

# DESIGN AND IMPLEMENTATION OF AN ENGLISH LESSON BASED ON HANDWRITING RECOGNITION AND AUGMENTED REALITY IN PRIMARY SCHOOL

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## ABSTRACT

In recent years, the development of mobile technology and devices makes Artificial Intelligence (AI) and Augmented Reality (AR) available tools in classroom teaching and learning. AI and AR are used to improve the learning effect as well as motivate the students' learning enthusiasm. In English as a second language (ESL) learning, several previous studies show the potential advantages of the usage of AI and AR. In this study, an English learning lesson with a mobile based handwriting recognition and AR application was designed and implemented in primary school lower grade. A series of class activities using the application as teaching tool are developed. The aim of this research is to find out the effect of the possible effect of AR application in practical English class and the influence of it on the pupils. Pre-post test and face-to-face interview are made and they show that there are some advantages the usage of the application has led to both teacher and students. Handwriting recognition-based AR application in ESL could motivate the students to pay more attention to the class and improve their learning enthusiasm.

## KEYWORDS

Artificial Intelligence, Augmented Reality, English as Second Language, ESL

## 1. INTRODUCTION

The 21st century is a global century. With the development of Transportation Technology and communication technology, international cultural exchanges are deepening, and the international flow of talents is becoming more frequent. To make our education responsive to the needs of such an era of globalization, learning English has gradually become a compulsory part of the basic education, which has become the most widely used language in the world and an international communication tool.

However, in the field of English teaching and learning in primary school, especially vocabulary teaching, still has many common problems. According to a questionnaire survey conducted by Shandong Normal University's Liu Youai, there are many common problems in the field of English teaching in primary schools, such as the teaching methods demand more diversity, the content of the textbooks go against the students' developing process, the lack of guidance of students' independent learning, and the low utilization of the existing teaching equipment, especially the high-tech teaching equipment. From the students' point of view, the problems in teachers' teaching lead to the students' poor autonomous learning ability and lack of interest in word learning.

In recent years, augmented reality (AR) and artificial intelligence (AI) have been widely used in education, and more and more courses and teaching have been designed based on AR and AI technology. In May 2019, the UNESCO organized the International Conference on Artificial Intelligence and Education to study emerging artificial intelligence technologies and innovative practices in the application of artificial intelligence (AI) in education. It shows that the application of AI in education has become a common topic of reflection and practice in the global education. He, Ren, Zhu, Cai and Chen (2014) have designed the "happy words" software based on mobile smart platforms such as smart phones and tablets. The software scans the word cards with the camera, and when it does, it displays a 3D model of the words on the screen and plays back the speech. The results show that this augmented reality-based approach can increase learners' interest in learning English

spelling and reading aloud, and improve their learning effectiveness. Cai in the "augmented reality (Ar) in the teaching of the application of case review" in which a summary of the existing courses based on augmented reality technology design, this paper empirically found, there was a positive correlation between students' learning attitude and the use of AR Teaching(Cai et al.,2017).

Many studies and projects have proved that using AR in education could improve students' English learning and teachers' teaching. So, to deal with the common problems in the field of English learning in the primary schools in China, we plan to design and implement a mobile-base handwriting recognition AR application, which can motivate students in ESL lesson learning and integrate technology with classroom teaching deeply.

## **2. RELATED WORKS**

### **2.1 AR in Education**

In recent years, Augmented Reality (also known as AR) has gradually entered people's daily life and caused widespread concern. As the smart phones becoming more and more capable for AR operation and AR devices becoming more and more affordable, mobile-based AR has been applied in many fields. Since the very beginning of AR, many teachers and scholars have paid great attention to this emerging technology especially with its further application in education(Akçayır & Akçayır, 2017). AR has great potential for learning activities because of its rich visual presentations and various user interaction(Cai, Chiang, Sun, Lin, & Lee, 2017), and teachers show their interests and willingness in using AR. Evidences show that AR has the ability to work on students' practical skills and conceptual understanding, as well as be able to support inquiry activities(Cheng & Tsai, 2013). Primary school students would have better performance in motivation, confidence and related dimension by using of AR in learning activities(Chiang, Yang, & Hwang, 2014; Han, Jo, Hyun, & So, 2015; Lu & Liu, 2015). So that AR has been regarded as a revolutionary solution of some teaching difficulties, like teaching of abstract concepts(Crandall et al., 2015).

In recent years, several AR projects were mainly used to teach the meaning and pronunciation of words. For instance, an AR application, named Leihua, help pre-school children to remember some basic vocabulary when they take exploration activities. Study shows that children would be enthusiasm when extra audios presented with AR. There were also some researchers taking notice of promoting learners to interact with special labels or the AR system. AR would present vivid 3D model for learners to have deeper memories when studying the same word in different language through MOW, learners needed to match word card and national flag card or meaning card accurately. Almost of these studies also showed AR's effects on improve students' motivation, satisfaction or attention.

Further researches later confirmed AR's effectiveness in teaching children and attempted to use AR in higher education to improve learners' language skills. An experimental research study scrutinized the effectiveness of using augmented reality applications as a teaching and learning tool when instructing kindergarten children in the English alphabet in the State of Kuwait(Safar, Al-Jafar, & Al-Yousefi, 2017). In a study Richardson (Richardson, 2016) used location-based mobile AR games creatively and proved that AR could be used to arrange tasks for advanced level language learners to improve their motivation and learning performance. In Yang and Mei's research(S. Yang & Mei, 2018) shows that afforded by the AR programming learners could had positive perception and attitude towards the immersive language learning experience.

In summary, previous studies have proved that AR used in EFL learning was able to ensure better attitude and performance through more interesting activities or immersive experiences. Therefore, we hope in our study, we could use our AR application as an efficient learning and teaching tool, to forward prove the previous researches' results, and to help improving the second language acquisition in the school's formal lessons.

### **2.2 AI in Education**

Artificial Intelligence including pattern recognition, deep learning, machine learning, data mining and intelligent algorithm, etc. In our project, the main application of artificial intelligence is using Optical character recognition or optical character reader, often abbreviated as OCR to scan and recognize the words on the card. We want to use handwriting recognition AR in English as a foreign/second language (also known as ESL) learning field of China.

With many studies proving that AR could help with the teaching of Mathematics or physics courses, we believe that AR has potential in ESL learning especially when combined with AI text recognition. Christos Troussas and others present a fully operating and evaluated adaptive and intelligent e-learning system for second language acquisition. This system uses a hybrid model for misconception detection and identification (MDI) and an inference system for the dynamic delivery of the learning and the results of the study are very encouraging and promising since they reveal that the hybrid model for misconception detection and identification and the inference system operate collaboratively and enhance the adaptivity of the students' needs and preferences objects tailored to learners' needs. (Troussas et al., 2019)

And Yang in his paper gives us a good conclusion of the application of the AI in the ESL field. He summarizes that with a wide variety of meaningful and interesting AI, giving learners easier access to the tools can help them develop their language skills. This AI technology can provide learners with more opportunities for interaction beyond the restriction from time and locations. It is hoped that language learning can be more fun and more efficient(S.-h. Yang, 2007).

In summary, previous studies have proved that AI could be apply to the education field, especially in the second language acquisition to make the language learning more interesting and efficient. In this study, we are going to use the handwriting recognition to develop a mobile-based application as a teaching and learning tool to make the English class more efficient in primary school.

### 3. DESIGN

The core goal of this study is to design and implement a mobile-base handwriting recognition AR application, which can motivate students in ESL lesson learning and integrate technology with classroom teaching deeply.

We designed a 40-minute class with handwriting recognition AR application which played as an exploring tool role in the class for lower-grade pupils in the primary school in China. We collected multi-dimensional data including the effect of the application and the attitude toward it, from teacher and students' point of view.

#### 3.1 Instructional Design

In this study, several learning activities with the mobile-base handwriting recognition AR application were designed for the lesson named "Can you tell me the way to...?". In this lesson, every group students had two tablets, so they could cooperate to learn with the handwriting recognition AR application.

The basic goal of this lesson is to memorize the words about position and distinguish direction in English. Beside that, reading and speaking activities were devised to make students to communicate with partners practicing the words and sentences they learnt. Based on the basic space imagination, facts about buildings were also mentioned to help students understand the function and structure of buildings.

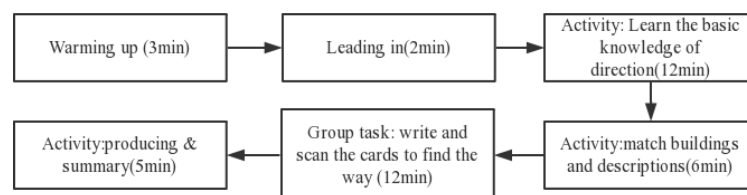


Figure 1. Structure of lesson

Figure 1 presents the basic structure. Warming up and leading in occupied the first 5 minutes of the lesson. The instructor drew out the topic through a short introduction and a flash animation.

Next the students learnt the basic knowledge of direction. In this section, several mini games involving teacher and students were designed. Under the teacher's instructions, the students work together to find the right locations in the classroom.

Then the route scope extended. Students were asked to place several buildings to their corresponding places on the map. First, the students needed to be familiar with the buildings. They were asked to match the buildings with their functions on the tablet which displayed the fundamental knowledge about the buildings. After that, they began to explore and find the way to different buildings. Due to the difficulty of this task, students would

cooperate with their group mates. One student named A wrote and arranged the cards while his or her partner named B taking the tablet's camera to capture them. Student B could see the route to the corresponding building and he or she needed to retell student A what he or she have read. According to student B's guidance, student A placed the buildings to their appropriate places on the map. After 10 minutes, the instructor led the class to find the right locations together while the students could check whether their match was right and corrected their own mistakes.

In the last part of this lesson, the instructor summarize the key points and help students to review the basic descriptions about the buildings and fundamental knowledge of direction by interactive games.

## 3.2 Augmented Reality Application Design

There are two main features in this mobile-based handwriting recognition AR application Way to the Buildings. It could run on both iOS and Android devices with good portability. To provide assistant for the different parts of the lesson, Way to the Building contains two separate features: (1) Buildings and descriptions matching and (2) Finding the way. These features are designed and implemented to make the activities in instructional design more vivid and interactive. The new way of presenting and examining knowledge were used to develop the student's learning enthusiasm.

This application was developed based on the Unity 3D engine. To realizing the function of Artificial Intelligence text recognition and building the Augmented Reality scenes, Vuforia SDK was used.

### 3.2.1 Buildings and Descriptions Matching

In this feature, students were asked to match the specific building with the description of each of them. For instance, the students should pair the description: "You can go here to buy medicine and you can also buy some food and drinks here." with the model of drugstore. In this part, students were asked to pair all the nine buildings with their description by dragging the models to the correct place.



Figure 2. Matching buildings and descriptions

As shown in Figure 2, if students correctly match the description with the building model, the building would be fixed below the description in the frame. Students would get the instant feedback during the whole tasks completing process. Positive feedback would appear once they completed all the nine pairing tasks.

### 3.2.2 Finding the Way

In this stage of learning activities, the application and physical teaching tools (paper map, word cards etc.) are used synergistically. By scanning the word cards by tablet, students could get the position information of each building. For example, when scanning the card "hospital", the corresponding location information will be displayed on the screen: " Please walk on, and then turn right at the first corner. It's on your right." Combining with the paper map which showed the start points, students could infer the location of the buildings and attach the word card to the paper map. Applying the handwriting recognition technology, no special card which is necessary for traditional AR application is needed. All the word cards provided for the students can be print in nearly any typeface even hand-writing. Students can also write the word themselves at any time.

In this feature, students can also interact with the building model. By gesture on the screen, the building models can be rotated and zoomed. After scanning the word card, the application will provide the word

pronunciation for the students automatically. Moreover, by simple touch at the model, students could listen to the pronunciation again if they want.

### 3.3 Participants and Research Design

Students of two parallel classes in the 4th Grade took part in this study, 35 of them divided into the experimental group and 32 into the control group. The experimental group cooperated to learn with handwriting recognition AR application as shown in Figure 3, while the control group learning by analyzing the materials and discussing with the group instead.



Figure 3. Cooperating in groups

For those students, English is their second language. They began to learn English in 1st grade in common. In the primary school level, the main goal of learning English is to enlarge the vocabulary and exalt the communication ability. This study paid attention to not only the learning of English but also the ability in communication in second language and cooperating.

A pretest- posttest control group study design was utilized for data collection to infer the learning performance with and without handwriting recognition AR. And after this lesson, both interviews and questionnaire surveys were conducted with the teacher and students to learn their view towards teaching and learning with handwriting recognition AR. Then a statistical analysis was made of the results.

## 4. RESULT

### 4.1 Performance Through Test Analysis

First, we examined the effectiveness of the performance test to ensure whether students could benefit from this learning approach. The inter-rater reliability of the ratings given by the two teachers was 0.745, showing high consistency. The full mark of the test is 12 points.

A paired sample t test was conducted first to compare scores of the experimental group. Table 1 shows the result. The posttest scores ( $M = 7.23$ ,  $SD = 3.19$ ) were higher than the pretest scores ( $M = 5.26$ ,  $SD = 3.00$ ), and the p-value(two-tailed) is of the mean is close to zero( $t = -4.87$ ,  $p < .01$ ). When the significance level is 0.01, we can draw to the result that students' scores with handwriting recognition AR application are significantly higher than those attained before the learning activity. As a conclusion, application has a statistically significant improvement in English learning and students' averages scores increased by 1.97 points.

Table 1. Paired t-test for pre-test and post-test score variables.

	Paired differences			t	df	Sig (2-tailed)
	Mean	Std. deviation	Std. error mean			
Post-test score –pre-test score	-1.971	2.395	.405	-4.870	34	.000

In addition, the posttest data collected from two groups were analyzed with independent samples t test. The descriptive statistics obtained are shown in Table 2. In the table, we can observe that the mean score of the experimental group ( $M = 7.23$ ,  $SD = 3.19$ ) is higher than that of the control group ( $M = 6.03$ ,  $SD = 2.80$ ), though the two groups do not have significant differences. According to the data, we conclude that with other unobserved variables controlled, the handwriting recognition AR learning tool has an improvement on the score of the performance test, and the difference is 1.20 points.

Table 2. Independent t-test for the experimental group and the control group

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	df Sig. (2-tailed)	Mean Difference	Std. Error Difference
score	Equal variances assumed	1.307	.257	1.090	65	.280	1.426	1.308
	Equal variances not assumed			1.093	64.963	.278	1.426	1.304

## 4.2 Attitude Through Questionnaire Analysis

We calculated the score of each construct by averaging all of the corresponding items within each construct through analyzing the questionnaire. Table 3 shows the result. The value of the "Learning Attitude with handwriting recognition AR application" construct ( $M = 14.77$ ,  $SD = 3.57$ ) is significantly higher than that of the "Learning Attitude" ( $M = 11.57$ ,  $SD = 2.71$ ;  $t = -7.52$ ,  $p < .01$ ), which suggests that the application could attract and intrigue the students.

Table 3. Paired t-test for attitude

	Paired differences			t	df	Sig (2-tailed)
	Mean	Std. deviation	Std. error mean			
without app-with app	-3.200	2.518	.426	-7.518	34	.000

Furthermore, the descriptive statistics of each item in "Learning Attitude with handwriting recognition AR application" construct are as following. The statement "I like learning English with handwriting recognition AR-based learning tool" has the highest value, which equals to the full mark, suggesting the application can enhance the students' interest and enthusiasm of English learning greatly. "I like reciting the English words using handwriting recognition AR." and "I think English class is interesting with handwriting recognition AR-based learning tools." both have a score of 4.89, which is very close to full mark, indicating that most students consider the application is a good tool to recite words and makes the English class more enjoyable.

## 4.3 Attitude through Interview Analysis

After the class, we took both paper based post-test and face-to-face interviews with teacher and several students. All the feedback and data could help us to ensure the usability and acceptance of this handwriting recognition AR application, from both knowledge skills and emotional attitudes.

### 4.3.1 Interview with the Teacher

In the interview with the teacher who acts as the instructor of the English lesson, our question mainly focus on the role AI and AR playing in the class and the advantages and flaws of them when applied to real class learning situation. The teacher took part in the design and improvement process when developing the application. The basic features in the application are designed for the activities in the lesson.

The first question of the interview is "Do you think this kind of application is helpful for the teaching process?". The teacher did not hesitate to give a positive answer. She mentioned that the AR and AI technology merge reality and virtual together and give students new learning experience which bring them closer to the knowledge. The teacher said, "this kind of 3-dimension and interactive design can lead the teaching method to

a more realistic level with lower cost compared to going out for a visit or using Virtual Reality devices." Indeed, our handwriting recognition AR application need only normal mobile device instead of some professional equipment like VR headset. And the application can better support the learning process for students which allow them to share their findings by using the tablet together instead of only operate them individually. This feature can also enhance the cooperation among the students.

When we asking about the effect of handwriting recognition AR in classroom, the keyword that the teacher mentioned is "interest". The teacher claimed that the students showed strong interest in the parts which based on the application and finished their tasks more concentratedly. "I find that students pay more attention to not only the instruction I've gave but also the tasks they were asked to achieve. Great interest lead them make better performance in the class, both tasks completing quality and enthusiasm. The application also help them to overcoming fear and trying to speak out when accomplishing tasks in their group."

Finally, about the technology we used, the teacher think that the AI well widen the application scenario. In the traditional AR applications, specially printed card are needed. But because of the AI text recognition technology, it's more convenient for teacher to prepare the word cards for they can even write them by hand. About the technology, the teacher added: "Students are much more proficient when operating the tablet and using the application than I expected. In this information age, schools should make more use of electronic equipment and cutting edge technical resources to help students to learn more efficiently and happily."

#### **4.3.2 Interview with the Students**

In this part, four students who have taken part in the class were interviewed.

The main purpose of the interview is to learn about students' attitudes toward the technology and the lesson with AI and AR. Moreover, we would like to know if they have the willingness to use the application to learn English in further learning.

In this interview, the most frequently mentioned words are "interesting" and "fresh". When being asked "Do you like the application in today's class?", all the students said "yes" without hesitation. "Today's class is far more interesting than the traditional ones." the students said, "I like this new way of learning very much." Also, the students showed their strong willing to continue using the handwriting recognition AR application in future's classes. They said that this application developed their interests in learning English.

The last question is aiming to check the differences between the traditional teaching tools and our application from student's perspective. The students said that the application is more vivid and intuitive than the traditional teaching tools(PowerPoint, videos etc.) and they are more willing to participate in learning activities. In addition, they mentioned that using the handwriting recognition AR application, they did more cooperation and communication during the class.

To sum up, the student's attitude towards the handwriting recognition AR application is mostly positive. Both the learning effect and learning enthusiasm were improved by this new type of learning tool.

## **5. CONCLUSION**

In this study, an interactive application based on AI and AR is designed for an ESL lesson. The application is designed and implemented to assistant and guide students in the learning activities in English class.

The experiment result suggests that the handwriting recognition AR application can improve primary school students' English performance on corresponding context. Comparing the test scores of the experimental group and the control group, we conclude that controlling other unobserved variables, students gained more knowledge with the handwriting recognition AR learning tool. And through the paired sample t test between the scores of the experimental group, we come to the conclusion that the handwriting recognition AR application is statistically significant useful in improving the learning performance of primary school students.

Not only the research indicates that through handwriting recognition AR learning tool, students' academic performance is enhanced, but also great acceptance and potential of it have been verified through questionnaire. The application can kindle the students' interest and enthusiasm of English learning greatly. Additionally, the effect of this application is evaluated by the students and teacher of the class. The handwriting recognition AR application created a vivid and realistic learning environment which can attract the students' attention and make them more concentrate on class. In terms of learning effects, the instant feedback(self-checking etc.) in this

application allows students to complete class tasks better and faster. In terms of learning attitude, this software makes students more motivated in class and better participate in group cooperation and communication.

Moreover, the Artificial Intelligence text recognition function made it more convenient for teacher to prepare the class materials. Good recognition accuracy ensure the students' task completing process and make it possible for students to write words on their own and scan it by the tablet to get information they needed.

For students, by analyzing the data we collected, we find that both better learning performance and more positive attitude are demonstrated.

Reflecting our study, we also find that there are still some further work and improvement to be done to make the research result more reliable. Further studies could design more strict experiment study with a larger sample which is representative and adopt some quantitative research methods to strengthen the study. There are some extra possible factors, like different individual characters of students (self-efficacy and cognitive style, learning status etc.), could be considered in the research. How the handwriting recognition AR application helps students in the learning process and ow to better integrate them with teaching is worth studying as well.

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