in class. It would be advantageous to investigate how the instruction promotes long-term retention or use time series designs.

### **Recommendations**

1. This study used a one-group pretest and posttest design. It is recommended that researchers add a control group to compare the results. More rigorous sampling methods can be used instead of convenience sampling to improve the representativeness of the sample.
2. The content in augmented reality can be developed into 3D, and there could be more augmented reality markers to scan to encourage students' interests and increase word multiple exposures.
3. It is interesting for future researchers to conduct a study with low English proficiency level students to see the effectiveness of the instruction and explore different teaching approaches to integrate with augmented reality.
4. The use of augmented reality direct vocabulary instruction based on cognitive theory of multimedia can be adapted for students' self-learning in the future, yet it requires the design of appropriate activities and assessment.

## References

- Archer, A. L., & Hughes, C. A. (2011). *Explicit instruction: Effective and efficient teaching*. New York: Guilford Press.
- Beck, I. L., McKeown, M. G., & Kucan, L. (2013). *Bringing words to life: Robust vocabulary instruction*. New York: Guilford Press.
- Binhomran, K., & Altalhab, S. (2021). The impact of implementing augmented reality to enhance the vocabulary of young EFL learners. *JALT CALL Journal*, 17(1), 23-44.
- Brysbaert, M., Warriner, A.B. & Kuperman, V. (2014). Concreteness ratings for 40 thousand generally known English word lemmas. *Behavior Research*, 46(3), 904-911.
- Fan, M., Antle, A. N., & Warren, J. L. (2020). Augmented reality for early language learning: A systematic review of augmented reality application design, instructional strategies, and evaluation outcomes. *Journal of Educational Computing Research*, 58(6), 1059-1100.
- Faraj, A. K. A. (2015). Effective strategies for turning receptive vocabulary into productive vocabulary in EFL context. *Journal of Education and practice*, 6(27), 10-19.
- Hung, Y. H., Chen, C. H. & Huang, S. W. (2017). Applying augmented reality to enhance learning: a study of different teaching materials. *Journal of Computer Assisted Learning*, 33(3), 252-266.
- Imamee, W. (2016). *Investigating Thai EFL students English vocabulary learning strategies at A Private University* (Master's thesis). Thammasat University, Bangkok.
- Jaiprasong, S., & Pongpairoj, N. (2020). L2 production of English word stress by L1 Thai learners. *LEARN Journal: Language Education and Acquisition Research Network*, 13(2), 142-157.
- Kaenchan, P. (2018). *Examining Thai students experiences of augmented reality technology in a university language education classroom* (Doctoral dissertation). Boston University, Boston.
- Lin, C. C., & Tseng, Y. F. (2012). Videos and animations for vocabulary learning: A study on difficult words. *The Turkish Online Journal of Educational Technology-TOJET*, 11(4), 346-355.
- Mayer, R. E. (2005). Cognitive theory of multimedia learning. In R. E. Mayer (Eds.), *The Cambridge Handbook of Multimedia Learning* (pp. 31-48). Cambridge: Cambridge University Press.

- Palaigeorgiou, G., Politou, F., Tsirika, F., & Kotabasis, G. (2017). FingerDetectives: Affordable augmented interactive miniatures for embodied vocabulary acquisition in second language learning. *European Conference on Games Based Learning* (pp. 523-530). Berkshire, Academic Conferences International Limited.
- Parmaxi, A. & Demetriou, A. (2020). Augmented reality in language learning: A state of the art review of 2014–2019. *Journal of Computer Assisted Learning*, 36(6), 861-875.
- Perry, B. (2015). Gamifying French language learning: A case study examining a quest-based, augmented reality mobile learning-tool. *Procedia-Social and Behavioral Sciences*, 174, 2308-2315.
- Pickens, J. (2005). Attitudes and perceptions. *Organizational behavior in health care*, 4(7), 43-76.
- Ritthirat, N. & Chiramanee, T. (2014). *Problems and obstacles to developing English speaking skill of Thai university students* (Master Thesis). Prince of Songkla University, Songkla.
- Saltan, F., & Arslan, Ö. (2016). The use of augmented reality in formal education: A scoping review. *Eurasia Journal of Mathematics, Science and Technology Education*, 13(2), 503-520.
- Santos, M. E. C., Lübke, A. I. W., Taketomi, T., Yamamoto, G., Rodrigo, M. M. T., Sandor, C., & Kato, H. (2016). Augmented reality as multimedia: the case for situated vocabulary learning. *Research and Practice in Technology Enhanced Learning*, 11, 1-23.
- Sasum, S., & Weeks, B. (2018). Why some Thai students cannot speak English fluently. In *Proceedings of RSU International Research Conference 2018* (pp. 361-367). Pathumthani: Rangsit University.
- Schmitt, N., & Schmitt, D. (2020). *Vocabulary in language teaching*. Cambridge: Cambridge university press.
- Sharakhimov, S., & Nurmukhamedov, U. (2021). Assessing learners' productive vocabulary knowledge: formats and considerations. *English Teaching Forum*, 59(4), 16-25.
- Sinturat, T., Kosashunhanan, K., Iamlaor, A., Khunasathitchai, K., & Teptong, N. (2022). English speaking problems of engineering students: A Case Study of Rajamangala University of Technology Thanyaburi. *Journal of Roi Kaensarn Academi*, 7(5), 1-9.
- Solak, E., & Cakir, R. (2016). Investigating the role of augmented reality technology in the language classroom. *Croatian Journal of Education: Hrvatski časopis za odgoj i obrazovanje*, 18(4), 1067-1085.



- Taskiran, A. (2019). The effect of augmented reality games on English as foreign language motivation. *E-Learning and Digital Media*, 16(2), 122-135.
- Teng, M. F. (2023). The effectiveness of multimedia input on vocabulary learning and retention. *Innovation in Language Learning and Teaching*, 17(3), 738-754.
- Thongchu, S., & Adipat, S. (2022). The development of English vocabulary writing skill by using augmented reality (AR) technology for high vocational certificate students. *Journal of Modern Learning Development*, 7(4), 1-9.
- Tyson, M. (2021). Impact of augmented reality on vocabulary acquisition and retention. *Issues and Trends in Learning Technologies*, 9(1), 3-26.
- Weerasinghe, M., Biener, V., Grubert, J., Quigley, A., Toniolo, A., Pucihar, K. Č., & Kljun, M. (2022). Vocabulary: learning vocabulary in AR supported by keyword visualisations. *IEEE Transactions on Visualization and Computer Graphics*, 28(11), 3748-3758.
- Yawiloeng, R. (2020). Second language vocabulary learning from viewing video in an EFL classroom. *English Language Teaching*, 13(7), 76-87.

## Citation

Hiranrakpattana, P., & Sukavatee, P. (2024). The use of augmented reality direct vocabulary instruction based on cognitive theory of multimedia learning to enhance vocabulary knowledge of Thai university student. *e-Journal of Education Studies, Burapha University*, 6(2), 1-16. Retrieved from <https://so01.tci-thaijo.org/index.php/ejes/article/view/272395>