Tan, S. C. et al. (Eds.) (2013). Workshop Proceedings of the 21st International Conference on Computers in Education. Indonesia: Asia-Pacific Society for Computers in Education

Using Augmented Reality to Assist an Interactive Multi-Language Learning System in an Elementary School

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Abstract: Second/foreign language learning has been a sustained concern due to competitiveness and globalization. Commonly, elementary school students in Taiwan learn not only their native language such as Mandarin but also English and Hokkien. It is not easy to acquaint students with multiple languages at the same time. Therefore, the solution to raise the students' interests and learning effectiveness during multi-language learning has been a hot issue. Augmented reality (AR) is a technology that blends virtual contents with the real environment, and it supports the context-aware ubiquitous learning. The application of AR is considered helpful to increase the students' motivations by past researchers. However, most researches focus on bilingual learning including Mandarin and English, and some specific learning objects (such as image cards) are needed to provide. Accordingly, an interactive multi-language learning system is proposed in this study to improve the inadequate parts mentioned above. It is expected to promote students' motivation and learning effectiveness.

Keywords: Second/foreign language learning, multi-language learning, augmented reality, context-aware ubiquitous learning, learning effectiveness

1. Introduction

Due to the growing trend of globalization, it is necessary to exchange information and communicate with people all over the world. Because language is the basis of communication, the necessity of second/foreign language learning to raise personal competitiveness to meet the global trend has become a sustained concern.

Commonly, elementary school students in Taiwan learn not only their native language such as Mandarin but also English and Hokkien. It is not easy to acquaint students with multiple languages at the same time. Therefore, the solution to raise the students' interests and learning effectiveness during multi-language learning has been a hot issue.

In the past, second/foreign language learning relied upon teachers' lecturing to explain the learning materials of textbooks (Savignon, 1988). It is possibly a severe test to teacher's presentation skills in the traditional teaching environment. Besides, no consideration of differences of students' abilities, traditional teaching may result in the students' cognitive load because of the poor level of prior knowledge. Due to the advance of technology, the increasing popularity of mobile devices enables learners to learn whenever and wherever without the restriction of time and place.

Augmented reality (hereafter abbreviated as AR) is a technology that allows the presentation of the real world with virtual objects superimposed upon or virtual objects composited with the real world (Azuma, 1997). AR has been applied so far in various research fields including language learning. Hsieh and Lin (2009) proposed an AR-enhanced English vocabulary learning system. Tsai, Li and Wu (2011) proposed an AR-enhanced Chinese learning system. Students can interact with the virtual objects in real word and learn more. Hence, students will have more fun and willingness to learn as well as impressive experience. These systems only supported single language learning, and some specific learning objects (such as image cards) need to be provided. However, it could not meet the requirements of students for learning multi-language in Taiwan.

Accordingly, an interactive multi-language learning system is proposed in this study. This system allows students learning multi-language in real environment without additional learning objects. It is expected to stimulate students' motivation, promote the learning effectiveness, and assist students to review the learning contents after school.

2. Literature Review

2.1 Language Learning

Clark and Paivio (1991) proposed a dual-coding theory. According to the theory, the way of people to process information is divided into two systems. One is the verbal system, and another one is the non-verbal system. In the verbal system, learning is in the way such as speaking, writing, or listening. In the non-verbal system, it uses the way to learn by graphics, sound, video, and even human emotions. In non-verbal system, learners can absorb related information to current study at the same time, so it allows more direct association of learning. Hence, it is helpful not only to reduce the cognitive load but also to be inferred from this association to impress and learn.

2.2 Development of Context-Aware Ubiquitous Learning

In recent years, there is an increasing possession of portable devices including smart phones, tablet PC (personal computer), pocket PC, PDA (personal digital assistant), and any devices which can be loaded digital information. Tatar, Roschelle, Vahey and Penuel (2003) proposed a notion named ubiquitous computing, and the concept was that the lightweight powerful networking and communications components enable ubiquitous application. Importing these technologies will provide personalized learning opportunities. Context-aware ubiquitous learning emphasizes on context-aware learning environment. For traditional learning in the classroom, teachers teach students knowledge is unilateral. Because the teaching time is limited, traditional teaching is considered unable to enhance learning motivation and interest. It may result in the students' rote learning rather than absorption of knowledge and problem-solving ability (Brown, Collins, & Duguid, 1989). In the context-aware ubiquitous learning environment, teachers will guide the students to take the initiative to learn. It can attract their attention to enhance the learner's real-world observation and problem-solving skills. In addition, it is not limited in any time and at any place.

Radio Frequency Identification (RFID) was considered to be an important technology. Landt (2005) stored the unique identifier and data in the microchip RFID tags. When RFID readers and RFID tags emit radio waves after induction, it can complete a non-contact recognition process. In the context-aware ubiquitous learning environment, learning objects can be combined with RFID tags, and students can use RFID readers to learn on some mobile devices. Although the reliability and speed of recognition of RFID is high, most of smart phones and tablet PCs do not support RFID, and its total cost is more expensive than the other technology such as Quick Response Code (QR Code). Thus, QR Code is considered a candidate to replace RFID gradually in ubiquitous learning.

QR Code is a technology mainly used to store text data, and it provides the good fault-tolerant identification. Besides, the feature of low cost and easy to copy is the advantages (Hsu, 2010). Nevertheless, RFID and QR Code respond the information in time, but it is unable to be presented to blend virtual materials with the real environment. It is likely to result in the information inconsistency between reality and virtuality. Augmented reality (AR) is a technology that allows the presentation of the real world with virtual objects superimposed upon or composited with the real world. The virtual objects that can be used in AR include texts, images, 3D objects and other media. Students can get the related and coherent information immediately (Azuma, 1997).

2.3 The Advantages and Disadvantages of Augmented Reality

Bimber (2007) pointed out that the interactive digital technology has been applied in various fields widely, such that it can convey information through the real environment or objects with AR technology. Bimber (2007) designed an AR system in the museum's exhibition, users can observe dinosaur fossils

with head mounted display (HMD), and the system also provides a detailed description of the relevant parts. Wu, Li, Yao and Pai (2012) designed an AR-enhanced system combined with the physical and chemical experiments. Students can use cards to learn and experience from teaching materials, and interactive features such as experimental process operations. In addition, the system can reduce the risk of experiment. According to the mentioned application and analysis, an AR system needs a user interface which is friendly and easy to use. In addition, it can't hide the object in the reality and need to improve the speed of identification (Azuma, Baillot, Behringer, Feiner, Julier, & MacIntyre, 2001).

2.4 The Application of Augmented Reality in Language Teaching

Kimer and Zorzal (2005) designed an alphabet-spelling game with AR technology. Among these spelling picture cards, students need to put the correct spelling picture cards together, and then the system will display the corresponding virtual object on screen. In this attractive environment, the system can enhance users' interaction and problem solving skills. Hsieh and Lin (2009) proposed an AR-enhanced English vocabulary learning system to achieve the effect of immersion learning. This system includes an English magic book which allows students to interact with. The system also provides many digital media and different stimulations of learning to students. The AR-enhanced English vocabulary learning system is able to be used by students to learn by themselves. Chang, Chen, Huang and Huang (2010) also used the AR technology to implement an English vocabulary learning system. To integrate the learning environment with game-based learning method in the proposed system, it enables no need of additional teaching materials and to promote the learner motivation. Tsai, Li and Wu (2011) proposed a Chinese learning system with AR technology. In the system, a lot of game cubes are provided, and each cube represents one Chinese character. When users combine Chinese cubes together to form a Chinese vocabulary, the explanation of the Chinese vocabulary will be displayed. Therefore, foreign learners can learn Chinese more easily with AR technology due to the instant interactivity.

AR technology is increasingly applied in various fields of studies. Because of the feature to allow the coexistence of virtuality and reality, it is expected to increase users' motivation and instant interactivity between user and system. Therefore, an interactive multi-language learning system enhanced by AR technology is developed in this study, and the advantage of the proposed system is to scan and focus simply the target object in real environment directly without any additional objects such as image cards. It is expected that this system can be used to stimulate students' learning motivation and enhance their learning effectiveness.

3. System Introduction

3.1 Hardware Architecture

Because an internal database is packed within the system, students can use a variety of mobile devices to launch the installed system instantly without Internet access as shown in Figure 1. All the students need to do is to scan the target objects, and then the corresponding virtual materials will be loaded and superimposed upon the screen. Therefore, students can interact with the AR-enhanced system to learn multiple languages.

Figure 1. The hardware architecture.

3.2 Software Architecture

The system is developed by the employment of Unity 3D game engine as the core and programming languages including JavaScript and C#. Open source software named Qualcomm AR (QCAR) is used to implement the augmented reality. Moreover, teaching materials are classified and imported into the corresponding databases such as text database, audio database, video database, and 3D model database.

3.3 Teaching Material

After discussion with teachers, totally 50 target objects provided by teachers are planned for this system as shown in Table 1.

Table 1: Target objects included in teaching materials.

Audio visual room	Auditorium	Basketball	Bulletin board
Black board	Chair	Chalk	Computer
Computer classroom	Counseling office	Desk	Dice
Door	Elevator	English classroom	Eraser
Faucet	Front gate	General affairs office	Glue
Guard room	Hallway	Health center	Hopscotch
Key	Library	Monkey bar	Music classroom
Parking lot	Playground	Principal office	Projector
Railing	Remote control	Ruler	Science classroom
Screen	See-saw	Sink	Slide
Stair (s)	Students affairs office	Studies affairs office	Swing
Television	Toilet	Trash can	Water
Window	Windowsill		

When students scan and focus on the target object through the system, they obtain corresponding learning contents including Mandarin, Hokkien and English as shown in Table 2.

Table 2: The presentation of teaching materials in the system.

Target Object	Mandarin	Hokkien	English	English Sentence
	桌子	toh-á	D.E.S.K. Desk	It is on the desk.

3.4 System Operation

The system is very easy to use. All the students need to do is to scan and focus on the target object with a mobile device such as a smart phone or a tablet PC as shown in Figure 2.

Figure 2. The operation to scan and focus on the target object with a mobile device.

After successful identification, it will display available buttons on the bottom of screen as shown in Figure 3. These buttons can be used to provide corresponding pronunciation in Mandarin, Hokkien, and English.

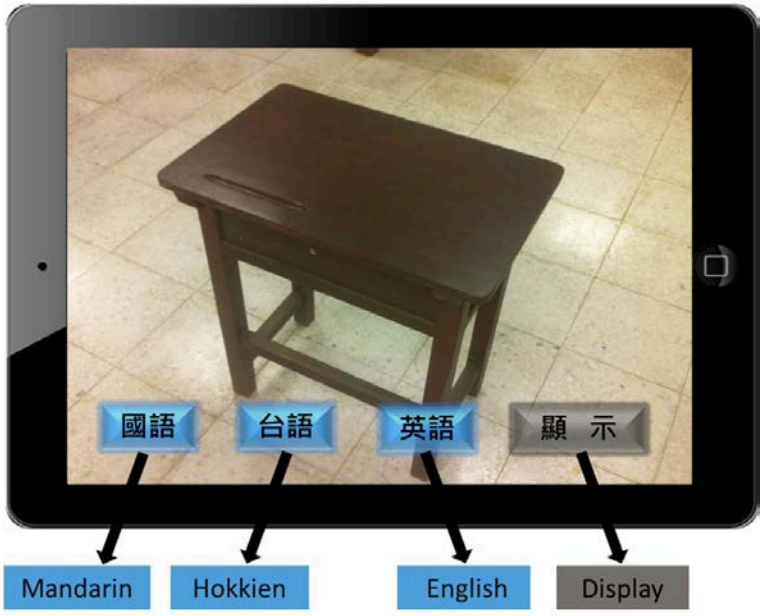

Figure 3. The screen presentation after successful identification of the target object.

If “Display” button is pressed, it will be toggled into “Hide” button, and all corresponding teaching materials for the target object including a Chinese vocabulary and an English vocabulary as well as an example of English sentence and its explanation in Chinese will be displayed on the screen as shown in Figure 4.

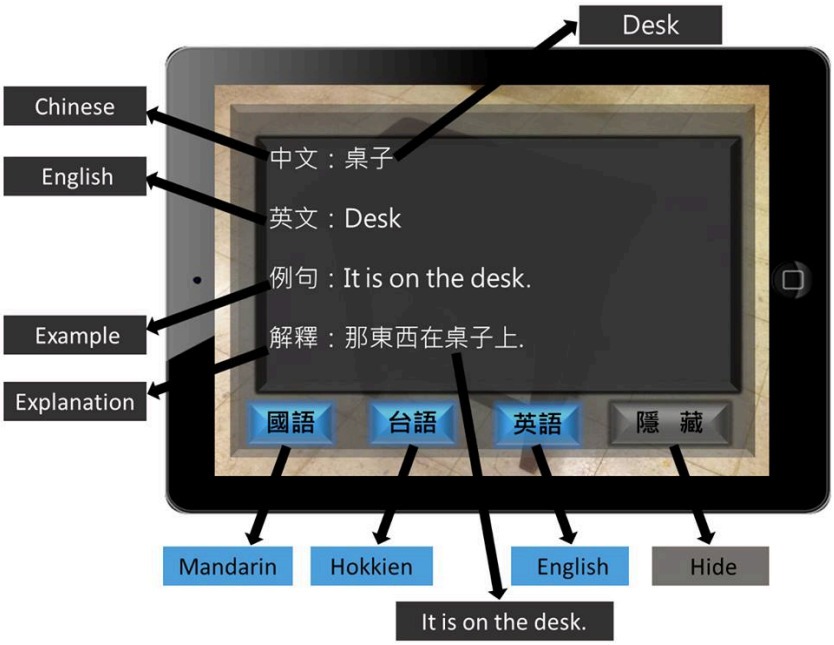

Figure 4. The screen presentation after “Display” button is pressed to toggle into “Hide” button.

As shown in Figure 5, there are three buttons (Mandarin button, Hokkien button, and English button) on the bottom of the screen. Each button provides a corresponding audio content. When “Mandarin” button is pressed by students, at first it will pronounce Mandarin Phonetic Symbols (MPS) one by one corresponding to individual characters of the Chinese vocabulary. Then, the whole Chinese vocabulary will be spoken in Mandarin, and the corresponding Chinese explanation will be spoken subsequently in Mandarin. When “Hokkien” button is pressed, the whole Chinese vocabulary will be spoken in Hokkien with Roman Pinyin, and then the corresponding Chinese explanation will be spoken at the same way. When “English” button is pressed, at first it will pronounce individual alphabets of the English vocabulary one by one in English. Then, the whole English vocabulary will be spoken in English, and the example of English sentence will be spoken subsequently. Students can repeat the audio content many times to enhance sensory stimulation and impression in the brain.

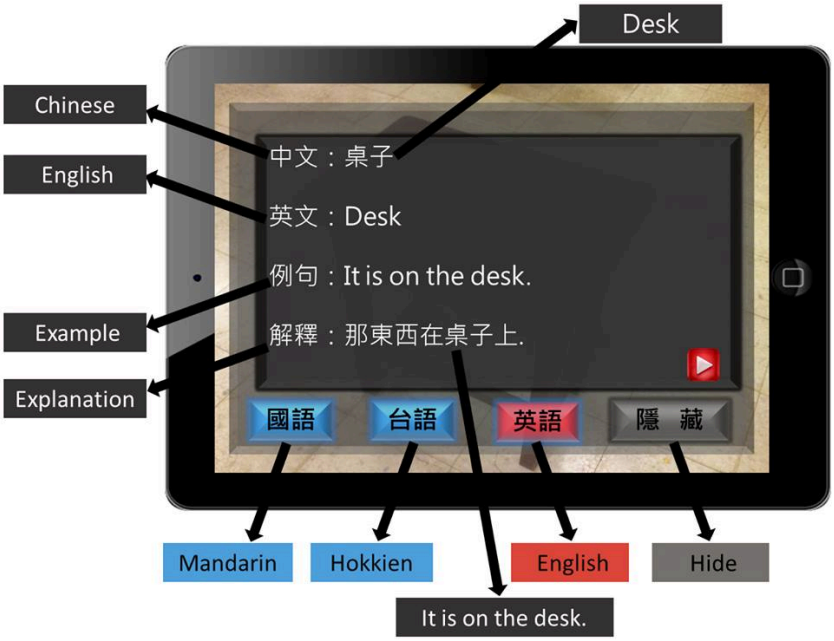

Figure 5. The screen presentation after “English” button is pressed.

4. Conclusion and Future Study

In this study, an interactive multi-language learning system with augmented reality is developed for an elementary school. Students can use the system to learn a Chinese vocabulary and its corresponding English vocabulary as well as its corresponding pronunciations including Mandarin, Hokkien, and English. The system also provides an example of English sentence and its corresponding Chinese explanation. The proposed system is expected to promote students' learning motivation and learning effectiveness by multiple sensory stimulations.

In the future, a teaching experiment will be implemented in September 2013, and the experimental subjects are students in an elementary school in Middle Taiwan. It is intended to explore the impact of students' learning style on their technology acceptance toward this system. Thus, in order to measure students' learning style, a questionnaire is designed according to the index of learning style proposed by Soloman and Felder (2001). In order to survey the technology acceptance of students toward this system, the important determinants in Technology Acceptance Model (TAM) proposed by Davis (1989) including perceived usefulness, perceived ease of use, attitude toward using, and behavioral intention to use, is applied to design a questionnaire. The experiment process is planned and illustrated as shown in Figure 6.

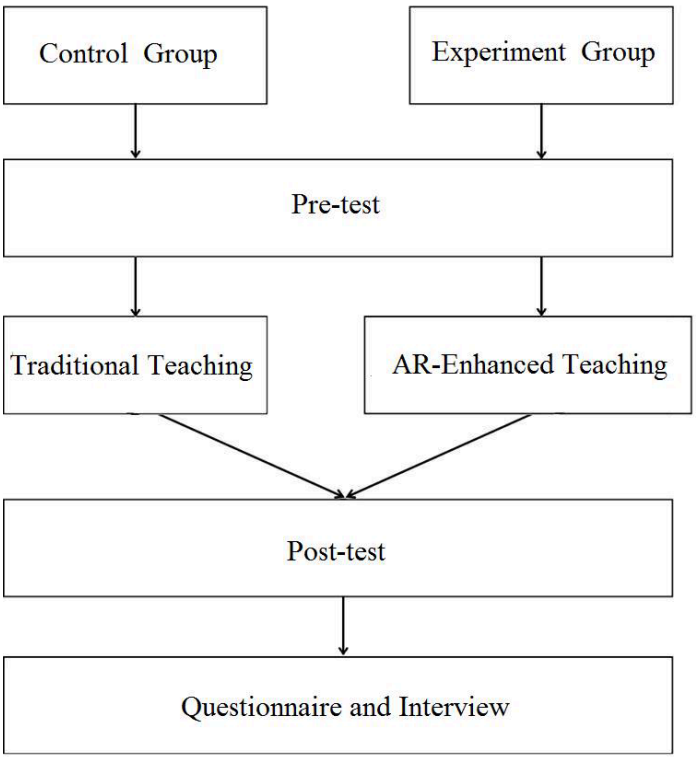

Figure 6. The experiment processes in the future study.

Acknowledgements

This study is sponsored by the National Science Council in Taiwan under the contract no. NSC102-2511-S-275 -003.

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