

# Interaction Design Based on Augmented Reality Technologies for English Vocabulary Learning

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**Abstract:** In this paper, we present the Augmented Reality English Vocabulary Learning System (AREVLS) with immersive English Vocabulary learning. AREVLS consists of two components: (1) Magic Book, and (2) Card Matching System. Moreover, we use Heuristic Evaluation and System Usability Scale (SUS) to make a questionnaire for English teachers in elementary schools as well as kindergartens. The research results show that the SUS has positive usability and participants enjoy the interaction with it. From the Heuristic Evaluation, the disadvantages of AREVLS are acquired, and the experts provide some feedback for further improving the system.

**Keywords:** Augmented Reality, English Vocabulary Learning, Heuristic Evaluation, Human Computer Interaction

## Introduction

With the progress of information technology development, the form of digital learning multimedia materials has changed dramatically from traditional books to digital media. Thus, the learning becomes more lively and interesting. In the beginning of learning English, students first learn English letters, pronunciation and vocabulary. As for the traditional teaching in classrooms, the interaction between teachers and students is usually by gestures as well as discussions, lack of interesting learning and interaction. On the shelf are many interactive learning media, changing the traditional learning way.

Paivio brings up Dual-Coding Theory [1, 2]. According to the theory, there are two kinds of systems respectively dealing with different cognitive messages in the human processing procedure. However, as we see text, we won't see it the way we see images. In terms of this, Paivio provides the idea of the importance of images to our learning. For the sake of images providing another access to coding, information can connect in many ways in learner's memories via the impulse of both text and image. The more the related information is, the deeper their memories will be. Thus, it is beneficial to our learning, for learners have less chance to forget what they have learned.

## Related Work

AR is applied in researches on English learning. Kirner et al. [3] develops an English letter spelling game. Its rule is players have to pick up the right cards to spell the correct word in the AR English letter cards. If their spelling is right, there will be a virtual object of the English letter card on the monitor. In such an attractive situation, the game can encourage

players to interact more actively and fortify their ability of solving problems. Hsieh and Lee [4] make the card design less complex with the conception of permutation and combination, offer students a new digital media of different learning stimulation, and present the English learning system with immersion learning effect, which help students learning English vocabulary. To sum up, the system contributes to making the traditional way of learning English vocabulary more vivid and better.

Based on the references stated above, we combine AREVLS with English Vocabulary Magic Book. In Mixed Reality, through the combination of virtual objects and real scenes, students are able to interact with virtual objects, get sense excitement to improve their learning effect, and finally have an interesting learning.

### Augmented Reality English Vocabulary Learning System

We devise an English vocabulary learning system by taking advantage of the AR technology. The system development is based on ARToolKit [5, 6]. In order to build a virtual object, we use SketchUp software and 3D Warehouse as the model-design tool.

The AREVLS interactive mechanism is primarily divided into two interactive ways, English Vocabulary Magic Book interactive mechanism and English vocabulary card matching interactive mechanism. English Vocabulary Magic Book interaction mechanism: if learners open the English Vocabulary Magic Book, the webcam will capture the AR marker of English Vocabulary Magic Book. Next, the system will automatically recognize the AR marker, combine the 3D virtual object in the virtual object database, and superimposes it on the English Vocabulary Magic Book. Figure 1 is the operation of English Vocabulary Magic Book. Taking letter C in Unit 1 for example, when the webcam captures the AR marker of English Vocabulary Magic Book, buttons of “phonics” and “vocabulary phonics” appear on the monitor. As learners use mouse to click “phonics”, the system will pronounce the letter and its phonics; as learners click “vocabulary phonics”, the system will pronounce the word. Figure 2 shows what is stated above.

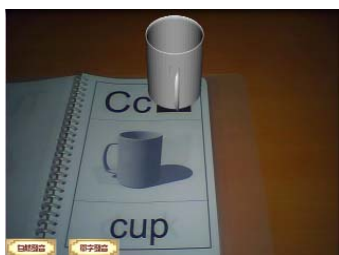


Figure 1: Letter C and D of AR English Vocabulary Magic Book

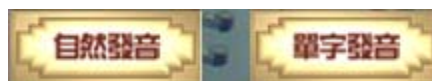


Figure 2: AR English Vocabulary Magic Book interactive button - "Phonics" and "Vocabulary Phonics"

Matching interactive mechanism of English vocabulary picture card: With an eye to testing if learners really know these words, after their learning, the system provides matching interactive mechanism of English vocabulary picture card, so they can have a set of unit cards to do the matching, as Figure 3 demonstrates. One word is with two cards. One is picture card and the other is vocabulary card. Students take the picture card to match the vocabulary card. Through the judgment of matching interactive mechanism of English vocabulary picture card, when the matching is right, the system will shows the 3D virtual object from the virtual object database through the monitor. In the contrast, when the wrong matching happens, there will be no 3D virtual object on the monitor, for the system

automatically judges that the picture card and the vocabulary card don't match each other, as Figure 4 shows.

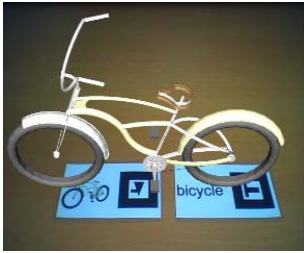
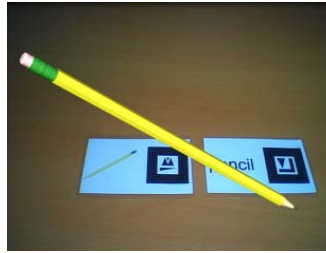
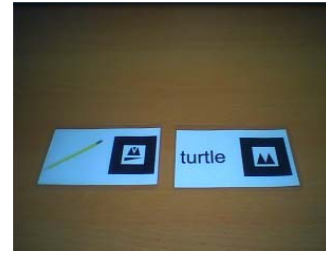


Figure 3: English Vocabulary Card Matching.



(a)



(b)

Figure 4: (a) is a correct matching; (b) is a false matching.

### System Evaluation

Although we have preliminarily finished the implementation of AREVLS, we can possibly miss many aspects, for the whole producing process was mainly done by the authors. Thus, we hope utilize expertise evaluation to quickly and accurately discover the problems for using AREVLS; meanwhile, we also use System Usability Scale to do system usability testing. With the results of evaluations, we can find out the problems of interface usability to improve our design or provide information for future development.

#### 1. Heuristic Evaluation

Heuristic Evaluation [7, 8] is developed by Jakob Nielsen according to usability exploring rules (Heuristics), which evaluates whether the elements of making up user interface is based on these principles. In Nielsen's research, it is proved that experts can usually check out around 75% usability problems and skilled experts are able to observe a lot of usability problems on their own. Also, based on Nielsen's advice, there should be four to six experts. In the research, we have five experts. Listed in Table 1 is the backgrounds and specialties of the experts.

Table 1: The backgrounds and specialties of experts

Expert	Specialty	Background
A	Augmented Reality , Human Computer Interaction	Computer Science and Information Engineering
B	Augmented Reality, Interactive Design	Computer Science and Information Engineering
C	Usability Engineering, Augmented Reality	Computer Science and Information Engineering
D	Usability Engineering, Human Computer Interaction	Computer Science and Information Engineering
E	Multimedia Design, Interactive Design	Visual Communication Design

Each expert spends one to two hours examining products at least twice. First, experts grasp the procedure of the whole interactive interface manipulation and gain some knowledge about the product. Then, experts check the usability problems of the entire system. Finally, experts discuss their evaluation results together, prioritize the problems, and offer solutions

to them. According to experts' opinions for interface design of AREVLS, the illustration for their opinions is as follows:

- (1) In English Vocabulary Card Matching, the system should come with voices. If learners do wrongly on card matching, the screen will display the image on the wrong matching with voices like "Please try again" and to let learners know their matching errors. For instance, by showing a cross mark (×) with the sentence "Please try again" spoken out, the system can let them know their incorrect matching while by using a check mark (✓) with the sentence "Congratulations, you are right" pronounced, it can let them know their correct matching
- (2) AREVLS is lack of instruction of assistant document. When users enter the system, they might be not clear about manipulating it. As a result, it will be better to display manipulation instructions on the window before users go into AREVLS. Then, they will be aware of operating.
- (3) 3D virtual objects can be displayed with Chinese characters. In addition to showing 3D virtual objects, we also display Chinese character beside 3D virtual objects. Consequently, there will be more visual effects to help learners learn.
- (4) AREVLS lacks unit introduction. We should let learners know the outline of the unit they are going to learn and make a short introduction before they learn a unit.
- (5) The name of each unit should be displayed on the window. While learners learn a unit, we have to display the name of each unit on the window to let them know which unit they are learning.

## 2. System Usability Scale

In the research, AREVLS serves as the assistant material of English vocabulary learning. Participants are teachers in elementary schools and kindergartens, English-learning beginners, and householders who are asked to receive the task assignment and start using the system. They then get to the operation in accordance with the task assignment, as Table 2 shows. After finishing the task assignment, we will evaluate the system usability.

Table 2: Task Assignment for interaction mechanism of English Vocabulary Magic Book and English Vocabulary Card

Task Assignment for Interactive Mechanism of English Vocabulary Magic Book	Task Assignment for Interactive Mechanism of English Vocabulary Card Matching
1. Open to letter Bb in Unit1 of English Vocabulary Magic Book.	1. Select English Vocabulary Card - correct matching.
2. Click letter phonics of Bb.	2. Shift the correct- matching English Vocabulary Card.
3. Click letter phonics of Bb again.	3. Move the correct- matching English Vocabulary Card up and down.
4. Click vocabulary pronunciation of Bb.	4. Select English Vocabulary Card - false matching.
5. Click vocabulary pronunciation of Bb again.	5. Shift the false- matching English Vocabulary Card.
6. Turn around English Vocabulary Magic Book horizontally.	6. Move the false - matching English Vocabulary Card up and down.

We utilize System Usability Scale (SUS) as our framework for evaluating the system usability. Participants are English teachers in elementary school and kindergartens and householders. We have interviews with these users on their ideas about AREVLS after they

finish operating the system and filling out the SUS questionnaire [9-11]. Listed in Table 3 are the “SUS scores” of AREVLS. As summarized in Table 3, the mean SUS score is 77, the median is 85, the maximum is 93 and the minimum is 43. Since the Mean and the Median are 77 and 85, respectively, these scores indicate that the AREVLS system is usable. Besides, according to each item of SUS, the Mean of item four is apparently lower while its SD is larger than that of any other items (Table 4). Therefore, we find out that users need someone to help them or give some instructions before the use the system.

Table 3: SUS scores descriptive statistics

	N	Mean	Median	Min	Max	SD
Stat	24	77	85	43	93	15

Table 4: SUS questionnaire and scores descriptive statistics of each item

System Usability Scale Items	1	2	3	4	5	6	7	8	9	10
Mean	3.33	3.25	3.33	1.67	3.08	3.5	2.92	3.5	3.08	3.08
SD	0.74	0.99	0.97	1.42	0.8	0.65	0.9	0.77	0.97	0.89

## Conclusion and Future Work

AREVLS designed in our research is composed of the English Vocabulary Magic Book and the English Vocabulary Card System. In this paper, we use Heuristic Evaluation and SUS to evaluate AREVLS. We find that the evaluation results show that AREVLS has positive usability and users enjoy the interaction with it. However, there still leaves something to be desired. Therefore, we will make further improvement based on the opinions collected from both experts and users. What’s more, we will add interesting materials to the learning system, offer more diverse learning tools, and carry out more experiments of AREVLS on learners to see their English learning achievement.

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