Abstract
With the rapid development of Augmented Reality (AR), an increasing number of studies has been conducted to explore the effectiveness of this technology in the field of education. Few, however, have examined how AR might influence EFL (English as a Foreign Language) learners’ vocabulary learning efficiency. To fill in this gap in the literature, the purpose of this study is to compare traditional English flash cards with the vocabulary learning method of Augmented Reality to see which English vocabulary learning is more efficient for elementary school students. The study was conducted at an elementary school in Taiwan, and the participants were 66 third grade pupils in total. The study was conducted at two stages in terms of data collection. At the first stage, the control and experimental groups took the same English vocabulary test without any teacher instruction as a pretest. At the second stage, the control group used flashcards to learn 20 target English words by themselves in 30 minutes. The experimental group adopted the Augmented Reality 3D effect of 20 target words by themselves in 30 minutes. After that, both groups took the same English vocabulary test again as a posttest. On the whole, Augmented Reality teaching effects apparently excel the effects of the traditional vocabulary learning methods. The results of this study have shown that the learning method of Augmented Reality was more efficient than the learning method using English flash cards at various proficiency levels (high, intermediate, and low) in terms of English vocabulary learning. The learning method of English flash cards had significant differences in high and low level groups as well as intermediate and
low level groups, with the exceptions of high and intermediate level groups. It is worth improving children’s English vocabulary learning by using Augmented Reality in their daily lives in terms of mobile learning.

**Keywords:** elementary school students, Augmented Reality, English flash cards, English vocabulary learning

**Introduction**

With the advancement of technology and development of information, the 21st century should be defined as an electronic century. Over the past few decades, computers have become more and more popular, the Internet has been ascendant, and digital data, digital life and digital learning have been merged into our life step by step, all of which have become routine occurrences that we must deal with every day. With globalization, all countries cannot but strive for enhancing the global competitiveness of their nations. On the other hand, technological equipment has become more and more advanced: there is knowledge and data in abundance on the Internet, digital teaching materials and content develop rapidly, and electronic whiteboards and electronic book downloading technology have become advanced as well, so that every country emphasizes the application of technology to school modernization and helps teachers and students to conduct teaching and learning in real classrooms (Hew and Brush, 2007). In addition, their fast transmission and extra-large memory capacity, and emerging innovative electronic products have been changing school “teaching” as well as “learning” (Kukulska-Hulme and Shield, 2008).

Currently, Augmented Reality is becoming ever more popular in a wide range of fields. According to Van Krevelen and Johnson (2010), real and virtual environments are seen as poles lying at opposite ends of a continuum, the middle of which is called “mixed reality”; the one closer to the real environment is Augmented Reality (AR), whereas the one closer to the virtual environment is Augmented Virtuality (AV). Augmented Reality (AR) is a technology extended from Virtual Reality (VR), also called Enlarged Reality or Extended Reality. As long as image input devices are applied, virtual objects and scenes will be overlapped in the real world, so that this allows users to feel being personally on the scene (Yuen, Yaoyuneyong, and Johnson, 2011). Augmented Reality can be applied to a wide range of areas, including learning materials, museums, entertainment experiences, medical treatments, etc. (Carmigniani et al., 2010). With the development
of digital technology, learners of this generation have become used to receiving diversified information via networks and digital multimedia channels (Perry, 2015). Besides, the development of new computer technology makes more room for teaching. Technology can be seen as technology-integrated teaching of teaching tools, helping solve students’ learning problems as well as enhancing their learning outcomes. Teaching patterns will evolve from traditional face-to-face instruction to Computer Assisted Instruction (CAI), and even to the highlighted information-integrated instruction (Santos et al., 2016).

In recent years, English teaching has been emphasized by various parties in Taiwan’s educational community. Not only has the Ministry of Education extended the English education to the third grade of elementary school, but the issue related to how to make children learn English efficiently and effectively has also become a focus topic these days. Integrating “edutainment” into our daily life is seen as the best way to help young children get used to English naturally. In the children's learning process, plenty of teaching materials and media can assist them in learning activities as well as increasing efficiency and fun for the entire learning process. With the development of digital technology, the teaching media have become more diversified. Apart from enriching the entire learning content and the way of presentation, it is more important that new interactions can be brought into learning, and children can experience the learning content by means of more comprehensive learning methods, such as games. As a result, their learning effects can be intensified by multisensory stimuli.

English, the common language in the world, has received more and more attention from children's parents. How to improve English skills has become an even more highlighted question by everyone. Accordingly, English learning atmosphere has also been widely spread, not only by books but also DVDs have increased dramatically. However, among these methods of improving English skills, many of them make learners easily bored. Owing to this, learners are always full of momentum and spirit when starting learning, but then their passion will dissipate after a while. If the English vocabulary which learners want to learn is not merely made into flashcards but also combines the method of Augmented Reality (AR), which expresses the meanings of the vocabulary with images and sounds, it will make vocabulary learning more vivid and interesting and help learners to more easily memorize the vocabulary. In addition, nowadays more and more studies indicate that using multimedia to assist language teaching can really help learners to promote their language acquisition. In addition to accelerating the efficiency of learners’ English learning, how to enhance learners’ learning interest as well as their learning motivation has also become a trend for scholars to discuss.
The sound and light effects and creative design provided by multimedia allow for arousing learners’ extrinsic motivation. On the other hand, the multimedia created by high-quality teaching design can make learning more effective and trigger learners’ intrinsic motivation. Besides, multimedia interactions, individual learning, etc., can also activate learners’ motivation. Using lively interaction flash cards with 3D images to recognize English vocabulary and reading vocabulary to intensify users’ listening and pronunciation can make users easily increase their interest in learning English and boost their learning efficiency (Rose and Bhuvaneswari, 2014). Hence, the purpose of this study was to compare the use of traditional English flash cards and the vocabulary learning method of Augmented Reality to see which of these English vocabulary learning methods is more efficient for elementary school pupils.

The research questions were as follows:

1. How does the use of traditional English flash cards compare with the vocabulary learning method of Augmented Reality in terms of increased English learning efficiency among elementary school third grade pupils?
2. How does the vocabulary learning method of Augmented Reality influence elementary school third grade pupils’ English vocabulary learning efficiency among high, intermediate, and low proficiency groups?
3. How do English flash cards influence elementary school third grade pupils’ English vocabulary learning efficiency among high, intermediate, and low proficiency groups?

**Literature Review**

**The Trend of Mobile Learning of English in Taiwan**

In recent years, the Ministry of Education has actively promoted the mobile learning project, especially in elementary and high school education, so mobile learning is in progress in the Taiwanese education system. Taiwan is a leading producer of mobile devices (e.g., tablet PCs and smart phones) and is second to none in the academic research field of mobile learning. Mobile devices make it possible for information technology to be integrated into the teaching domain, and using them is the way of teaching that is controlled by the teacher in a regular classroom. The designated one-to-one learning model used in a computer classroom can extend to learning conducted in a regular classroom and outdoors, so that the real one-to-one learning model can be implemented (Huang, 2009). According to the definition made by Godwin (2011), mobile learning means conducting electronic
teaching via mobile devices. The emergence of this new type of learning allows for more diversified ways of learning. As long as someone is willing to learn, he/she can start learning at any time and in any place to efficiently enrich his/her individual knowledge.

According to the research results over the years, the received characteristics of mobile learning are listed as follows (Joseph and Uther, 2009; Kukulska-Hulme and Shield, 2008; Roca and Gagne, 2008; Chen and Hsu, 2008; Bordbar, 2010; Sole, Calic, and Neijmann, 2010):

1. Setting up a student-centered learning model
   Students can use mobile carriers to conduct their individual learning, such as repetitive practices, tests, etc. Mobile carriers also can record their learning processes and outcomes, providing students with suitable learning guidelines by means of system functions and teaching contents.

2. Digital camera function
   The contemporary mobile carriers have the digital camera function. If this function is integrated into the learning system design, teachers can collect and record learning data by means of photo-taking, video-taking, etc., and can instantly transmit data via the wireless networks.

3. Teaching scenarios are not restricted and information is accessible
   Mobile learning is not limited by space, so teachers can bring the teaching scenario outdoors and merge information into teaching, and can even connect teaching materials to network under any circumstances via wireless networks.

As mentioned above, the trend of mobile learning is currently very popular in Taiwan, especially in learning English. The significant role of learning English has greatly contributed to the movement of teaching vocabulary in English as a foreign language. There is no denying that vocabulary is the most important factor for learners of English as a second language and foreign language. English vocabulary plays a basic and significant role of learning English. Without vocabulary base, it is difficult to study reading, listening, speaking, or writing (Akbulut, 2007). In vocabulary learning, it is relatively difficult to learn new words, to keep these words in memory and to recall them when they are needed. With the development of innovative teaching methods of multimedia, vocabulary learning methods can be a more interesting and colorful process. It seems difficult to learn a bulk of words just by looking words up in dictionaries. Therefore, adapting animated pictures to learning new vocabulary is necessary (Arikan and Taraf, 2010). When learners try to explore the meaning of words by associating the scenes that they are looking at on the screen, they learn the pronunciation of vocabulary and the written form of words simultaneously. To learn vocabulary with animated pictures is thought to
make the learning process much easier for young students (Koyooglu and Akbas, 2011). In addition, adapting vivid interaction applications of Augmented Reality (AR) with 3D images to recognize English vocabulary and reading vocabulary to intensify listening, reading, and pronunciation can make users easily increase their interest in learning English and boost their learning efficiency (Rose and Bhuvaneswari, 2014).

**Method**

**Participants**

The study was conducted at an elementary school in Taiwan, and the participants were 66 third grade pupils. On the whole, the pupil group had the same characteristics in terms of their English proficiency. 20 target words were chosen from Happy Playground Learning Box, which is produced by Happito Creative Company. Basically, these 20 words are basic level for students, and all the words are nouns. The researcher adopted these 20 target words to assess the pupils in the pre-test. The total possible pretest score was 100. Based on the results of the pretest, the pupils were classified into three English vocabulary proficiency groups: low, intermediate, and high. 22 pupils who received scores below 60 were classified into the low level group; 26 pupils between 60 and 79 points were classified into the intermediate level group; and 18 pupils who obtained above 80 points were classified into the high level group. According to the stratified random sampling, among the high level group, 9 pupils were randomly assigned to the experimental group (using AR to learn English vocabulary) and the remaining 9 pupils who used the traditional vocabulary learning method (using flashcards to learn English vocabulary) were assigned to the control group. Among the intermediate level group, 13 pupils were randomly assigned to the experimental group (using AR to learn English vocabulary) and the remaining 13 pupils who used the traditional vocabulary learning method (using flashcards to learn English vocabulary) were assigned to the control group. Among the low level group, 11 pupils were randomly assigned to the experimental group (using AR to learn English vocabulary) and the remaining 11 pupils who used the traditional vocabulary learning method (using flashcards to learn English vocabulary) were assigned to the control group.

**Materials**

The 20 target words were chosen from Happy Playground Learning Box, which is produced by Happito Creative Company. Basically, these 20 words are basic
level for students, and all the words are nouns. In order to make the pupils learn all English vocabulary with letters of the alphabet, we made some letters of the alphabet into flashcards, which were presented to them as displayed in Figure 1, including Chinese and English names and pictures which represent the vocabulary. As mentioned above, the control group used this method to learn English vocabulary. With respect to the experimental group, the participants were asked to download the APP of AR to their smart phones, so that they could view the Augmented Reality 3D effect of the vocabulary on the screens of their cell phones. Not only can the English vocabulary be displayed, but also sound effects and actions can be made via learners’ gentle touches with their fingers. Sound effects refer to the pronunciation of the vocabulary. The Augmented Reality 3D effect of the vocabulary on the screen is presented in Figure 2.

![Figure 1. An example of English Vocabulary Flashcard](image1)

![Figure 2. An example of augmented reality information](image2)
**Data Collection**

The pupils’ English vocabulary was measured with the use of a multiple-choice test. The test had 20 items, with four choices for each item. Scores ranged from 0 to 100 in the multiple-choice test. The study was conducted in two stages in terms of data collection. At the first stage, the control and experimental groups took the same English vocabulary test without any instruction from the teacher as the pretest. At the second stage, the control group used flashcards to learn 20 target English words by themselves in 30 minutes. The experimental group adopted the Augmented Reality 3D effect of the 20 target words by themselves in 30 minutes. After that, both groups took the same English vocabulary test again as the posttest.

**Data Analysis**

In order to analyze the study, a paired-sample t-test was conducted to evaluate the effects of the traditional English flashcards and the learning method of Augmented Reality on the pupils’ English vocabulary learning. A One-way ANOVA was used to evaluate the results of the control (traditional English flashcards) and experimental (the learning method of Augmented Reality) groups among the low, intermediate, and high level learners.

**Results**

Overall, a paired-sample t-test showed that both the method of learning through the use of traditional English flashcards and the learning method of Augmented Reality had a significant effect on English vocabulary learning, $t(65)=3.53$, $p<.0001$ (cf., Table 1).

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>t</th>
<th>df</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.35</td>
<td>11.01</td>
<td>3.53</td>
<td>65</td>
<td>.000*</td>
</tr>
</tbody>
</table>

In addition, the results also showed that the learning method of Augmented Reality was more efficient than the learning with English flashcards among the various proficiency levels (high, intermediate, and low levels) with respect to English vocabulary learning (cf., Table 2).
Table 2. A comparison of English flashcards (FC) and augmented reality (AR) training effect on each proficiency level (high, intermediate, and low)

<table>
<thead>
<tr>
<th></th>
<th>AR</th>
<th>FC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M(SD)</td>
<td>95% CI</td>
</tr>
<tr>
<td>High</td>
<td>5.83(4.33)</td>
<td>(2.50, 9.16)</td>
</tr>
<tr>
<td>Intermediate</td>
<td>13.85(4.16)</td>
<td>(11.33, 16.36)</td>
</tr>
<tr>
<td>Low</td>
<td>20.68(6.43)</td>
<td>(16.36, 25.00)</td>
</tr>
</tbody>
</table>

Note: CI refers to confidence interval

A One-way ANOVA identified that the learning method of Augmented Reality had a significant effect on the pupils’ English vocabulary learning among the various levels (low, intermediate, and high), F (2,30)=21.23, p<.0001 (cf., Table 3). Besides, the results also showed that the high proficiency level group was higher than the intermediate and low level groups. The intermediate level group was higher than the lower level group (cf., Table 4).

Table 3. One-way ANOVA (comparison of pupils’ English vocabulary learning efficiency, using augmented reality)

<table>
<thead>
<tr>
<th>Sources</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>between groups</td>
<td>2</td>
<td>1091.55</td>
<td>545.78</td>
<td>21.23</td>
<td>&lt; .0001</td>
</tr>
<tr>
<td>within groups</td>
<td>30</td>
<td>771.33</td>
<td>25.71</td>
<td></td>
<td></td>
</tr>
<tr>
<td>total</td>
<td>32</td>
<td>1862.88</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Comparison of pupils’ English vocabulary learning efficiency among various proficiency levels (high, intermediate, and low), using augmented reality

<table>
<thead>
<tr>
<th>Proficiency groups</th>
<th>Mean Differences</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>high vs. intermediate</td>
<td>8.01</td>
<td>(2.35, 13.68)</td>
<td>*</td>
</tr>
<tr>
<td>high vs. low</td>
<td>14.85</td>
<td>(8.98, 20.72)</td>
<td>*</td>
</tr>
<tr>
<td>intermediate vs. low</td>
<td>6.84</td>
<td>(1.49, 12.19)</td>
<td>*</td>
</tr>
</tbody>
</table>

Note: * refers to P < .005

On the other hand, a one-way ANOVA identified that the learning with the use of English flashcards also had a significant effect on the pupils’ English vocabulary learning among the levels (low, intermediate, and high groups), F (2,30)=11.28,
$p < .0001$ (cf., Table 5). The high and intermediate level groups were better than the low level group. Interestingly, there was no significant difference between the high and intermediate level groups (cf., Table 6).

**Table 5.** One-way ANOVA (comparison of pupils’ English vocabulary learning efficiency when using flashcards)

<table>
<thead>
<tr>
<th>Sources</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>between groups</td>
<td>597.00</td>
<td>2</td>
<td>298.99</td>
<td>11.28</td>
<td>0.0002</td>
</tr>
<tr>
<td>within groups</td>
<td>795.19</td>
<td>30</td>
<td>26.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>total</td>
<td>1393.18</td>
<td>32</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 6.** Comparison of pupils’ English vocabulary learning efficiency among various proficiency levels (high, intermediate, and low) when using flashcards

<table>
<thead>
<tr>
<th>Proficiency groups</th>
<th>Mean Differences</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>high vs. intermediate</td>
<td>4.49</td>
<td>(-1.26, 10.24)</td>
<td></td>
</tr>
<tr>
<td>high vs. low</td>
<td>10.83</td>
<td>(4.87, 16.79)</td>
<td>*</td>
</tr>
<tr>
<td>intermediate vs. low</td>
<td>6.35</td>
<td>(0.92, 11.78)</td>
<td>*</td>
</tr>
</tbody>
</table>

Note: * refer to $P < .05$

**Discussion and Conclusions**

On the whole, the results of this study show that the Augmented Reality learning method was more efficient than the learning with the use of English flashcards among the various proficiency levels in terms of English vocabulary learning. In other words, Augmented Reality teaching effects apparently excel the effects of the traditional vocabulary learning methods. Furthermore, it has a significant effect on English learning for the school children of the highest and the lowest advancement levels. As mentioned above, the results of this study are consistent with Lin's (2009) study. On the contrary, learning with the use of English flashcards showed significant differences between the high and low level groups as well as intermediate and low level groups, with the exception of the high and intermediate level groups. It is obvious that the Augmented Reality learning method is more efficient and suitable for various proficiency level groups with respect to learning English vocabulary in this study.
Over the past few years, with the arrival of the global village era and the development of Internet technology, it has become relatively important to have common language skills to be able to effectively communicate with people worldwide. Since the range of technology applications has become increasingly wider, making use of the growth of information technology to increase the efficiency of English learning and discarding the traditional way of English learning have become a trend. Generally speaking, the multimedia learning system of combining words, graphics, voices, and animations has interactive and learner-centered features, providing an ideal learning environment. During the learning process, learners can select the learning content and schedule and repetitively use it based on their needs, which can help advance their learning efficiency.

The outdated traditional learning methods have been unable to satisfy the contemporary learners’ needs. Therefore, new technology should be used to make education more attractive and efficient and enable the teaching environment to become more diversified. Combining AR game-based learning is also a future trend, a way of learning integrating virtuality with reality as well as edutainment, which is certainly full of interest, more situational, and combined with hands-on activities.

The AR interactive English vocabulary learning method is used to help users conduct their learning. This AR game-based English vocabulary learning system may not be able to help learners learn some sophisticated English vocabulary, whereas it is able to trigger beginners’ interest in learning English. Although the bilingual teaching system tends to employ the teaching of cartoon images, we hope children can directly learn real objects. When hearing an English word, they will associate it with its cartoon image first and then with the real image. Take “mouse,” for example. When hearing “mouse,” they will associate it with its cartoon image first and then think of what a real mouse looks like. Now that children seem to be more and more out of touch with nature and more and more unable to see the things found in nature, we intend to use this system to help children get to know more about nature. Applying AR to learning English vocabulary can make children happier due to its being more entertaining, which results in better learning, and thus children can receive the best learning effects from games. When they see a picture or a real object, such as a cat, a dog, an elephant, a lion, etc., they can subconsciously associate this object with its Chinese and English names and learn from the games unconsciously. It can make children fond of learning, help them repetitively learn by themselves, and let them forget that they are playing and learning from the games. If they forget what they have learned, they can go back
and check it, so that they do not need their teacher to stay with them to repeatedly teach the same lessons.

References


