Chang, M. et al. (Eds.) (2019). Proceedings of the 27th International Conference on Computers in Education. Taiwan: Asia-Pacific Society for Computers in Education

Effects of Learning Activities Based on Augmented Reality on Students' Understanding and Expression in an English Class

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Abstract: In English as foreign language(EFL) learning, students' understanding and expression of the context are very important. However, teachers usually meet difficulties in explaining scientific phenomenon with easily understandable English words when teaching text related to science. It leads students to mechanically understand and memorize according to their own imagination. In this study, a series of learning activities based on Augmented Reality(AR) technology was carried out to cope with this problem. A specially developed AR application created a virtual-reality combined environment for students to observe and interact with the sun and the earth in grade 4. Moreover, diverse research methods were used to analyze students' understanding about learning content and oral expression about learning topic. The experimental results reveals that learning activities based on AR can assist students in the construction of understanding and expression about learning contents. Furthermore, by interviewing the students, the mechanism of how AR worked in this class was reported. Students have more time to learn and communicate in AR-based activities. They acquire more knowledge by interacting with other people in light of learning materials, instead of passively listening to the teacher or reading books. In this regard, they get more authentic and profound learning experience to support better understanding and expression of learning contents. These findings can be valuable references for those who intend to implement learning activities based on AR or those who want to improve students' understanding and expression in EFL classes.

Keywords: augmented reality, understanding, expression, English as foreign language learning, EFL

1. Introduction

In recent years, Augmented Reality (AR) has gradually been closed to people's daily life and aroused widespread concern. In the field of education, mobile-based AR has been focused on by a crowd of researchers and recommended to teachers for teaching (Akcayir & Akcayir, 2017). With the adoption of AR in learning activities, it is assumed that primary school students will have better performance in motivation, confidence and related dimensions(Chiang, Yang, & Hwang, 2014; Han, Jo, Hyun, & So, 2015). Based on its advantages, AR has been regarded as a breakthrough in the solution of some teaching difficulties, such as teaching of abstract concepts(Crandall et al., 2015).

In this study, we try to use AR in English as a foreign/second language (EFL) learning field. In a primary school in China, the EFL teachers had difficulties in creating attractive situations when giving lessons about an interdisciplinary integration content. According to AR's characteristics on enhancing physical real world by adding virtual computer-generated information to it, we presented a special situation for teachers and students through an AR application. And we did a new instructional design to contribute to a good integration of AR and courses at the classroom level.

2. Current states and related works

AR is a technology that supplements the real world with virtual objects and appears to coexist in the real world(Azuma et al., 2001; Rt, 1997). AR has been used in EFL learning for a long time.
During the early time, researchers used AR to directly afford models, audios or videos when learners catching right labels in real environment. In these years, AR was mainly used to teach the meaning and pronunciation of words(Amaia, Inigo, Jorge, & Enara, 2016; He, Ren, Zhu, Cai, & Chen, 2014). There were also some researchers taking notice of promoting learners to interact with special labels or the AR system(Barreira et al., 2012). These studies primarily 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(Safar, Al-Jafar, & Al-Yousefi, 2017). Richardson (2016) presented that AR can be used to arrange tasks for advanced level language learners to improve their motivation and learning performance. Yang and Mei (2018)founded that learners have positive perception and attitude towards the immersive language learning experience afforded by the AR programming.
In summary, previous studies have proved that AR used in EFL learning is able to ensure better attitude and performance through more interesting activities or immersive experience. However, almost all of these studies focus on informal learning neglecting the learning difficulties happen in class. Wu, Lee, Chang, and Liang (2013) suggested that researchers need to explore the possibilities and solutions of integrating AR into regular school curricula. Therefore, we hope this study can show AR's effects on solving teaching difficulties in a formal lesson based on this technology's features and previous researches' results.

3. Method

The main aim of this study is to test the effects of learning activities. On the basis of a well-designed AR application, students' understanding and expression in a regular 50-minute EFL class was recorded and analyzed. A pre-test and a post-test were carried out to trace students' change. And interviews with students were conducted at the next step to investigate how AR assists students in class.

3.1 Research Questions

Based on literature review and our prediction, the research questions of this study are presented below.
Q1: Can leaning activities based on AR benefit student' understanding in regular EFL class?
Q2: Can leaning activities based on AR benefit student' expression in regular EFL class?
Q3: How does AR assist students learning in regular EFL class?

3.2 Participants

92 students in grade 4 and their English teacher in Beijing, the capital of China, participated in this study. These students and their teacher all had experience of using mobile devices in class before this study. And these students experienced other AR applications before this class to learn how to use camera to observe and interact with virtual objects in an AR environment with location-based technology and multisensory technology.

3.3 Instruments

The pre-test consisting of 5 short-answer questions aims to evaluate students' prior knowledge of sun and earth. The first three questions are used to test students' English vocabulary and expression skills about the sun. And the last two questions are used to test students' cognition about cycles of day and night as well as four seasons. The last two questions are also used as post-test to acquire students' conceptual changes after class. Two teachers were required to score the last two questions with standards below in Table 12:

Table 12
The Standards for Students' Cognition about the Sun and the Earth

Score	Standard
1	Blank
2	Response containing error messages
3	Response containing irrelevant messages
4	Response containing incomplete messages
5	Response containing complete messages

Semi-structured interviews were used to examine if and how AR helped students to learn in students' own view. The outline of the interviews is shown below.

- What activity do you think is particularly interesting in class?
- Do you remember how we saw the sun and the earth in class?
- You learned through AR today, and is there any difference from this class and your previous English classes?
- Could you tell me what abilities you have improved in class?
- Do you want to continue to use AR to learn in the future?
- How do you think AR can be better used in this class?

4. AR Application Design

In this study, the application containing three main scenes is designed and implemented. The mobile-based AR application, called the Sun and the Earth, which can run on Android devices with cameras and gyroscopes. This application is developed based on Unity 3D engine, and Vuforia SDK is used to link virtual objects with the real environment. This application contains three main scenes: (1) See the Sun, (2) Day and Night, and (3) Four Seasons. These scenes are designed and implemented to make learning activities in class more vivid and interactive.

In the first scene, users can see the solar system around by lifting the device to different directions with gyroscope. There is a thermometer on the right side of the screen. It gets redder and taller when users make the sun bigger. And if the sun becomes big enough, the thermometer will explode and a voice will say so hot.

In the second scene, users can see the sun and the earth from a side-view, so that they can directly observe the cycles of day and night on earth. Users can start or stop the earth's rotation by clicking on the earth and feel about the cycles of day and night directly by observing the girl in pink and the boy in blue standing in different hemispheres on the earth.

In the third scene, users can see the earth's revolution around the sun from an overlooking perspective. With gyroscope in device, users can see earth in different seasons when facing different directions. There is a tree in the northern hemisphere showing the changing process of four seasons clearly, and a text message at the top of the screen present the season information. Users can start or stop the changing process by clicking on the earth.

5. Instructional Design

In this study, an English reading lesson for fourth grade students, named "The Sun", containing some learning activities with mobile-based AR applications is designed. This class should be an extended lesson which is implemented after students have learned basic vocabulary to describe the sun.

The basic goal of this class is to introduce the sun and its influence on the earth logically in English. Students dialogues will be carried out to help students understand the content better and perfect their oral expression. Students should learn at their own pace in dialogues, and they also develop the autonomous learning ability through the chatting activities. However, the sun and the earth are huge objective things that can hardly be observed and controlled by humans. The use of AR offers contextual support for students' dialogues by presenting corresponding phenomenon directly and allowing interaction with visual objects.

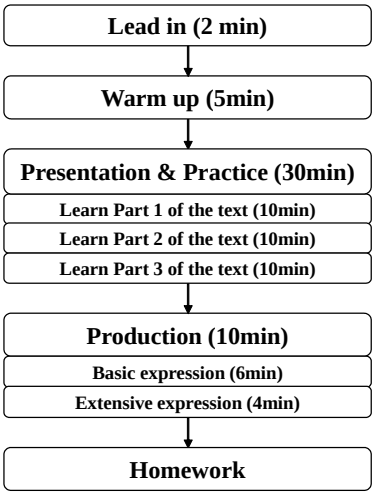

Figure 44. **Structure of This Class**

The basic structure of this class is shown in Figure 44. In this class, the AR application is used in leading in and learning about Part 2 and Part 3 of the text. Part 2 claims why earth has day and night and Part 3 states why earth has four seasons. These are difficult parts to understand and express in the text. In warming up, teacher first asks students to guess the sun according to some descriptions and enjoy a song about the sun to review some related words. Then they use AR to see the sun closer to intuitively feel the heat of the sun.

AR in learning activity of Part 2 help students practice these sentences: (1) Earth takes one day to spin around, (2) Yao Li is in the day, (3) Mike is at night, (4) China faces the sun, and (5) America faces away the sun. AR in learning activity of Part 3 help students to act as the sun and the earth and practice these sentence: (1) You take one year to go around me, and (2) It's spring/summer/fall/winter. After finishing the group work, volunteers can present in class.

6. Results

6.1 Students' understanding

One objective of this study is to examine the effectiveness of learning activities based on AR in terms of students' understanding in a regular EFL class. All the students were required to take the pre-test before class and post-test after class, but some of them didn't finish both tests for personal factors. Basically, the number of students is 73. By analyzing the changing process of students' cognition towards why we have day and night or four seasons. The *t*-test results show that students understand the content significantly better after the class as shown in Table 13.

Table 13

t-test Results of the Students' Understanding of Contents and Score Gap between 2 Parts

Item		Mean	SD	t	N
Day & Night	pre-test	3.14	1.35	-7.50***	73
	post-test	4.25	1.06		
Four seasons	pre-test	1.64	1.20	-10.62***	
	post-test	3.49	1.00		

(***p<0.01)

In terms of why we have day and night, the means of pre-test and post-test are 3.14 and 4.25, as SD's are 1.35 and 1.06. There are 43.8% and 84.9% of the students getting more than 4 score in pre-test and post-test. The *t*-test result also confirms that there are significant differences between their scores in pre-test and post-test. This implies that the students get better understanding about the sun gives us day and night through the learning activity based on AR.

In terms of why we have four seasons, the means of pre-test and post-test are 1.64 and 3.49, as SD's are 1.20 and 1.00. There are 12.3% and 67.1% of the students getting more than 4 score in pre-test and

post-test. The *t*-test result also shows there are significant differences between their scores in pre-test and post-test. These results meant learning activity based on AR that related to why we have four seasons help students construct their understanding effectively. However, some messages might not be presented clearly enough, so students tried to explain the phenomenon with some incorrect or irrelevant information. If the messages about the formation of seasons are presented more clearly, students will have better performance. It also inspires us the amount and clarity of information in an AR application is very important for the effects of using it.

6.2 Students' expression

3 questions in pre-test were used to test students' vocabulary and expression ability before class. Most of the students are able to describe the sun in terms of shape and heat. The common answer is that the sun was big and hot. The color of the sun is also a factor that many students talked about. Some students said the sun was like a ball. Few students referred to the relationship between the sun and the earth. Even if the earth appeared in students' answers, it was usually presented in a comparison of size or heat. So the students' expressions before class were simple and illogical.

Formative evaluation was used to test students' expression in class. Almost all of the students can introduce the sun in a comprehensive and logical way as the activities going on. Students were required to introduce the sun with following sentences: (1) It is a star, (2) It is very big, (3) It is made of superhot gas, (4) It can give heat and light, (5) It can give day and night, (6) It can give four seasons, and (7) It is the most important part of our solar system. Students practiced saying these sentences for several times and were checked by their partner in group and teacher in class. Some of the students could explain why the sun give day and night as well as four seasons. They can say earth takes one day to spin around and earth takes one year to go round the sun.

The improvement in students' expression was established in learning activities based on AR. One of the teaching difficulties in this class was to break and reconstruct students' understanding of the sun. The presentation and interaction with AR helps students get better understanding, and then it becomes much easier for them to expand own expression about the sun.

6.3 How did AR work

5 students performing well in class were interviewed according to the semi-structured outline to show how AR assisted students to learn in this EFL class. Students thought the visual presentation of AR brought about more authentic experience and more frequent interaction with others. The use of AR extended the teaching space from the podium to the entire classroom. As for abilities, they thought AR benefits in the improvement of collaboration ability, inquiry ability and autonomous learning ability. They thought there was a clearer division of work in the activities based on AR. And they were able to discovery some new knowledge when they use AR to learn. In summary, students will have more time to learn and communicate by using AR in class. In this way, they can get more authentic and rich learning experience to support better understanding and expression of learning contents.

7. Conclusion

The experimental results in this study revealed that learning activities based on AR was able to assist in the construction of understanding and expression about learning contents. Furthermore, by interviewing the students, the mechanism of how AR worked in this class was reported. Students would have more time to learn and communicate in AR-based activities. They needed to acquire knowledge by interacting with learning material and other people instead of just listening to the teacher or reading books. In this way, they get better understanding and expression of learning contents.

This study proves that AR takes advantages in EFL learning not only in informal learning but also in formal learning. First, AR can let learning experience be more authentic and interesting, which improve students' positive attitude and motivation(Amaia et al., 2016; He et al., 2014; Yang & Mei, 2018). Second, complex language skills are also improved in learning activities based on AR(Liu & Tsai, 2013; Safar et al., 2017). This study found the authentic presentation and frequent interaction are the

cores of using AR in class. Only when the use of AR enriches the learning environment and changes students learning style to autonomous learning, students can really improve their abilities through the use of the technology.

The results of analyzing in this study also inspire us to notice the amount and clarity of knowledge in an AR application. When we design and develop the AR applications, we choose what objects and relationships will be presented in them. Proper presentation may help students pay attention to knowledge that they ignore in daily life. And inappropriate presentation may bring misunderstanding of the learning content. It's worthy to be further discussed how to choose and present knowledge in AR applications.

Acknowledgements

Our work is supported by the National Natural Science Foundation of China (61602043) and 2019 Comprehensive Discipline Construction Fund of Faculty of Education, International Joint Research Project of Faculty of Education, Beijing Normal University.

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