Ogata, H. et al. (Eds.) (2015). Proceedings of the 23rd International Conference on Computers in Education. China: Asia-Pacific Society for Computers in Education

A Systematic Vocabulary Learning-based Mobile Game Application to Improving English Vocabulary Learning Achievement of University Admission Examination in Thailand

Charoenchai WONGWATKIT[a*], Sorra-at TEKAEW[a], Sirikwan KANJANA[a] & Chonlada KHRUTTHAKA[b]
[a]*Department of Computer and Information Technology, Faculty of Industrial Education and Technology, King Mongkut's University of Technology Thonburi, Thailand*
[b]*Institute for Innovative Learning, Mahidol University, Thailand*
*charoenchai.won@mail.kmutt.ac.th

Abstract: By compared to other subjects of university admission examination in Thailand, English subject scores have been at the lowest level since 2007. With the importance of vocabulary and the benefit of mobile application in learning English, in this study, we developed a mobile game application to improve students' vocabulary learning proficiency. The application was designed based on the effective approach of learning vocabulary called Systematic Vocabulary Learning (SVL) model. We also analyzed selected vocabulary using thematic clustering technique for the most powerful vocabulary to learn in the application. Students learned the vocabulary based on the selected theme, while flashcards were used for encountering, getting, and understanding vocabulary. During the developed game, they consolidated their vocabulary knowledge with a vocabulary-matching task. To investigate the effectiveness of the developed mobile game application, we conducted an experiment on senior high school students. The findings revealed that the students improved their vocabulary learning after experiencing the mobile game application. At the same time, by considering learning improvement of individuals, most of them gained medium size of knowledge. Moreover, the students were highly satisfied with the Systematic Vocabulary Learning approach, while Enjoyment, Motivation and Challenge attitudes were rated highest satisfaction. In other words, this developed mobile game application is helpful for students to improve their English vocabulary learning for higher scores on the examination.

Keywords: Systematic vocabulary learning, mobile game-assisted language learning, educational computer game

1. Introduction

In Thailand, entering public universities has been widely demanding for every senior high-school students. For each year, more than 400 thousand students registered for the university admission examination, known as Admission Tests. This examination includes three national standardized tests: 1) the Ordinary National Educational Test (O-NET) for their mastery of core subjects – Thai Language, Social Studies, English Language, Mathematics, Science, Physical Education, Arts and Technology, 2) the General Aptitude Test (GAT) for their aptitude in general, and 3) the Professional and Academic Aptitude Test (PAT) for their professional performance and aptitude. In these three types of testing, cumulative Grade Point Average (GPAX) of student academic records is required. From National Institute of Educational Testing Service (Public Organization) called NIETS recording in academic year 2007-2013, it showed that the scores of English Language subject were repeatedly lowest among other subjects; especially in 2013, over 75% of O-NET examiners (300,000 students from 414,688 students) got English scores in the range of 0-30 out of 100 (The National Institute of Education Testing Service Public Organization, 2014).

Considering the poor English scores of the national standardized test, typical students consider English, as a Foreign Language (EFL), difficult due to its language, and have fewer

opportunities to use it regularly in everyday life (Prapphal, 2008; Wu, Surasin, & Prammanee, 2014). Owing to its grammar and structure complexity, there are two main reasons that make students failed in English: (1) holding limited numbers of vocabulary, and (2) encountering difficulties in using vocabulary to make the sentence. In addition to the number of vocabulary, more understanding on vocabulary (e.g., synonyms, anonyms, pronunciation, and meaning) is necessarily required for successful English learning and testing (Webb, 2007). Although the students are good on grammar, they might only be able to guess the test answers correctly if they know vocabulary of the context at least 95% (Qian, 2006). Essentially, learning vocabulary in appropriate way was a key success in English (Sun et al., 2011).

To learn vocabulary systematically, Hatch and Brown (1995) developed a Systematic Vocabulary Learning (SVL) model consisting of five steps such as encountering, getting, understanding, consolidating, and using. In 2012, Azar developed a game for learning English vocabulary based on SVL model and found that it not only helped students learn vocabulary better, but also made their learning enjoyable and pleasurable; while, Gromik (2012) and Hwang, Yang, and Wang (2013) revealed that students who learned vocabulary by using mobile devices could learn second language (L2) better. Although, learning vocabulary through mobile game application is an interesting issue for supporting students' vocabulary learning, integrating SVL model with mobile game application has not been studied yet.

To address this shortcoming, we developed a mobile game application basing on the SVL model to support learning English vocabulary for university admission examination in Thailand. English vocabulary from the recent O-NETs and NIETS list were also analyzed by using the thematic clustering technique. During the application based on the selected theme, students were encountering, getting, and understanding vocabulary on flashcards, and enjoyed playing through a vocabulary-matching game for recalling the vocabulary that they have learned. Consequently, an experiment was conducted involving 50 high-school students in an English course to investigate the following research questions:

- Do the students have better vocabulary learning achievement after experiencing the developed mobile game application?
- How is the students' satisfaction level toward the developed mobile game application based on SVL?

2. Literature Review

2.1 Systematic Vocabulary Learning (SVL) Model

Most of non-English speakers or EFL face with the difficulties when learning English. Several researchers studied the strategies of EFL learners and they found that the learners had a variety of the language learning strategies such as watching English TV program, reading English newspapers or magazines and so on (Fan, 2003; Liu, 2011; Wu et al., 2014; Yao & Sakulokoo, 2010). Moreover, learning words or vocabulary has been recognized as a fundamental knowledge to develop second language (L2) proficiency (Sun et al., 2011). Thus, the vocabulary is the most important to learn academic reading and writing.

In 1995, Hatch and Brown developed a Systematic Vocabulary Learning (SVL) model consisting of five phases: (1) encountering, (2) getting, (3) understanding, (4) consolidating, and (5) using. The encountering phase is the first step in which learners have sources of new vocabulary such as books, music, movies, videos, etc. In the getting phase, learners have the opportunity to see or hear the clear image form or sound of new words, because they can remember or recognize words easier. The understanding phase is the third step, which signified the meaning of new words to the learners. The consolidating phase is the fourth step that students consolidate the form-meaning connection in memory, and there are many kinds of activities in this phase such as flashcards, matching exercises, crossword puzzles, etc. The using phase is the fifth step of SVL that designated in which students use the new vocabulary learned to construct or produce in either writing or speech. Therefore, these five phases of SVL model have been recognized as a highly important process in learning vocabulary, and all strategies of vocabulary learning are related to these phases (Fan, 2003; Hatch & Brown, 1995).

In 2012, Azar developed a game for learning English vocabulary based on SVL model and found that it could help students improve their vocabulary learning. Therefore, the systematic vocabulary learning tool should be developed as an alternative language learning strategy to enhance fundamental language learning for ESL learners.

2.2 Mobile Game-assisted Language Learning

With the advancement of technology, it has been recognized as an effective tool in enhancing learning performance. Over the past several years, computers have been used to help students remedy the difficulties of learning (Marty, 1981). With a rapid trend of mobility, the computers have been replaced with new devices with more responses such as mobile phones, smart phones, PDAs, tablets. Learning by using those devices can emerge anywhere and anytime (Hwang, Tsai, & Yang, 2008; Shih, Chu, Hwang, & Kinshuk, 2011).

Mobile-Assisted Language Learning (MALL) was emerged to be an innovative learning method to motivate students to learn languages anytime anywhere (Kukulska-hulme, 2009). In language learning, MALL tends to promote collaborative learning and effectiveness learning (Smith et al., 2013; Wu, Yang, Hwang, & Chu, 2008). Researchers pointed out that MALL with its positive effects on vocabulary learning can improve EFL users to learn L2 (Facer et al., 2004; Gromik, 2012; Hwang et al., 2013; López, Rodríguez-Fórtiz, Rodríguez-Almendros, & Martínez-Segura, 2013; Todd & Tepsuriwong, 2008). However, it has been investigated that some experimental designs could provide just only a few vocabulary items and no students have enough patience to study for long time. Another limitation is that students were taught in passive learning that was quite not different from traditional learning. Moreover, they have less opportunity to choose learning material based on their preference (Cavus & Ibrahim, 2009; Hayati, Jalilifar, & Mashhadi, 2013). Consequently, even the vocabulary integrated with mobile devices are useful, it still lacked of a great vocabulary learning process, like SVL. Therefore, to motivate the students to have better language learning, engaging students should be more concerned on this issue.

Nowadays, games are recognized as an effective learning tool, because educational games are designed to help students learn certain contents, expand ideas, reinforce improvement and assist learning skill when playing. Recent studies have developed educational games and applied into many learning disciplines such as science, mathematics, medical, military, environment (Brox, Fernandez-Luque, & Tøllefsen, 2011; Connolly, Stansfield, & Hainey, 2007; Dobson & Ha, 2008; Luealamai & Panijpan, 2012; Mayo, 2007; Mckenzie et al., 2008; Peng, 2009). Moreover, the games have been embedded into language learning served as an effective learning tool. In 2010, Liu and Chu investigated the influence of English learning achievement and motivation, and the outcomes showed that incorporating games into English learning process could improve learning achievement and motivation better than using non-gaming method (Rosas et al., 2003). In 2011, Chen and Yang revealed that the commercial game, Bone, was helpful in improving students' language skills and learning attitudes. Moreover, the benefits of games could motivate students to learn with happiness and enjoyment during the learning process (Cornillie, Clarebout, & Desmet, 2012; Neville, Shelton, & McInnis, 2009). In 2003, Rosas et al. reported that the nature of game could make the positive effect in several aspects such as learning motivation, learning achievement, and cognitive performance; while in 2013, Hwang et al. showed that their developed concept map-embedded gaming could significantly enhance the students' learning achievement and decrease students' cognitive load. Due to the advantages of mobile-assisted language learning and digital game-based learning, the mobile game assisted learning has been considered to foster language learning.

Although there are several studies on the mobile game-assisted language learning, they might not employ effectively vocabulary learning strategy yet. In other words, the mobile game-assisted language learning based on SVL model is invested very little. Consequently, the development of mobile game-assisted language learning integrated with SVL model might be more powerful on enhancing EFL students to learn L2.

3. Vocabulary Analysis: Thematic Clusters

Prior to the mobile application development, we have first done a vocabulary selection process for most relevant vocabulary. Vocabulary categorization was then carried out based on Thematic Clusters approach for more effective L2 learning (Hippner-Page, 2000; Tinkham, 1997). In other words, clustering vocabulary in themes can help students to learn vocabulary of the second language more fluently. As shown in Figure 1, the vocabulary analysis procedure is depicted as follows:

1. Extracting vocabulary collected from the O-NETs during 2005-2010.
2. Comparing them with the NIETS vocabulary list collected from 15 high-school books published by NIETS.
3. Selecting vocabulary by 2 criterions: (1) appearing in more than 1 O-NETs, and (2) appearing in NIETS vocabulary list. 336 vocabularies in total were selected.
4. Categorizing selected vocabulary into 6 themes by 3 English teachers with at least 10 years teaching experience.

Finally, we have education, technology, society, science, business and crime themes with 47, 52, 50, 52, 66 and 69 vocabularies, respectively.

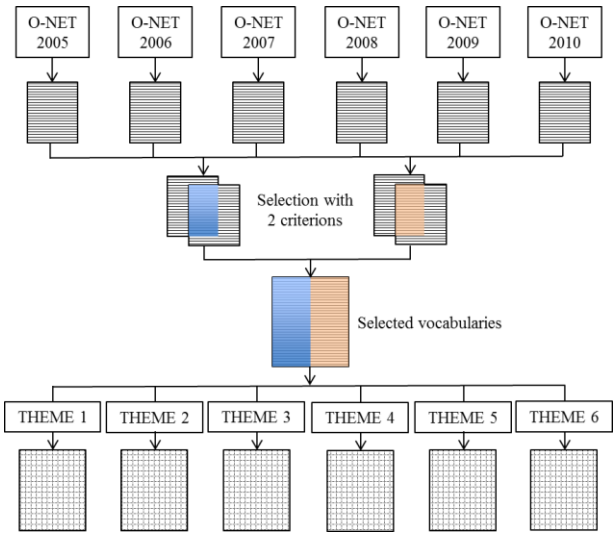


Figure 1. Vocabulary Analysis Procedure

4. The Development of Vocabulary Game-based Mobile Application (VocabSmash)

This game-based application (hereinafter called VocabSmash), was developed with a personal edition of Unity software. This software features rich functionalities for game development and also provides a variety of plugins for making the game more interesting to the users. The goal of VocabSmash is to enable students to learn vocabulary systematically based on SVL model. First 4 steps of the model were employed, as shown *italic* in text. Each theme of vocabulary was designed differently, e.g., icons, background, sound to provide better learning environment to the students; while the learning activity in each theme remained the same. Students will experience the application as follows:

In the first page of the application, as shown in Figure 2 (a), the student starts the game with PLAY button. FACEBOOK LOGIN is available for sharing results when finished learning. The student then selects a theme of vocabulary, as shown in Figure 2 (b). While encountering each vocabulary in the theme randomly on the flashcards—*Encountering*, as shown in Figure 2 (c), the student also gets its phonetic symbol, function, meaning, sample sentence, and synonyms for more understanding of the present vocabulary—*Getting* and *Understanding*. These would also help students relate what he/she is facing with what he/she has known.

Once the student has spent some time on learning vocabulary, it's time to recall what student has learned from the flashcards via a vocabulary-matching game—*Consolidating*, this could help students make a strong memory connection between the form and the meaning of vocabulary (Azar,

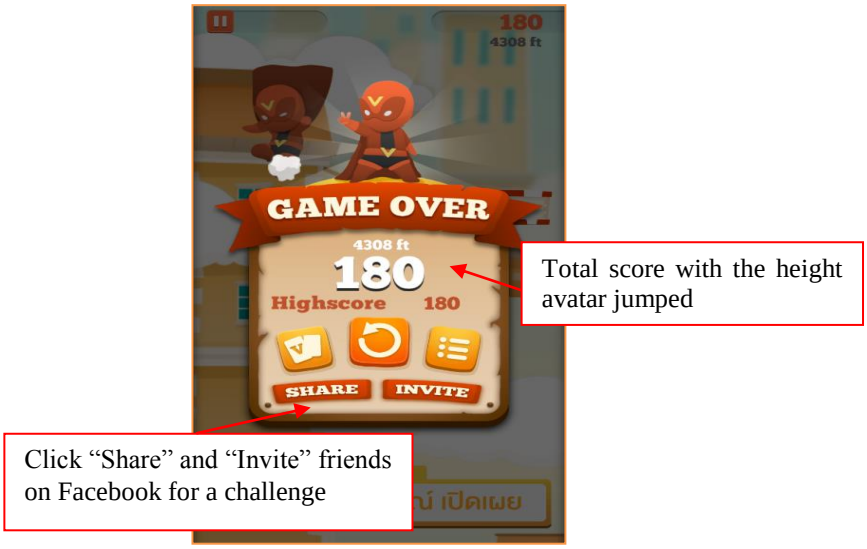
2012). While playing this game, as shown in Figure 2 (d), one vocabulary at a time with its meaning and function is shown. In the meantime, student controls the avatar to jump on the correct vocabulary for scores. Once the right vocabulary is jumped on, the next one is ready to come. If the student selects incorrect vocabulary, the game will provide haptic feedback to the student. The student controls the avatar by tilting the mobile; however, the duration of learning depends on how long the student can keep avatar alive. Note that there are 3 lives for the avatar in total. The game would make them recall what he/she has learned from the flashcards with challenge and enjoyment. After finished the game, the total score is shown accompanying with the high score. If the student logged in Facebook, the student can challenge friends by clicking on SHARE and INVITE buttons, as shown in Figure 2 (e).

(a) Starting Page

(b) Selecting Theme

(c) Vocabulary Flashcard

(d) Matching Vocabulary with the Meaning



(e) Total Score

Figure 2. Illustrative Examples of Screenshots of VocabSmash

5. Experimental Design

To evaluate the effectiveness of VocabSmash for learning vocabulary systematically, an experiment was conducted in an English course involving the 50 high-school students to answer the research questions with the following steps:

1. The students were asked to take the pretest to examine their prior vocabulary knowledge for 10 minutes.
2. The students were asked to select at least one vocabulary theme based on their preferences to study English vocabulary in VocabSmash for 20 minutes.
3. After finishing the game, they were asked to take the parallel posttest for 10 minutes, followed by the satisfaction questionnaire for 10 minutes.

The research tools used in the experiment consisted of pretest, posttest and satisfaction questionnaire. The pretest and the posttest were designed by 3 high-school English teachers who have at least 10 years teaching experience. Each test contained 20 multiple-choice-question items with 1 score per item. The KR-20 showed that the reliability of the pretest and the posttest were 0.87 and 0.82 respectively, indicating that the tests are reliable. In addition, a questionnaire was adapted from Dorji et al. (2015) to measure the satisfaction toward VocabSmash. It consisted of 8 items of 5-point Likert scale in which "5" represents highest satisfaction, and "1" represents lowest satisfaction. The Cronbach's alpha value for the satisfaction questionnaire was 0.88, indicating good reliability in internal consistency.

6. Experimental Results

6.1 English Vocabulary Learning Improvement

To analyze students' English vocabulary learning improvement, descriptive statistics and *t*-test were used. As shown in Table 1, the results show that the students have higher posttest scores than pretest score. To see the difference between both scores, Paired-sample *t*-test was conducted and the result shows that the pretest and posttest scores are significantly different. It implies that the developed mobile game application can help students learn more English vocabulary.

Table 1: Student's pretest and posttest scores.

Tests	N	Average Score	Standard Deviation	*t*	*p*-value
Pretest (20 scores)	50	9.00	3.528	13.13	0.00*
Posttest (20 scores)	50	13.44	3.978		

*$p<0.05$

To further investigate individual student's learning improvement, we used single normalized gain <g> to analyze their pretest and posttest scores progression (Coletta & Phillips, 2005). Considering Figure 3, 16 students have low-size gain (<g> < 0.3), while 22 students have medium-size gain (0.3 <= <g> >= 0.7) and 12 students have high-size gain (<g> > 0.7). It means that the students who experienced the VocabSmash gained different levels of learning gain sizes, mostly in low and medium levels.

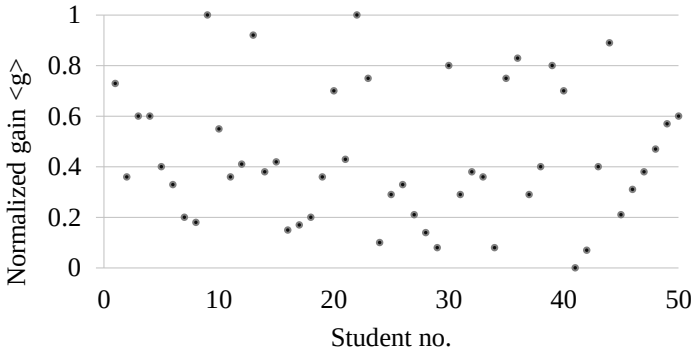


Figure 3. Single Student Normalized Gain

6.2 Satisfactions towards VocabSmash

Table 2 shows the results of students' satisfaction toward the game-based mobile application: VocabSmash. Overall, the students are high satisfied with the application. The students rated highest satisfaction for all items regarding Enjoyment, and Motivation and Challenge. In other words, this game application can encourage them to learn vocabulary with enjoyment throughout the learning activities on mobile. However, the students rated just high satisfaction for all items in Systematic Learning, which was lower satisfaction than others. This could be implied that the students may not feel they are learning vocabulary systematically while enjoying the game.

Table 2: Student's satisfactions towards the developed game-based mobile application.

	Satisfaction	**Mean**	***SD***	**Remark**
Systematic Learning	I think I learn vocabulary systematically.	4.26	0.75	High Satisfaction
	I have to relate what I learned from the flashcard with the game.	4.23	0.46	High Satisfaction
	Learning vocabulary in the systematic way make me learn better.	4.35	0.33	High Satisfaction
Enjoyment	I enjoy learning vocabulary with this mobile game.	4.57	0.28	Highest Satisfaction
	It's fun to recall vocabulary learned while controlling the avatar.	4.72	0.62	Highest Satisfaction
Motivation & Challenge	I want to learn vocabulary in other themes when I finished one.	4.51	0.37	Highest Satisfaction
	I feel I am challenged to learn the vocabulary until finished.	4.66	0.32	Highest Satisfaction
	I have more motivation to learn when my friends challenge me.	4.53	0.66	Highest Satisfaction

7. Conclusions and Discussion

This study aimed to improve English vocabulary learning for senior high-school students in Thailand who are going to take the university admission examination, known as Admission Tests. Among all subjects, English scores have been the lowest level the last 7 years. Studies showed that vocabulary learning is the critical issue to address. With the benefits of mobile application in education, we developed the game-based application called VocabSmash to address the mentioned issue. SVL approach was also adopted into this application to help student to learn systematically in English vocabulary. The English vocabulary installed in the VocabSmash were selected from the recent O-NETs and NIETS vocabulary lists, and analyzed by using the thematic clustering technique. As a result of experimental study, it shows that this mobile game application can help students improve their English vocabulary; while looking at individual students, most of them gained medium size in this learning improvement. Moreover, this application makes them highly satisfied in the Systematic Learning approach, and interestingly Enjoyment, and Motivation and Challenge are rated with highest satisfaction.

With the effective learning outcome, this application seems to be the appropriate approach for the students. However, there are several points to be addressed. First, it should be expanded to cover all 5 steps of SVL for more effectiveness in vocabulary learning since this version did not cover 'Using' step. Second, feedback is needed to guide the students to learn more meaningfully (Jacoby, Heugh, Bax, & Branford-White, 2014; Timmers, Braber-van den Broek, & van den Berg, 2013), while English vocabulary installed should be automatically updated with database queries functionalities. Third, the learning path during the game and the vocabulary list should be adapted based on the individuals' learning situation for better learning performance (Wang & Liao, 2011). Finally, the comparative experimental study between the proposed mobile game application and the other approaches to investigate other parameters should be conducted. It is also challenging enough to porting this mobile game approach to other languages such as Chinese (Selmier & Oh, 2012), and ASEAN languages including Malay, Bahasa Indonesia, Filipino, and Vietnamese (Office of Basic Education Commission, 2011).

References

Azar, A. S. (2012). The effect of games on EFL learners' vocabulary learning strategies. International Journal of Basic and Applied Science, 1(2), 252–256.

Brox, E., Fernandez-Luque, L., & Tøllefsen, T. (2011). Healthy gaming–video game design to promote health. Appl Clin Inf, 2, 128–142.

Cavus, N., & Ibrahim, D. (2009). m-Learning: An experiment in using SMS to support learning new English language words. British Journal of Educational Technology, 40(1), 78–91.

Chen, H. H.-J., & Yang, C. (2011). Investigating the Effects of an Adventure Video Game on Foreign Language Learning. Edutainment, 168–175.

Coletta, V. P., & Phillips, J. A. (2005). Interpreting FCI scores: Normalized gain, preinstruction scores, and scientific reasoning ability. American Journal of Physics, 73(12), 1172–1182.

Connolly, T. M., Stansfield, M., & Hainey, T. (2007). An application of games-based learning within software engineering. British Journal of Educational Technology, 38(3), 416–428.

Cornillie, F., Clarebout, G., & Desmet, P. (2012). Between learning and playing? Exploring learners' perceptions of corrective feedback in an immersive game for English pragmatics. ReCALL, 24(03), 257–278.

Dobson, M. W., & Ha, D. (2008). Exploring interactive stories in an HIV/AIDS learning game: HEALTHSIMNET. Simulation & Gaming, 39(1), 39–63.

Dorji, U., Panjaburee, P., & Srisawasdi, N. (2015). A Learning Cycle Approach to Developing Educational Computer Game for Improving Students' Learning and Awareness in Electric Energy Consumption and Conservation. Educational Technology & Society, 18(1), 91–105.

Facer, K., Joiner, R. W., Stanton, D., Reid, J., 0002, R. H., & Kirk, D. S. (2004). Savannah: mobile gaming and learning? J. Comp. Assisted Learning, 20(6), 399–409.

Fan, M. Y. (2003). Frequency of Use, Perceived Usefulness, and Actual Usefulness of Second Language Vocabulary Strategies: A Study of Hong Kong Learners. The Modern Language Journal, 87(2), 222–241.

Gromik, N. A. (2012). Cell phone video recording feature as a language learning tool: A case study. Computers & Education, 58(1), 223–230.

Hatch, E., & Brown, C. (1995). Vocabulary, Semantics, and Language Education. Cambridge University Press. Retrieved from http://eric.ed.gov/?id=ED396578
Hayati, A., Jalilifar, A., & Mashhadi, A. (2013). Using Short Message Service (SMS) to teach English idioms to EFL students. British Journal of Educational Technology, 44(1), 66–81.
Hippner-Page, T. (2000). Semantic Clustering Versus Thematic Clustering of English Vocabulary Words for Second Language Instruction: Which Method Is More Effective?.
Hwang, G-J., Tsai, C.-C., & Yang, S. J. H. (2008). Criteria, strategies and research issues of context-aware ubiquitous learning. Educational Technology & Society. 11(2), 81-91.
Hwang, G.-J., Yang, L.-H., & Wang, S.-Y. (2013). A concept map-embedded educational computer game for improving students' learning performance in natural science courses. Computers & Education, 69, 121–130.
Jacoby, J., Heugh, S., Bax, C., & Branford-White, C. (2014). Enhancing learning through formative assessment. Innovations in Education and Teaching International, 51(1), 72–83.
Kukulska-hulme, A. (2009). Will mobile learning change language learning? ReCALL, 21(2), 157–165.
Liu, T.-Y., & Chu, Y.-L. (2010). Using ubiquitous games in an English listening and speaking course: Impact on learning outcomes and motivation. Computers & Education, 55(2), 630–643.
Liu, Z.-L. (2011). A study on English vocabulary learning strategies for non-English majors in independent college. Cross-Cultural Communication, 6(4), 152–164.
López, Á. F., Rodríguez-Fórtiz, M. J., Rodríguez-Almendros, M. L., & Martínez-Segura, M. J. (2013). Mobile learning technology based on iOS devices to support students with special education needs. Computers & Education, 61, 77–90.
Luealamai, S., & Panijpan, B. (2012). Learning About the Unit Cell and Crystal Lattice With Computerized Simulations and Games: A Pilot Study. Simulation & Gaming, 43(1), 67–84.
Marty, F. (1981). Reflections on the use of computers in second-language acqusition — I. System, 9(2), 85–98.
Mayo, M. J. (2007). Games for science and engineering education. Communications of the ACM, 50(7), 30–35.
Mckenzie, F. D., Petty, M. D., Kruszewski, P. A., Gaskins, R. C., Nguyen, Q.-A. H., Seevinck, J., & Weisel, E. W. (2008). Integrating crowd-behavior modeling into military simulation using game technology. Simulation & Gaming, 39(1), 10–38.
Office of Basic Education Commission. Ministry of Education. (2011). Guidelines for Knowledge Management into ASEAN Community. Bangkok: Agriculture Cooperative Association of Thailand.
Peng, W. (2009). Design and Evaluation of a Computer Game to Promote a Healthy Diet for Young Adults. Health Communication, 24(2), 115–127.
Prapphal, K. (2008). Issues and trends in language testing and assessment in Thailand. Language Testing, 25(1), 127–143.
Qian, D. D. (2006). Assessing the Roles of Depth and Breadth of Vocabulary Knowledge in Reading Comprehension. Canadian Modern Language Review, 56(2), 282–308.
Rosas, R., Nussbaum, M., Cumsille, P., Marianov, V., Correa, M., Flores, P., et al. (2003). Beyond Nintendo: design and assessment of educational video games for first and second grade students. Computers & Education, 40(1), 71–94.
Selmier, W. T., & Oh, C. H. (2012). International business complexity and the internationalization of languages. Business Horizons, 55(2), 189–200.
Shih, J-L., Chu, H-C., Hwang, G-J., & Kinshuk. (2011). An investigation on attitudes of students and teachers for participating in a context-aware ubiquitous learning activity. British Journal of Educational Technology. 42(3). 373-394.
Smith, G. G., Li, M., Drobisz, J., Park, H.-R., Kim, D., & Smith, S. D. (2013). Play games or study? Computer games in eBooks to learn English vocabulary. Computers & Education, 69, 274–286.
Sun, K.-T., Huang, Y.-M., & Liu, M.-C. (2011). A WordNet-Based Near-Synonyms and Similar-Looking Word Learning System. Educational Technology & Society, 14(1), 121–134.
The National Institute of Education Testing Service Public Organization. (2014). Exam Information: O-NET. Retrieved August 5, 2014, from http://www.niets.or.th/index.php/exam_information/view_en1/1/1
Tinkham, T. (1997). The effects of semantic and thematic clustering on the learning of second language vocabulary. Second Language Research, 13(2), 138–163.
Timmers, C. F., Braber-van den Broek, J., & van den Berg, S. M. (2013). Motivational beliefs, student effort, and feedback behaviour in computer-based formative assessment. Computers & Education, 60(1), 25–31.
Todd, R. W., & Tepsuriwong, S. (2008). Mobile mazes: Investigating a mobile phone game for language learning. CALL-EJ Online, 10(1), 10–1.
Wang, Y. H., & Liao, H. C. (2011). Adaptive learning for ESL based on computation. British Journal of Educational Technology, 42(1), 66–87.
Webb, S. (2007). The Effects of Synonymy on Second-Language Vocabulary Learning. Reading in a Foreign Language, 19(2), 120–136.
Wu, M., Surasin, J., & Prammanee, N. (2014). An analysis of English vocabulary learning strategies used by

senior students in Hainan Lingshui Middle School of China. Hrd Journal, 5(2), 54–61.
Wu, T.-T., Yang, T.-C., Hwang, G.-J., & Chu, H.-C. (2008). Conducting Situated Learning in a Context-Aware Ubiquitous Learning Environment (pp. 82–86). Presented at the WMUTE '08: Proceedings of the Fifth IEEE International Conference on Wireless, Mobile, and Ubiquitous Technology in Education, IEEE Computer Society.
Yao, Y., & Sakulokoo, S. (2010). English vocabulary learning strategy: A case study of english program at Chonkanyanukoon School, Chonburi, Thailand. IJEAP: International Journal of Education in Asia Pacific, 1(1), 79–91.