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Title Page

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An Evaluative Study of a Mobile Application for Middle School Students Struggling with English Vocabulary Learning

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Abstract

This study evaluated the effectiveness of a mobile application (app) designed within the framework of cognitive apprenticeship, in order to facilitate students struggling with learning English as a foreign language (EFL). The participants were ten seventh-graders, who were performing significantly below grade level in their EFL classroom. The research questions targeted changes in learning outcomes with the aid of the app, attitudes the participants had towards the learning experience, and student perceptions regarding the design of the app. Data were collected by interviews, observation, surveys, and exams. The results indicated use of the app enhanced EFL learning. Not only did the app provide a feasible path for the students moving from individual learning to cooperative learning, it also bolstered their confidence in learning, ultimately promoting positive attitudes toward EFL learning. Finally, the design of the app was confirmed as an effective tool for mobile instruction, yet student perceptions of the interface design indicated a need for modification to be more adaptive. The findings confirm the legitimacy of the app's instructional design and may provide evidence-based learning materials to scaffold EFL learning.

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This study evaluated the effectiveness of a mobile application (app) designed within the framework of cognitive apprenticeship, in order to facilitate students struggling with learning English as a foreign language (EFL). The participants were ten seventh-graders, who were performing significantly below grade level in their EFL classroom. The research questions targeted changes in learning outcomes with the aid of the app, attitudes the participants had towards the learning experience, and student perceptions regarding the design of the app. Data were collected by interviews, observation, surveys, and exams. The results indicated use of the app enhanced EFL learning. Not only did the app provide a feasible path for the students moving from individual learning to cooperative learning, it also bolstered their confidence in learning, ultimately promoting positive attitudes toward EFL learning. Finally, the design of the app was confirmed as an effective tool for mobile instruction, yet student perceptions of the interface design indicated a need for modification to be more adaptive. The findings confirm the legitimacy of the app's instructional design and may provide evidence-based learning materials to scaffold EFL learning.

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1. Introduction

Vocabulary is a critical element of language composition and development of language knowledge and skills (Cameron, 2001). According to Cortazzi and Jin (1996), students who study foreign languages acknowledge that vocabulary plays a significant role in foreign language learning. According to Meara and Jones (1987), the amount of vocabulary mastery highly predicts language learning ability. In addition, Laufer (1991) found a significant correlation between vocabulary and reading. Larger amounts of vocabulary mastery positively influences reading comprehension, specifically in understanding the context and connectivity of an article. Developing English vocabulary is essential to improving language proficiency. At present, mobile APP software has become among the tools of choice for English learning (Zhang, Song & Burston, 2011).

The development of hardware technology for mobile devices, like smart phones and tablet computers, enhances the convenience of learning both inside and outside of the classroom. The combination of mobile devices and related software may support individual and cooperative learning in classrooms. Mobile technology affords students the opportunity to learn at anytime and anywhere, enhancing their interest in learning and increasing their motivation to learn. (Cavus & Ibrahim, 2009; Levy & Kennedy, 2005). Mobile technology may also support adaptive learning and promote digital learning in non-classroom areas (Milrad & Spikol, 2007).

With the increasing impact of mobile computer technology on society, the integration of technology in teaching and learning is becoming more prevalent. Mobile assisted language learning (MALL) has been explored within computer-assisted language learning (CALL) research. Several studies have shown that MALL supports language learning (Basoglu & Akdemir, 2010; Cavus & Ibrahim, 2009; Levy & Kennedy, 2005; Song, 2008; Thornton & Houser, 2005). Because MALL offers features such as single-word pronunciation and distinctive language patterns, students are able to learn more vocabulary which look similar to or come from same word categories. MALL may be attractive to low-achieving students with low self-efficacy in learning, because the technology may decrease their anxiety by allowing them to practice the language without having to practice face-to-face with others. Low-achieving students may also enjoy language learning APP games enhancing learning motivation. MALL may enhance peer relationships through the affordances of cooperative learning, and may also be used to support teacher feedback within the framework of cognitive apprenticeship (Sandberg, Maris, & Geus, 2011). This study investigated the integration of mobile technology for English language learning, offering low-achieving students an adaptive and flexible learning situation to improve their attitude toward language learning and their English learning effectiveness.

This study aimed to investigate the effectiveness of MALL on English language learning with under-performing students and explore their attitudes and perceptions related to learning via MALL. The study examined how the students used the APP to promote their vocabulary learning through individual interviews and surveys. Student participant achievements, attitudes, and opinions were analysed to inform digital English vocabulary learning materials for the seventh-graders performing below proficiency. The research questions were as follows:

1. What are the learning outcomes of the junior high school low-achieving students who used the APP to learn English vocabulary?
2. What is the attitude of the students toward MAPP?
3. What are the students' perceptions of MAPP design?

2. Literature review

2.1. Research on low-achieving students

Low-achieving students in English language learning often struggle with literacy and vocabulary retention, which also affects their grammar learning and reading comprehension. Therefore, low-achieving students may improve their English language learning by increasing their English vocabulary and assisting them in understanding the meaning of sentences (McCarthy, 1990; Schmitt, 2010). Teachers often expect that their students will learn the vocabulary after they finish teaching the words. Students often learn vocabulary in an environment where they are not fully exposed to English, which promotes passive memorization. According to Pimsleur's (1967) theory of memory, a student must continue practicing after learning ten new words, or most of the words will be forgotten after a few days. A significant finding from Lai (2016) indicated that regardless of how many vocabulary teaching strategies teachers adopt or vocabulary learning skills students use, a longer period of practice is expected before the students make positive strides in learning outcomes.

Students usually remember vocabulary in a memorized way (Yazdi & Kafipour, 2014; Zarrin & Khan, 2014). Passive teaching methods and boring course content often disengages students in learning (Yip & Kwan, 2006). Oxford and Scarella (1994) found that teachers often teach too many words at one time and neglect to teach English language learning strategies and problem solving skills required of strategic language learners. For example, active learning strategies such as use of word cards with imagery and structured reviewing of vocabulary may promote language learning. Although access to web-based information is ubiquitous, engaging low-achieving students in learning is what junior high school English teachers must work for.

Difficulty in learning vocabulary among the junior high school students is due largely to the lack of an adaptive learning environment. Students' long-term frustration with their low achievement results in the habit of not asking questions or drawing attention to themselves. In order to overcome the deficiencies and improve external environmental factors, MAPP may support a successful learning experience, motivate students to learn, and improve their teachability (Levy & Kennedy, 2005; Song, 2008). This study investigates the design of MAPP games and considers the learning needs and learning environment for English vocabulary learning for low-achieving students.

2.2. Integration of mobile technologies

According to Jacobijn, Sandberg et al., (2011), current trends in mobile learning are divided into two categories: technology performance and informal learning. The improvement of technology performance includes location detection, networking speed, and presentation of multiple media (audios, videos, graphics, and animation). Informal learning means learning outside of school, such as learning within the context of daily life. Mayer (2003) and Sharples (2000) pointed out that mobile learning is closely related to the principle of constructivist authenticity, allowing students to participate in learning activities that are meaningful and related to their life.

Jaeseok (2013) purported that the development of mobile technology has improved language education. The most important advantage is portability and learners can learn anytime and anywhere (Hwang & Tsai, 2011; Kukulska-Hulme & Shield, 2008). Mobile technology-assisted language learning design may personalize individuals' learning processes based on their own learning preferences, and accommodate students' learning needs and learning abilities (Sun & Yang, 2013). In addition, other individualized elements such as keyboards, touch screens, screen size and sound capabilities influence effectiveness of mobile learning (Russell & Cieslik, 2012). Because of these characteristics, Miangah and Nearat (2012) found that mobile technology-assisted language learning can enhance student learning, meet student learning needs, and become a mainstream teaching method.

Mobile technology can effectively improve students' effectiveness of language learning (Sung, Chang, & Yang, 2015). Basoglu and Akdemir (2010) indicated that vocabulary learning through mobile phones is more effective than use of flash cards. Students' use of APP for English vocabulary can effectively improve student learning due to the affordances the technology may offer (Basoglu & Akdemir, 2010; Cavus & Ibrahim, 2009; Thornton & Houser, 2005). First, it can be used anywhere, anytime, and help students develop the habit of using informal time properly. Second, it is portable and allows students to develop and practice daily reading habits. Furthermore, it can improve attitude towards self-disciplined learning and develop self-regulated learning skills. Finally, it may have a positive effect on student vocabulary learning by routinely reviewing the learning content on a daily basis and decreasing student learning anxiety.

According to Pęcherzewska and Knot (2007), the main device of mobile technology-assisted language learning is mobile phones (Agnes Kukulska-Hulme & Lesley Shield, 2008). Studies have shown that using mobile phones in learning English vocabulary is effective. For example, Calic and Neijmann (2010) found that mobile phones can enable students to demonstrate their learning in various ways. Students can use mobile phones for language learning outside the classroom. Using mobile phones may encourage student participation in learning activities and interaction with peers and teachers. The use of mobile phones for learning promote contextual learning and respond to student needs. For example, Thornton and Houser (2005) conducted a comparative study of vocabulary learning using mobile phones, e-mail and textbooks. The results indicated that 333 Japanese students (99%) preferred to using mobile phones to transmit and receive messages. Additionally, the MALL Research Project Report (2009) proposed that mobile phones can effectively improve students' learning confidence, including listening and speaking. In this study, students conducted language conversations through mobile phones. The results showed that the students enjoyed using mobile phones for learning and the privacy and freedom the technology supports. Second, teachers may also identify students' learning preferences and difficulties by analyzing students' interactions with mobile learning. The use of mobile technologies may improve low-achieving students' language acquisition.

In recent years, research of mobile learning has focused mainly on English vocabulary learning (Kabiri & Khatibi, 2013; Levy & Kennedy, 2005). Saran, Seferoglu, and Cagiltay (2012)

compared mobile phones, computer web pages, and paper formats for English vocabulary learning to see which brings about better learning efficiency. The results indicated that students using mobile phones to learn English vocabulary learn more words than through learning via other media. Sandberg et al. (2011) indicated that it is better for students to use smartphones to learn English, because students can take the phone home to continue learning and achieve the “anytime, anywhere” feature. Vocabulary learning not only has a good effect on student learning, but also enhances teacher instructional effectiveness (Chen & Li, 2010; Kim & Kim 2012). Petersen, Sell, and Watts (2011) proposed to use mobile phones to connect with Cloudbank's system to learn English words. This system was able to collect, describe, and share the content related to the students' daily lives and cultures by using English vocabulary, deepening students' motivation for learning. Their results showed that mobile technology learning had a positive effect on learning and teaching. Based on the research, this study adopted mobile learning as the primary medium for language acquisition.

Well-designed games can increase student motivation and persistence in learning. At the same time, it can also indicate students' learning preferences (Mitchell & Saville-Smith, 2004). Schwabe and Göth (2005) designed and analyzed a treasure hunting mobile learning game that provided students with the opportunity to explore and learn by designing directional games. Their research showed that such features like map navigation and “hunting and hiding” triggered student interest in learning. The game-based learning design may enhance learning through its effectiveness in increasing learning motivation and improving the quality of the learning activity (Cagiltay, 2007). Mobile devices may be used anywhere, anytime, and may come with a large screen. Students may learn through the devices in and outside the classroom. This study used APP through mobile devices (including Tablet PCs or smart phones) to promote English vocabulary development and to find out whether it provides substantial merit for low-achieving students' English learning.

Although the aforementioned studies have supported a positive impact of mobile technology-assisted language learning, some studies have shown mixed results. For example, the first program for mobile technology-assisted language learning, the Spanish mobile language learning program, was developed by Stanford Learning Laboratory. They used the audio and e-mail features of mobile technology for language learning. The course content included

vocabulary exercises, words and phrase translations, quizzes and training with teaching assistants. The results showed that the mobile phone technology is valid for vocabulary lessons and quizzes. However, the mobile phone's small screen was not suitable for learning new content, but effective for practice and repetition. Poor quality sound systems may decrease students' understanding of the content of the study (Thornton & Houser, 2005) and inhibit student completion of homework. Stockwell (2008) found that students prefer to use tablets rather than mobile phones for learning. The mobile phone's small screen, narrow keyboard, and limited power storage capacity affects the length of time required for students to complete the work. Garcia (2002) investigated learning in a multimedia online business Spanish for foreigners course using smart phones. The course included video learning, exercises, and vocabulary. The study found that the multimedia aspects of the technology improved learning motivation, but other variables disrupted learning. For example, students had difficulty in typing data. Teachers had to reduce the size of images to accommodate smart phone's small screen. Students encountered problems with links, network connections, Internet chat problems, and slow Internet connections. These difficulties discouraged students' use of mobile phones to learn. Due to these technical difficulties, this study chose to have students use the tablet computer instead of the smart phone as the medium for language learning instruction. Additionally, our study designed the learning vocabulary content so that it closely connected with the students' lives.

2.3. Cognitive apprenticeship

Cognitive apprenticeship (Collins, Brown, & Newman, 1987) emphasizes learning within its social context as well as the critical processes of demonstration, teaching, and support from experts. The framework focuses on cognition and metacognitive aspects of the experts, rather than the traditional apprenticeship emphasis on the development of motor skills. Experts demonstrate and model the task to be learned, and then student apprentices practice the task until they can complete the task without the help of the expert. The cognitive apprenticeship framework includes modelling, coaching, scaffolding, articulation, reflection and exploration (Collins, Brown & Newman, 1989).

Cognitive apprenticeship is based on systematic learning activities and demonstrations by experts, so that learners can experience expert internal thinking processes. At the same time,

learners have the opportunity to actually perform, operate and experience; self-interpret and absorb; and transform and use their knowledge in performing the learning task. In the process of implementation, the experts scaffold and support the learner based on the learner's current understanding and learning needs. The learners share their thinking processes at the same time to learn through the instruction, demonstration, and feedback of the educators. Through such processes, learners are actively assisted in constructing their own knowledge, and developing their ability to apply what they have learned. The metacognitive thinking and problem solving skills may transfer to other learning contexts. Through the APP's cognitive apprenticeship framework, students are engaged in adaptive learning, which helps them to construct their own knowledge and develop corresponding skills (Wu et al., 2012).

3. Method

3.1. Pilot study

A pre-test was conducted to assess the survey, interview questions and the design of the APP. Two low-achieving students were studied. Through observations, the process of using APP to learn, and the difficulties encountered were recorded. In addition, the researchers pre-tested the vocabulary quizzes and the attitude instrument. Based on the results, the interface design, interview questions and the attitude survey were revised. Modelling of how to play the app game was added. Finally, the students needed scaffolding for correct pronunciation; therefore, the Kenyon and Knott (KK) phonetic symbols were added.

3.2. Participants

The research participants were 10 seventh-grade low-achieving students in an urban Catholic boys' middle school in north Taiwan. In this research context, seventh-graders are first-year middle school students who meet greater challenges in English learning, compared to their more playful English learning during their previous elementary schools. As such, seventh-graders were the focus of the study. The ten low-achieving students were selected according to the performance results of the students for the last 35% of the original class. Students, with permission of their parents, all agreed to participate in the study.

3.3. Settings

3.3.1. App design: The selected content of the APP application included lessons of listening, speaking, reading, and writing, based on their textbooks and levelled according to the levels of students. The teacher and English teaching experts selected and levelled the vocabulary to compile the final version. The instructional framework was based on the cognitive apprenticeship model as shown in Table 1:

Insert Table 1 here.

This APP, named "Detective ABC", is a series of mission-oriented puzzle-solving game stories designed with different content levels. Through the stories, players are provided with authentic situations. The main presentation method uses colour pictures with Chinese characteristics and English letters so that students can clearly select the unit of which they want to be challenged, thus increasing their attention. There are 11 learning units, and each unit has 4 vocabularies. Each unit has different story contexts, including emotional units (two), weather units (two), diet units (two), clothing units (one), home units (two), and traffic units (two). Watching the demonstration, the students learn how to operate the APP and know that after the task is completed, they can get clues. The game consists of five levels. The first and the second levels target vocabulary comprehension. Examples include "Choose the correct English words from Chinese characters" and "Choose the correct Chinese characters from English words." The third level targets listening skills, and the fourth emphasizes correct pronunciation. The fifth level features spelling the vocabularies correctly. Completion of the fifth level checkpoint, indicates that the students have successfully passed all of the stages. The content structure of the game is shown in Figure 1.

Insert Figure 1 here.

This study adopted game scenarios to allow the students to understand how to operate the game and use the "get clues" function in the application. Students used the pronunciation function to help pronounce correctly. The games include vocabulary listening, speaking, reading and writing. When students encounter an impassable level in the process of game playing, they can

return to the home page to get clues. This enable the students to understand their learning difficulties, solve difficulties, build their own knowledge structure, and become independent thinkers and problem solvers. The game is designed to improve student application and transfer of the learned concepts to everyday life.

3.3.2. How to download: The APP is designed for the Android system. Users can go to <https://tinyurl.com/ybrt534s> and download the file “NEWDetectiveABC.apk” saved in the Download folder on their cell phone or the tablet.

3.4. Data collection

The research team adopted surveys, interviews, observations and exams to collect data. Students had 40 minutes to use the APP to learn English vocabularies before three tests were implemented. Afterwards, the students completed the English learning attitude scale. The scale was modified from Li's (1999) scale to measure student perceptions (about English functionalities, 8 items), behaviour (about student participation in the classroom when using APPs, 10 items), and feelings (about student psychological emotional states when using APP, 7 items). The scale has four options for selection (strongly agree, agree, disagree, strongly disagree). The higher the total score, the more positive the APP English learning attitude is. The reliability of the questionnaire was .85 at the perceptual level, .91 at the behavioural level, and .79 at the affective level. The reliability of the entire questionnaire was .94. In terms of validity, there was a panel of researchers, technological experts and English teachers who examined the survey contents. Based on their suggestions, the survey items were revised to secure the expert validity.

There were four parts to the self-compiled vocabulary learning tests: first, read Chinese word and circle the correct English word; second, look at the picture to select the correct English word; third, listen to the English and speak Chinese; and fourth, listen to Chinese and speak English. After studying the unit content of the APP, each student selected and ticked the correct vocabulary in the test paper which they recognized. Based on the selection of the vocabulary, the researchers had the students experience the most unfamiliar learning units and measure their learning results. The difficulty level of the two unit quizzes were the same and the dates

of the quizzes were one-day apart. The content of the quizzes consisted of four parts: reading Chinese characters and circling the correct English words (4 questions), circling the correct English words according to pictures (3 questions), listening (3 questions) and speaking (4 questions). Owing to the students' low language levels, the study adaptively presented the students' pre-writing performance through their reading Chinese and circling the correct English words and presented their reading performance through their reading Chinese and circling the correct pictures.

After two formal tests, the research team conducted individual interviews with the ten students to understand their attitudes towards using APP to learn vocabulary and their perceptions of APP design. This study adopted semi-structured interviews and made further inquiries based on the students' opinions. Each student was interviewed for approximately 30-40 minutes. The interview outline consisted of three parts: the English learning experience, the perceptions of the APP interface, and the content. The outline of the interview was reviewed by teaching technology experts and the teacher. Through interviews, student attitudes and perceptions were examined, and the usability of APP design was examined. Finally, the researchers examined student use of the APP mainly through observations to understand the difficulties encountered, which would further inform the student attitude and perceptions of the APP.

3.5. Data analysis

The data were collected by means of qualitative methods as the main method, and quantified as an auxiliary method. The data from interviews, observations, and student feedback were summarized and coded. Three ways to process and analyse qualitative data were adopted—description, analysis, and interpretation (Wolcott, 1994). The first step of the description was as follows. The researchers transcribed the interview recordings into verbatim scripts and recorded the important information in details. Followed by the steps, well-written scripts were written and coded so that the data became systematic. Then the research team read the data to find the contextual meaning of the text. During the reading process, keywords and important messages were marked. The research team verified and strengthened the reliability and validity of the data, and then classified the data according to different topics. Finally, the purpose of interpretation was to confirm the meaning of the data. The researchers used observation sheets, notes, and abstracts from interviews as supplemental content. They summarized and concluded

the significance of the data. To avoid making inappropriate interpretations, this study conducted cross-examinations through multiple data collections to establish the credibility and validity of the research.

4. Results and discussion

4.1. Learning outcome

Student interviews and vocabulary test scores defined student learning outcomes. Overall, student vocabulary tests scores improved. Namely, the APP helped the students listen, read and write English vocabulary, but had less effect on speaking. The test details are shown in Table 2.

Insert Table 2 here.

As shown in Table 2, students were able to correctly select English words when they read Chinese characters. Through interviews, students indicated that using the APP to learn English improved their spelling skills. The first reason was the training of learning strategies, the second was providing training opportunities, and the third was the easy and pleasant features that helped students memorize English words. However, S4 reported that using APP to learn English had little effect on spelling improvement. He said he required more time to improve his spelling on his own. S4 explained in the interview that he did not use the learning strategies to learn words and did not use K.K. phonetic symbols. As a result, the students may only memorize words in short term and not enter long-term memory, so the learning effect may not be high. Furthermore, most students emphasized that the K.K. phonetic function in the APP helped them remember the English words.

The APP pronunciation function allowed students to first read the word first and then hear the syllables to remember it, scaffolding their pronunciation and moving the words into long-term memory. Students said that the APP provided repeated practice, and playing the APP several times helped them to memorize English words, and reducing their pressure and anxiety. This is consistent with the empirical characteristics suggested by Thornton and Houser (2005), Basoglu and Akdemir (2010), Song (2008), Cavus and Ibrahim (2009), Levy and Kennedy

(2005), and Russell and Cieslik (2012). The mobile application allowed the students to practice English in accordance with their own learning progress and time outside of the classroom.

As shown in Table 2, the students circled the correct English words without any problem. In the first level, images were presented to the students, and the students selected the corresponding words. In the second level, the students had to match images with the English words. This allowed repeated practice and in an enjoyable way. For example, S2 commented, "I think it is helpful. I feel that the APP is letting me practice. I can immediately know the meaning of the words when I take the exam." This indicates that the multimedia characteristics of the APP can help students read and understand the content.

In general, the students had little learning difficulties in listening. The pronunciation feature of image matching helped them practice listening. They reported that the pronunciation function made them more familiar with the words and remember the vocabulary. Students suggested that the "get the clue" function be modified by having the APP spell the English words letter-by-letter after the APP pronounces the words, so that they can practice listening while memorizing the words. Through repeated practice, the students became more familiar with the words and developed their listening competency. However, S4 suggested that after each word is played, the word be spelled letter-by-letter again in order to connect the pronunciation of the word with the letters.

Students stated that developing their speaking ability in the APP was the weakest part, and the listening scores of the second quiz were lower. The teacher did not have the students orally practice in regular instruction. The students were less likely to speak English, unless they read English words in class. Most students commented that the APP provided many opportunities to speak English and to compete with peers, which motivated them more to learn. For example, S9 said, "Even if you're wrong, you can speak it again until you get right." As Milad and Spikol (2007) indicate, through peer-to-peer cooperation in learning process, students who are both inward and outward can learn English vocabulary. The technology-integrated materials, peer competition and constant access to learning resources enhanced student motivation to learn, review, and speak.

Based on the findings, it is confirmed that the APP impacted student learning outcomes. In general, the students not only made higher scores on vocabulary tests, but also improved spelling, reading, listening comprehension, and acquired opportunity for oral practice. The APP provided opportunities for repeated practice, and the function of pronunciation learning strategies enabled the students to learn English in a relaxed and pleasant atmosphere. Regarding spelling, the pronunciation function helped them in spelling through repeated practice. Regarding reading, the levelled content helped improve reading competency. Regarding listening, the pronunciation function improved listening through repeated practice, such as the “get clues” page. Regarding speaking, the APP provided the students with the opportunity to practice speaking and correct pronunciation. The above results echoed Thornton and Houser’s (2005) and Calic and Neijmann’s (2010) studies that indicated that mobile technologies support English vocabulary learning and effectively improved student learning outcomes.

4.2. Attitudes of learning English vocabulary through the APP

According to the results of the attitude scale, as shown in Table 3, students’ attitudes toward the APP were generally above the mean level, showing that students had a positive attitude toward using APP for English learning. At the perceptual level, it showed that most students held the most positive perceptions ($M=3.3$, $SD=0.63$), which were significantly higher than the behavioural level ($M=2.78$, $SD=0.72$) and affective level ($M=2.77$, $SD=0.68$) ($p<.05$). The students reported that learning English was helpful to their lives and that learning English is important. On the behavioural level, the students indicated that they will use the APP to learn English vocabulary. On the affective level, students reported positive feelings that learning English with APP was easy and comfortable. This result validates the studies of Thornton and Houser’s (2005) and Calic and Neijmann’s (2010), which showed that the APP can improve students’ interest in learning and provide students’ learning opportunities. With the integration of the mobile technology, the students were more willing to participate in learning activities and were willing to participate in peer studies with others and interact with the teacher.

Further qualitative data analyses confirmed that at the perceptual level, students think that English is important. However, S2 and S5 indicated that they would not necessarily use English

in the future. S2 said, "I don't think it is necessary to use English when working in future, depending on what the work is." And S5 said, "If you do not know English, you can still communicate with others in Chinese, and I prefer to learn French rather than English." Additionally, students reported that even if they learn English at an earlier age, they may not be able to speak English well. As S10 stated, "I feel that learning English earlier is not necessarily better, because it depends on how we learn it. Like I started learning English when I was a child, but I didn't learn English well. I think English is very hard, even studying hard still does not work well." This result validates the studies of Ou's (1997), Oxford et al.'s (1993), and Thompson & Rubin's (1993). Their studies showed that using a suitable vocabulary learning strategy can comprehensively improve students' listening, speaking, reading and writing skills and achievements. Obviously, learners know the importance of English, but do not know how to learn it. To successfully learn a single word, learners must have vocabulary learning strategies.

On the behavioural level, the students reported that the APP increased the content in game learning. As S1 stated, "In addition to words, the APP can also add grammar and sentences, as well as present English which can be translated to Chinese or Chinese to English." Students indicated that they would use APP to learn English, but if they wanted to strengthen their oral communicative skills, the APP would require modification. For example, in the fourth level of the APP, the problem of the GOOGLE identification system and the ways in which the game is played was confusing. S5 said that when they attend English classes, teachers would provide opportunities for students to demonstrate their learning. Students who are willing to demonstrate how to read English vocabulary would be rewarded. This reward function is not seen in the APP. S5's personality is lively and outgoing, and he likes to interact with peers. When using the APP to learn, if peers do not understand, S5 would demonstrate. As such, to meet different students' learning needs, providing multiple mobile learning activities through integrating individual and collaborative and indoor and outdoor, would be essential (Chang, Shen, & Chan, 2003).

On the affective level, most students had a positive attitude and reported that learning English with the APP was more interesting and provided a sense of cooperation, compared to learning through their English textbook. These findings are supported by other studies. For example,

Ciampa (2013), Zheng, Chen, and Kong (2017) also found that students tended to have positive perceptions and attitudes toward language learning activities that incorporated mobile technologies. On the other hand, S5 mentioned that he felt interested when he first used APP to learn English, but quickly felt bored after completing the five levels of activities. S5 said, "It was fun to start with the APP game, but then it became boring to play again because it was already played. It would be fun to play different games each time, or just play for 15 minutes." This implies that the novelty is very important to learners, and teachers must grasp the short teachable time to teach well. After all, when the game novelty fades away, the low-achieving student may return to disengagement with learning.

Insert Table 3 here.

4.3. Students' Perceptions on APP Design

4.3.1. Students' perceptions on the APP interface

4.3.1.1. Screen and operation modes

The students believed that the overall picture, character, and graphic colour of the screens were in general, appropriate and clear, except the main page was monotonous. For example, S1 said, "If the pattern or colour can be a little richer, it would be better." Some students did not understand the English word 'Detective' in the game, and they wanted more scaffolding options, such as explaining the meaning of the word "Detective." For the buttons in each screen, some students thought that the buttons should be animated and have sound effects to draw their attention. As S5 said, "The main page is fine, but you can also add some animations, and they should have provided Chinese pronunciation below." S2 expressed that the way in which the APP games were demonstrated should include a dividing line between each level, and clearly indicate a downward direction to inform the student that a demonstration was below. In addition, some students mentioned the game demonstration function should follow the style of the main page and inform users as to the function of the game demonstration. For the "get clues" section, students mentioned the APP helped them recite the vocabulary, because the pronunciation function could prompt clues. For example, S4 commented that the pronunciation function can help the student read the pronunciation of the English word first and then read the spelling so as to practice listening while reciting the English word.

Regarding the interface of the first three levels, most students said that the contents of the levels were easier, and there were not many problems. They suggested that the second level should include a pronunciation function to help them remember the words. Some students stated that the order of topics from the first level to the third level should be changed. Regarding the fourth level, the students said that the overall screen, characters, and graphics were clear, but within the learning process (embedded with the GOOGLE identification system), students' learning difficulties became greater. The students considered that it would be more appropriate to have their teacher listen to their pronunciation, because the GOOGLE identification system was so strict that the students tended not to pass their pronunciation and felt helpless. Regarding the fifth level, most students were fine with the interface design. However, there was some minor issue for attention. For example, S4 reported, "The screen of the fifth level is a bit empty. You could add countdown time there because it is more exciting to play with. You could also compete with your classmates to see who is passing through the level faster." In conjunction with individual student's learning features, a timer could be added to the space below the fifth screen to allow students to see the completion time and allow them to compare with their peers' time and stimulate their interest in learning. These findings support the studies of Chinnery (2006), Kukulska-Hulme (2009), and Miangah and Nearat (2012), emphasizing that the design of the app must take into account the limitations of its own characteristics, regarding whether the content of the course meets the learning needs of students, and whether the app is easy to use.

4.3.1.2. Sound Effects

Sound effects included the sound of the keys, the sound of the lights-on when questions were answered correctly, the clap sound when a task or mission was completed at each level, and the sound of the pronunciation function. Students did not have an opinion on the sound of the keys. Only S2 said, "The sound of the key is OK, but sometimes the sound will not come out, or I do not know if I need to pull down the key to hear it." In terms of the lights-on sound, the students considered that the sound lasted too long and was too loud, and sometimes obscured the sound of the next question. Some students suggested that when the answer is correct, the voice could use laughter or show a smiley face. When the answer is wrong, the voice could use a crying sound or be presented with a crying face. For the clapping sound to reward mission

(task) completion, some students said it could be shortened to avoid affecting performance in the next level. S4 believed that special sounds could be added to improve students' sense of accomplishment when the final level is completed. As he suggested, "The last level can use a more special sound, such as the Phantom of the Opera." Then, a few students commented that the clapping sound for rewarding correct answers was not pleasant for them, because "it's a little fake." For the pronunciation function, the original arrangement was set as a single word read twice; each word was repeated with 3 seconds intervals. The students' opinions for the arrangement were summarized as follows. If each word is pronounced twice, the system should have set the students to listen to each word twice. If the students do not listen twice, they should not hear the pronunciation when pressing another word to avoid confusion. Second, the interval between two words should be shortened to avoid overlapping with the pronunciation of the next word. As S1 responded, "I've got it right after listening to the question, but it would pronounce the same word again after it has been answered correctly, and this confused me about which question I am doing." In addition, some students mentioned the operational problems—the tablet quality needed improvement.

4.3.1.3. Background music

In general, students thought that the APP games were more interesting if they have background music. The music helps attract their attention. Some students said background music should be at every level. "Each level has background music to make users feel comfortable." However, some students reported no preference for background music in the APP. For example, S5 further mentioned that when playing games, he usually listens to Youtube music. In addition, the student thought that the music should depend on the content level. If there are many word pronunciations in the level, no background music is necessary, because the background music may disrupt the word pronunciation. Finally, some students considered the background music as too soft and this did not affect their motivation to answer questions. Future studies are need to further investigate learner preferences.

4.3.2. How the game is played

In general, the students thought that the APP was more fun and easier than learning English in classrooms. The students pointed out that the rewarding scores (represented with health points

in the study) should be categorized into groups representing different meanings, in order to increase the challenge of the games. As S1 said, "Even if you don't have any health points, you still can continue to play the game, so you don't understand the purpose of the health points is in the game." At the same time, some students suggested that the way the game is played could be more complex and challenging. Another student S4 stated that another APP feature to be added could be to allow users to interact with their peers and their teacher, and immediately receive feedback if they encountered problems. In the interview process, students mentioned that game descriptions should be added to the game demos so that they could better understand the content structure of the game stories. Moreover, providing a multi-channel learning path to meet the different learning needs of diverse students would be helpful.

4.3.3. Students' perception of the APP instructional framework (cognitive apprenticeship)

This study used the six steps of cognitive apprenticeship (modelling, coaching, scaffolding, articulation, reflection, exploration) for the students to learn vocabulary. The topics of the vocabulary were authentic to facilitate application to real life situations. Regarding the students' perception of the APP instructional framework, more details are as follows. In the *modelling* process, most students stated that the function of pronunciation demonstrated how to read the words. They also used K.K. phonetic symbols and underlined words to help them recite words. A few students suggested that spelling be added in the pronunciation function to help them more effectively memorize the word. Another student said that the number of words could be increased, "It can teach me to remember a word, but I think the APP can increase to five words for each level; four words for each level are too few." The pronunciation function played the *coaching* role in each level. The students all agreed that the function effectively instructed them to spell out the correct words and read the words. "It can teach me to remember the words or read the words." Regarding providing *scaffolding* for the students to learn the vocabulary sets successfully, teaching the students strategies to pronounce the words (especially the K.K. phonetic symbols) were appreciated. The fourth level (oral tests) played the *articulation* role by providing the students with the opportunities to speak in the games. In regular classrooms, the students usually had no or little chance to speak English. Through the fourth level, they could practice English. "The exams are less likely to test speaking unless the teacher teaches how to read the text during class. The oral exercises in the game could help me practice speaking English." The APP embedded the "get clue" *reflection* feature to have the students conduct repeated practice if they failed the exams, providing the students with opportunities to

review and reflect on the errors they made. The students agreed that *reflection* helped them become more familiar with the words and remember them better. In terms of *exploration*, the students were allowed to explore in more than one learning unit to gain different levels of challenges, which all students liked. They thought they could learn more English vocabulary and become more familiar with it. On the other hand, some students suggested that the APP include more learning units which could be used in everyday life. Some students suggested each unit contain fewer words, instead of the current four words in each. How to chunk learning materials to meet the individual needs would need future study to explore. For cognitive apprenticeship, the students held a positive attitude and said that the APP could help them understand their own learning difficulties and improve their learning strategies. These findings confirm the studies of Thornton and Houser (2005) and Calic and Neijmann (2010) that cognitive apprenticeship provides a wholesome learning environment for learners to participate.

The study has some limitations and recommendations for future research. First, the research participants were ten low-achieving seventh-grade male students from a private Catholic junior high school, and the APP made the positive effect, especially in the aspect of cognition. Then, it is unknown whether the APP can trigger the learning motivations and interests of the low-grade students. As such, the findings cannot be generalized, and a good follow-up study would be to determine if the APP would have similar effects on normal-achieving students, especially in the aspects of learning motivations and interests. The contents of the study were based on the teaching materials adopted by their school teacher. Instead of only studying vocabulary, future research may include extended sentences, paragraphs, and even articles to enrich the comprehension of APP research in foreign language learning. Due to practical considerations, the number of times of the test and the interview time were limited. Future research may increase the number of tests and prolong the interview time, or use experimental research methods to compare the differences in learning results. Considering the students' language levels and learning difficulties, this study had the students read Chinese and circle the correct English words as their writing performance. Their reading performance was assessed through their reading Chinese and circling the correct pictures. Future research designs need more assessment approaches to evaluate student performance. The attitude scale used in this study was based on the questionnaire of Li (1999) and was revised according to the needs of the study. The method of data collection was based on qualitative and quantified methods without

analyzing the individual students. It is suggested that individual differences can be further elaborated in future study.

Teachers often ignore low-achieving students' learning pace for the purpose of teaching progress and coping with the exam. For low-achieving students, although teachers teach well, students may not be able to fully absorb the entire course content, but students have at least the basis for learning. Therefore, teachers should think about teaching students how to learn, that is, providing students with specific strategies for learning English. In the teaching process, teachers teach students learning strategies and methods. Students should acquire learning strategies and methods that suit them, so that they can achieve better results. Hopefully, future research will amend the APP vocabulary study to stimulate more ideas based on their own teaching practice so that they can better meet the learning needs of low-achieving students.

5. Conclusion

This study sought to understand how low-achieving seventh-grade junior high school students used APP to learn English vocabulary. Cognitive apprenticeship was the basis for the APP design. The study analyzed the students' learning outcomes in APP, explored students' attitudes towards the use of APP to learn English vocabulary as well as their perceptions on APP design. The study confirmed that the overall score of most students in the vocabulary tests increased. APP can help students learn the spelling of English vocabulary. Students can use the pronunciation function in APP to help them remember the words. They can use K.K. phonetic symbols or natural sounding methods to learn English vocabulary without just memorizing. The students were able to read English vocabulary correctly in the process of repeated practice in each unit, and the pronunciation function of each level enabled the students to have opportunities to listen and learn. Although the APP has limited effectiveness in developing oral competency, it allowed the students to acquire speaking opportunities and use pronunciation functions to allow the students to pronounce correctly. Students held a positive attitude and perspective on what they were learning and how the APP was designed. APP learning creates a relaxed and enjoyable environment where students can learn anytime, anywhere. Effective language teaching requires adaptability, scaffolding, and contextualization. When large-class teaching cannot achieve its goals, teachers must consider integrating science and technology into language learning. Effective mobile technology applications which are based on sound

instructional design can help low-achieving students who are often marginalized in the classroom. The affordances of the mobile technology may encourage them to regain a sense of accomplishment in learning.

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Table 1: The cognitive apprenticeship model with corresponding instructional activities.

Table 2: Student vocabulary test results.

Table 3: Attitude scale results.

Figure 1: APP design.

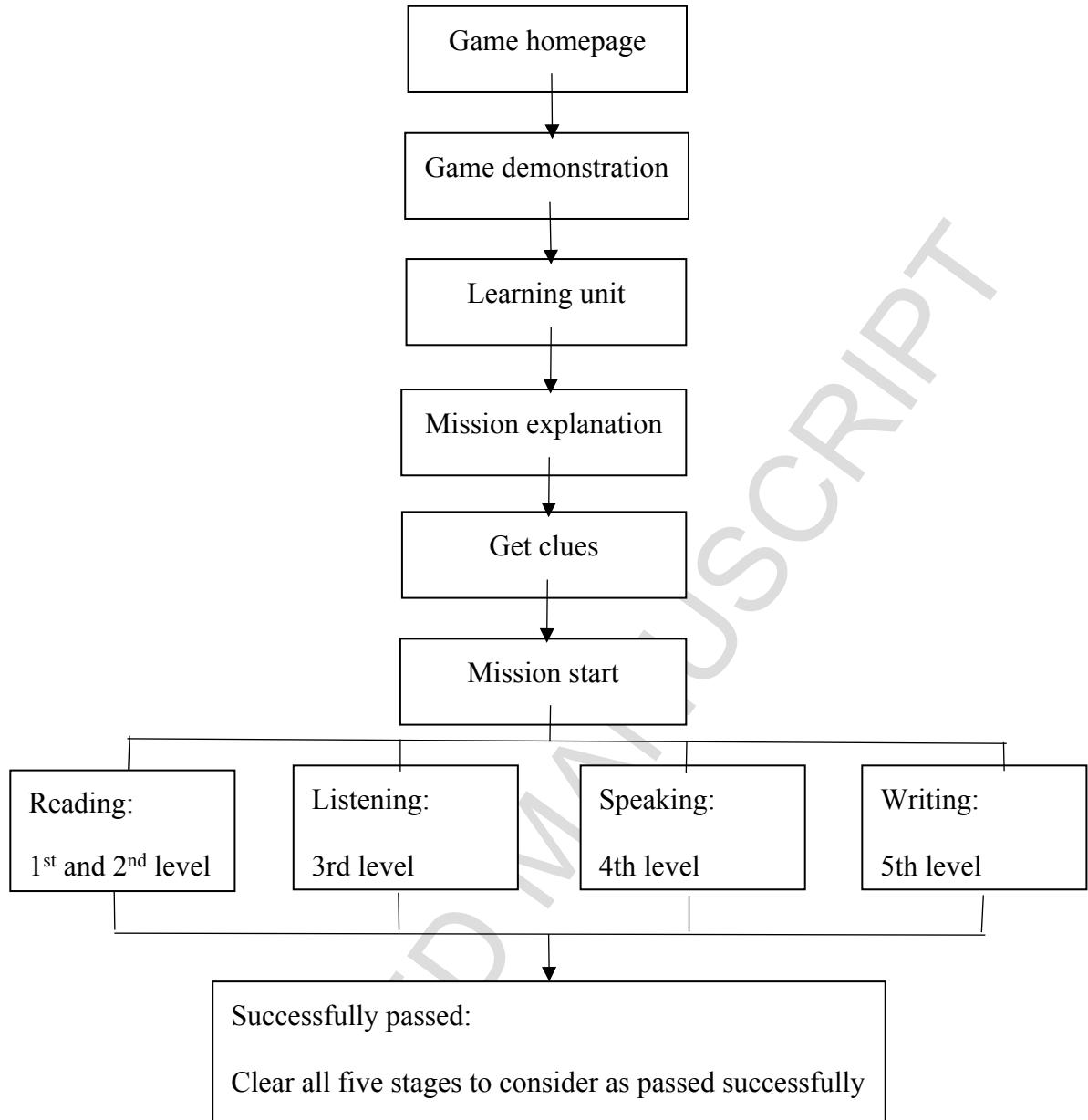


Figure 1: APP design

Highlights

- The app successfully facilitated learning.
- The app provided a feasible path for individual and cooperative learning
- The app enhanced students' confidence in learning.
- The app promoted students' positive attitudes.
- The app design effectively supported mobile instruction.

Table 1: The cognitive apprenticeship model with corresponding instructional activities

Cognitive apprenticeship model	The corresponding design of this study
Modelling	Demonstrate the student unit vocabulary via the "Get clues" function in the application. There are four single words in each unit, and each single word has the function of pronunciation as demonstration.
Coaching	Students use the pronunciation and guidance function to help them pass the game challenges, pronounce or spell correctly.
Scaffolding	The game consists of four levels regarding listening, speaking, reading and writing of vocabulary. The content starts from easy tasks and ends at the most difficult ones. The vocabulary unit is presented with the form of natural pronunciation and K.K. phonetic symbols so that students can self-learn to pronounce and spell single words.
Articulation	Regarding speaking, students can interact with the APP and the APP system assesses students immediately.
Reflection	When students encounter an impassable level in the process of playing a game, they can return to the home page of the game to get clues. This will encourage students to reflect on their learning difficulties.
Exploration	After students complete the task unit, they can challenge other units and use their tests to see if they understand the learned vocabulary.

Table 2: Student vocabulary test results

		Learning Unit	Reading	Writing	Listening	Speaking	Total
S1	1 st	Home	4	3	3	4	14
	2 nd		4	3	3	3	13
S2	1 st	Traffic	4	3	3	1	11
	2 nd		4	3	3	4	14
S3	1 st	Food	4	3	3	4	14
	2 nd		4	3	3	4	14
S4	1 st	Traffic	4	3	3	2	12
	2 nd		3	3	3	3	12
S5	1 st	Weather	4	3	3	3	13
	2 nd		4	3	3	4	14
S6	1 st	Food	4	3	3	4	14
	2 nd		4	3	3	4	14
S7	1 st	Traffic	4	3	3	4	14
	2 nd		4	3	3	4	14
S8	1 st	Clothes	4	3	3	2	12
	2 nd		4	3	3	3	13
S9	1 st	Emotion	4	3	3	1	11
	2 nd		4	3	3	2	12
S10	1 st	Emotion	4	3	3	3	13
	2 nd		4	3	3	2	12

Note: The full point of each individual item was 4.

Table 3: Attitude scale results

No.	Topic	Mean	Standard Deviation
	Perceptual (English functional)	3.33	.63
1.	I think the sooner you learn English, the better.	3.3	.64
2.	For my future work, I need to learn English.	3.4	.49
3.	I think English is important.	3.5	.5
4.	I think English is very useful.	3.4	.49
5.	When I grow up, I have to use English in many ways.	3.2	.87
6.	English has nothing to do with my future life.	3	.6
7.	Learning English did not help increase knowledge.	3.3	.46
8.	Learning English helps to understand foreign things.	3.5	.67
	Behavioural (class participation)	2.78	.72
9.	I use APP to learn English.	3	.63
10.	I continue to learn English with APP.	3	.63
11.	I use the APP to do English homework.	2.8	.6
12.	I have a high interest in learning English with APP.	2.7	.9
13.	I listen to English songs in the APP.	3.3	.64
14.	I often take APP English lessons.	2.7	.64
15.	I demonstrate or perform in the APP English class.	2.6	.8
16.	My classmates and I used the vocabulary learned in the APP to speak English.	2.5	.5
17.	When using the APP during English lesson, I answered the teacher's question.	2.4	.66
18.	I am not afraid of learning English with APP.	2.8	.6
	Affection (psychological emotional state)	2.77	.68
19.	I admire conversations with others in fluent English.	3	.77
20.	Using APP in English class made me happy.	2.5	.5
21.	Using APP in English class made me feel very comfortable.	2.8	.6
22.	I think it's easy to go to the APP English class.	2.7	.64
23.	I think it's boring to go to the APP English class.	2.6	.49

24.	I was very nervous when I thought of going to APP English class.	2.9	.83
25.	I think there is nothing to be afraid of when I go to APP English classes.	2.9	.7

The item choices were coded with 4 (completely agree), 3 (agree), 2 (disagree), and 1 (completely disagree).