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Development of a Customized English Learning System based on Augmented Reality Technology

Gwo-Haur Hwang[1*], Beyin Chen[2] & Hen-Lin Huang[2]
[1]*Department of Information Networking and System Administration, Ling Tung University, Taiwan*
[2]*Department of Information Management, Ling Tung University, Taiwan*
*ghhwang@teamail.ltu.edu.tw

Abstract: The augmented reality (AR) is a kind of technology that can combine the virtual information and the real image. Many scholars indicate that AR can effectively enhance learners' learning motivation and effectiveness. This study proposes an English learning system based on AR technology. For customized design, the system adds the functions of related words and 3 learning scopes: phrases, and sentences, related words. In addition, an easy mode and an advanced mode are provided. These functions are less considered in the past and will also be regarded as the basis of future personalized preference analysis. Through the system, it is hoped that the learning motivation and learning effectiveness of learners can be enhanced. In the future, personalized preference will be analyzed according the collected historical data of learners' behavior.

Keywords: customized design, English learning, augmented reality, personalized preference

1. Introduction

With the advances of sciences and technologies and the rise of the concept of the global village, people around the world can cross national boundaries through networks and communicate in the aspects of information and culture. Among these developments, the language is essential as a communication bridge. In the global trend of internationalization, learning English is no longer just the needs of individuals only, but also a trend of into a new era (Hwang, Lee, Hwang, Huang, Lin & Cai, 2013). Taiwan is an EFL (English as Foreign Language) English learning environment. In Taiwan, a formal exposure to English is until entering elementary schools (Lu, 2012). In the traditional teaching environments, through explaining the rigid text of the textbooks by teachers, the English learning can be conducted, which is passive learning (Savigan, 1988). In other words, the teachers just unilaterally give students the knowledge. In addition, due to the restrictions of the teaching time, students usually recite the knowledge, so that the knowledge cannot be applied to everyday life (Brown, Collins & Duguid, 1989).

Looi, Seow, Zhang, So, Chen and Wong (2010) have used a context-aware ubiquitous learning system to record the situation of learners. It allowed teachers to rapidly understand students' learning process and individual differences and to develop better teaching methods. By this, students can get the most necessary information in a timely and appropriate manner (Chen, Lien & Lu, 2009). The development process of context-aware technology first is RFID (Radio Frequency Identification) technology, which can complete a non-contact identification process by using the RFID reader to induce the RFID tags (Landt, 2005). Although the reliability and the identification speed of RFID technology are very high, but most smart phones and tablets do not support the reading of the RFID tags. In addition, the cost is also much more expensive than QR (Quick Response) codes. Thus, in the field of context-aware ubiquitous learning, QR Code technology has gradually replaced RFID technology. However, the virtual information and reality information provided by these two technologies are completely separated. This will result in that the users do not have coherent information when they receive information. According the "Spatial Contiguity Principle" and "Temporal Contiguity Principle" of 12 multimedia design principles proposed by Mayer (2009), the learning effectiveness of learners can be increased if at the time of scanning real objects, the corresponding and associated information can be immediately generated beside the objects.

The augmented reality (AR) is a kind of technology that can combine the virtual information and the real image (Azuma, 1997). The technology allows that the learning process can more meet the above principles proposed by Mayer. Billinghurst (2003) has pointed out that AR can provide unique educational benefits. First, the use of AR as teaching aids allows learners smoothly to interact with virtual objects (interactive learning concept) in virtual and real environments. Second, the use of AR as teaching aids will extend as a new teaching and learning strategies. The learning mode can be conducted even if the students do not have any computer experience. Finally, AR has the characteristics that let learners be immersed in learning contents. It allows that learning is no longer just to face boring textbooks. Lai, Hwang, and Chen (2012) have pointed out that AR can indeed effectively enhance students' learning motivation. Therefore, if a language learning system is built through AR technology, learners will be able to scan the learning objects directly in the real scene. The real-time multimedia information or teaching materials can be obtained, without destroying the original scene, but also saving the additional cost of teaching objects.

In addition, past researcheres have indicated that learners like to have options to set the functions according to their own preference and actual situation especially when the learning environment has many variables (Mitchell, Chen and Macredie, 2005). Therefore, this study proposes a customized AR English learning system. It is different from the general paper textbooks or traditional media textbooks which are just flat texts or pictures and lack context and interactivity. We expect that the customized AR English learning system can increase the learning wishes of learners through the good interactivity of AR technology. In addition, it can record the learning process which provides the future teaching reference for teachers.

2. Literature Review

2.1 The problems of English learning

In the past, second/foreign language learning relied upon teachers' lecturing to explain the learning materials of textbooks (Savignon, 1988). In other words, because the teaching time is limited, traditional teaching is considered unable to enhance learning motivation and interest. It may result in the students' to learn English by a rote style rather than by a style of increasing knowledge and problem-solving ability (Brown, Collins, & Duguid, 1989). Looi, Seow, Zhang, So, Chen and Wong (2010) have indicated that if the technologies of context-aware and ubiquitous learning are imported in teaching, learning will be able to be conducted at any time and any place. Thus, the role of teachers will transfer from imparter to guider. Teachers will guide students to learn actively and attract their attention so that the learners' ability of observation of the real world and the ability to actually solve problems can be enhanced. (Chen, Lien & Lu, 2009). Among the technologies of context-awareness, RFID and QR code technologies have the disadvantages of information discontinuous problem. Therefore, this paper uses AR technology to implement our learning system.

2.2 The applications of AR technology on education

AR is to import the images, objects, and scenes generated by computers to the real environment. Its purpose is to enhance the effect of perception. That is, the virtual objects are added to the real environment. This technology must have 3 characteristics: "combine the virtual and the real world", "be able to interact immediately", "be necessary in 3D space" (Azuma, 1997). Milgram, Takemura, Utsumi and Kishino (1994) regard real and virtual environments as a closed set as shown in Figure 1. The left is a purely real environment and the right is a purely virtual environment. The virtual reality attempts to replace the real world, while the augmented reality is to augment the virtual picture generated by computers into the real environment.

Figure 1. The definition of AR (Milgram et al., 1994).

AR is currently widely used, for example, education, medical science, military training, engineering, industrial design, art, entertainment, etc. (Azuma, 1997). Among these applications, the application of AR on education has obtained the attention of many scholars. The reason is that the traditional way of multimedia learning lacks immediacy and interactivity. During the learning, the virtual and real information is separated. This disadvantage has been greatly improved after the rise of AR technology. Therefore, there are many scholars applying AR technologies to mobile navigation and context-aware ubiquitous learning.

There are many applications of AR technologies on mobile navigation. For example, Kuo (2008) applied AR to "epidemic battle Camp" exhibition at the National Science and Technology Museum. It allowed the audience to interact with objects in a 3D environment. The objects may be not able to actually take to the exhibition; may be not able to let the audience touch; or may be necessary to be amplified. Thus, the better communication effectiveness can be achieved. In addition, the stay time of visitors in front of display units can be extended. Sejin and Woontack (2009) proposed the guide learning of context-aware applied in the Museum of Art. It allowed users to follow the guiding indicator to deepen the art articles. In addition, according to different users, it provided personalized guidance interface. However, this study did not carry out effective analysis. Lin, Tang and Peng (2011) also used AR technologies to build digital teaching materials of arts and humanities learning of an elementary school. The results showed that the learners felt comfortable and easy when learning and operating AR aids. In addition, they have also maintained a certain degree of concentration and a sense of curiosity to AR aids. Wernhuar and Ou (2012) proposed an AR system of butterfly virtual ecological learning environment used on smart phones. The system was easy to maintain and solved the problem of insufficient butterfly species. The experimental results showed that the use of AR technology can improve the learning effectiveness. Chen and Tsai (2013) also applied AR to a library of an elementary school. They explored the effect of gender, prior knowledge and cognitive style on learning. The results found that AR learning way can enhance the overall learning satisfaction of learners. In summary, AR applied to mobile navigation can increase the learning willing and motivation of learners, but also enhance the learning effectiveness.

Many studies have also applied the AR technology to classroom teaching and reading. For example, Dünser and Hornecker (2007) studied and looked at the children' learning status of reading textbooks. They explored how for children of 6 to 7 years old to operate interactive teaching media. The results showed that a rich interface may increase the willingness of students to learn. Amir and Vineet (2012) proposed a system to assist construction engineering students with AR technology to simulate the actual construction. Thus, the shortcomings of traditional construction which cannot practice actually can be improved. Under the simulation of AR environments, the students can conduct learning according to the real situation. Wu, Li, Yao and Pai (2012) designed an interactive AR system of chemistry experiment. Students can operate the picture cards of experiment equipment to complete a virtual chemistry experiment via AR technology. The difference between the traditional teaching style and the AR teaching style is that the students can watch the entire chemical reaction process through the 3D model. In addition, the experimental dangers that may occur can also be avoided. Chu and Lin (2013) have built an AR system which combined Kelly grid. It was used in natural science courses of an elementary school. The results showed that students' learning attitude was improved significantly. Chen, Zhao, Liu, Lin and Lu (2013) have built an AR system of gear teaching which imported the game concept. The experimental results indicated that the system can effectively enhance the concentration and the learning interest of students. In conclusion, we found that the use of AR technologies in the classroom can improve the shortcomings of the previous learning environment. In addition, it also enhanced the concentration of learners in classroom.

In addition, there are many applications of AR technology on language learning. For example, Hsieh and Lin (2009) designed an AR system of English vocabulary learning which had immersive learning outcomes. The experimental results showed that the learners will be willing to use the system. Chang, Chen, Huang and Huang (2010) also built an AR game-based English vocabulary learning system. The above two English vocabulary learning systems are both based on AR technology, but the methods are different. The former is to use English vocabulary magic books so that learners can scan the learning objects in the books while the latter is to scan the 3D learning objects directly to conduct learning. The advantage of the latter is able to scan real objects in a real environment. It does not need extra teaching objects. So, this study adopts the latter method. Tsai, Li and Wu (2011) applied AR technology to Chinese learning. The learning system allowed foreigners to learn Chinese by combining learning objects of text boxes and the instant interactivity of AR technology.

However, the above teaching systems are all for vocabulary. The applications of related words or example sentences are lacking. In addition, it is inconvenient because additional objects are required. Therefore, in this study, we will develop a customized English learning system based on AR technology. It is hoped that through the combination of the real situation and the virtual information, the learning motivation and effectiveness of learners can be enhanced.

2.3 Customized design

Personalized design is to design system architecture or user interface according to the unique and special requirement of every user (Fink & Kobsa, 2000). Personalized design can be provided by 2 styles. One is customized and the other is adaptive. Regarding customized, users have the right of selection. That is, they are allowed to modify the content presentation styles, user interfaces and navigation tools themselves. Regarding adaptive, the system actively provides appropriate content presentation styles, user interfaces and navigation tools according to the observed user behavior. In other words, the former is user-oriented while the latter is system-oriented. Both have advantages respectively. The former gives users considerable options, but needs extra effort to choose their suitable manners. The latter although can decrease users’ loading, but may erroneously compute the users' preferences. However, the past researches have shown that most users prefer to have options (Mitchell, Chen and Macredie, 2005). Especially when the learning environment has many variables, the users like to set the content presentation styles, user interfaces, and navigation tools according to their own preference and actual situation.

3. System Implementation

3.1 The hardware architecture

Learners only need to install the customized AR English learning system to a smart phone or a tablet and then can scan the learning object using the smart phone or the tablet. When the identification is completed, the interactive learning in the real object and the virtual teaching material will be conducted. The operation of the system is very easy. So, even if the learners do not have any computer experience, they can use the system very easily. The hardware architecture of the system is shown in Figure 2.

Figure 2. The hardware architecture.

3.2 The software architecture

The software architecture of the system is shown in Figure3. There are 4 databases, which store text material, voice material, picture material, and the usage behavior record of learners, respectively. The text material database stores the English words, phrases, and sentences of all objects. The voice material database stores the English and Chinese pronunciation of all teaching material. The picture material database stores the animation and image of all objects. The learners' portfolio database records the behavior operation process, for example, the setting of personalized preference, the time of all objects scanned, the time of the function button clicked.

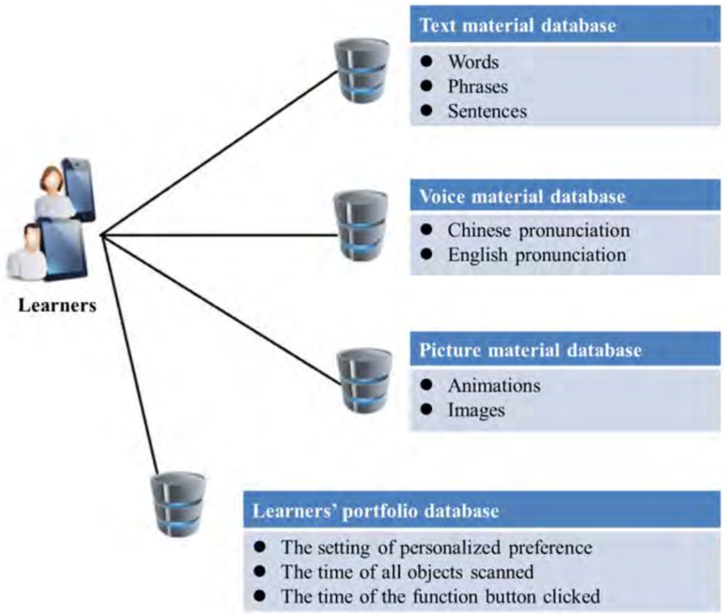

Figure 3. The software architecture.

3.3 The snapshots when the system was executed

The operation of the system is very simple. After starting the system, learners just need to scan the real objects with smart phones or tablets as shown in Figure 4.

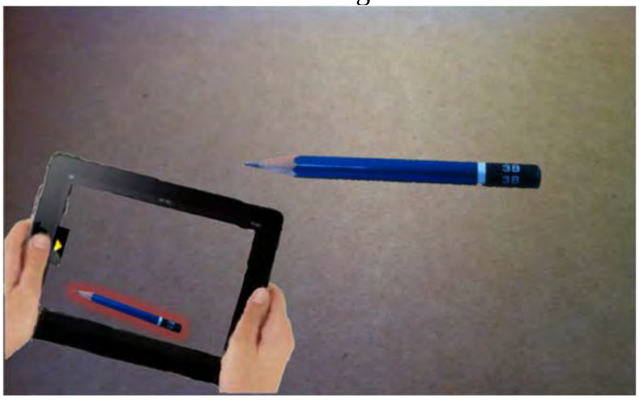

Figure 4. Scan the actual scene objects with a tablet.

The system provides 3 learning scopes: phrases, sentences, related words. In the learning process, learners can turn on or off these functions with their own preferences. In addition, there are 2 learning modes can be selected. One is the easy mode and the other is the advanced mode. These functions are for customized design and as shown in Figure 5.

Figure 5. Customized selection.

When learners successfully scan an object, the screen will show the main teaching material (for example, a pen) and the teaching material of related word (for example, an eraser). A flashing light will appear around the two teaching materials to enhance the display, so that the learners can clearly know where the operable objects are. After the learners click the object that want to learn (For example, the eraser), the corresponding function buttons will appear, as shown in Figure 6. Such design is to meet the "Spatial Contiguity Principle" and "Temporal Contiguity Principle" of 12 multimedia design principles proposed by Mayer (2009). The design allows learners can simultaneously observe the real learning object and corresponding virtual teaching material. Thus, the best learning effectiveness can be obtained.

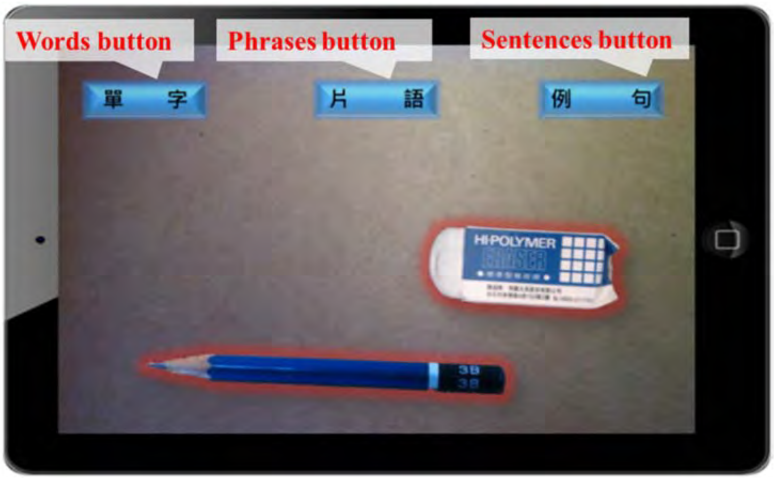

Figure 6. Learners successfully scan the learning object.

When learners click the function button of "words", the system will first split the word into letters and read out each letter. Meanwhile, the screen also appears the corresponding letters in marquee style. Then, the word will be read out once. Then, the Chinese meaning will be explained using Chinese voice, as shown in Figure 7. Such design is to meet the "Modality Principle" of 12 multimedia design principles proposed by Mayer (2009). The design allows the learners can use auditory and visual multisensory to receive a single message. Thus, the best learning outcomes can be achieved.

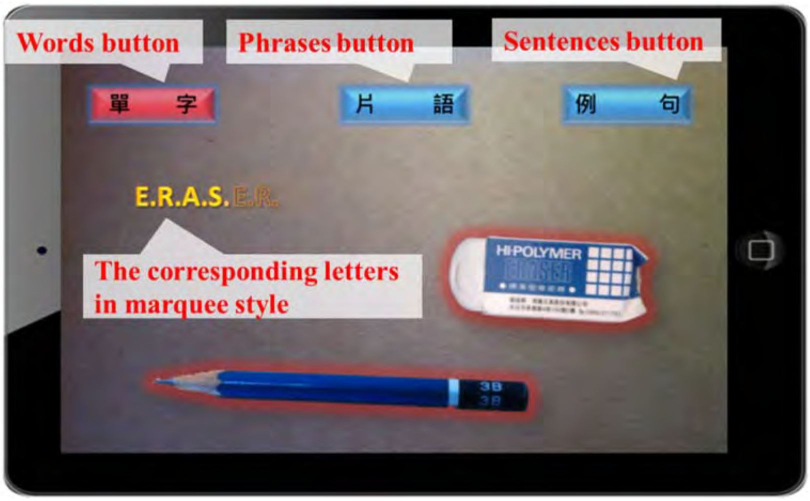

Figure 7. The function of “words” button.

If learners click the function button of "phrases", the teaching material of phrases will appear on the screen. Then, the phrase will be read out using English and the Chinese meaning will be explained using Chinese voice. In addition, the corresponding animation will appear. The system will give simple phrase in the easy mode (as shown in Figure 8) and give more difficult phrase in the advanced mode (as shown in Figure 9).

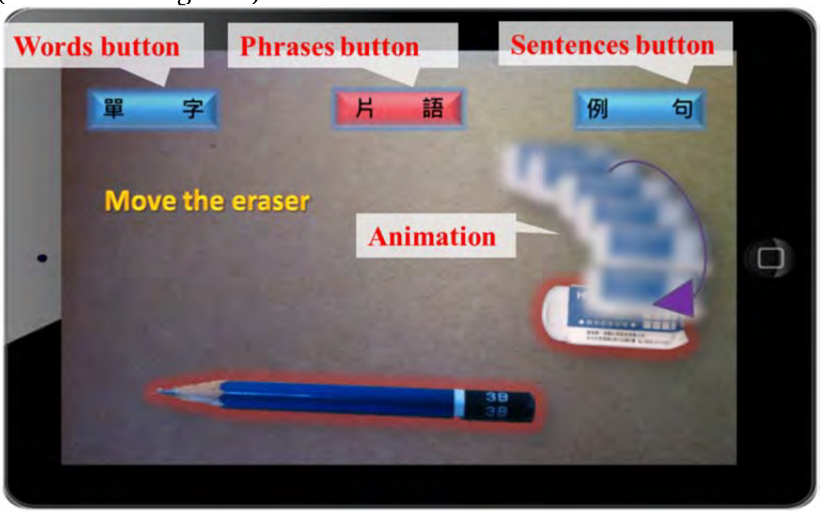

Figure 8. The function of “phrases” button in easy mode.

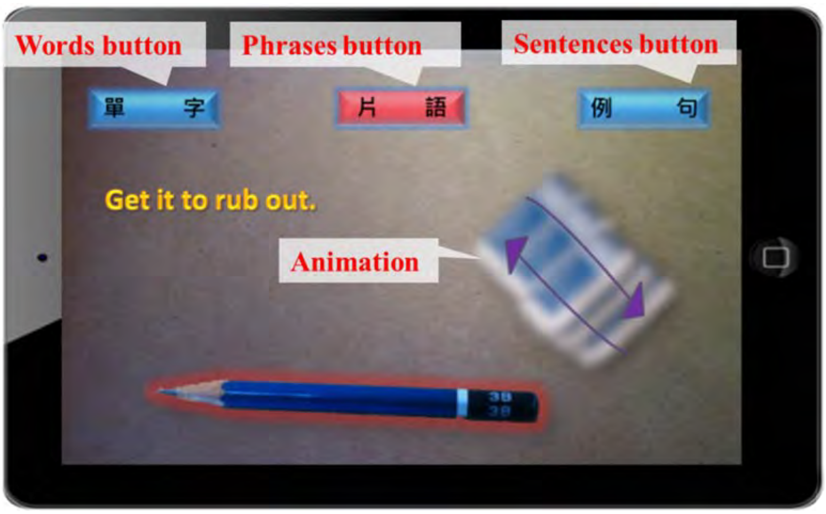

Figure 9. The function of “phrases” button in advanced mode.

If learners click the function button of "sentences", the teaching material of sentences will appear on the screen. Then, the sentence will be read out using English and the Chinese meaning will be explained using Chinese voice. In addition, the corresponding animation will appear. According the easy or advanced mode, the degree of difficulty of the sentence is also different, as shown in Figure 10.

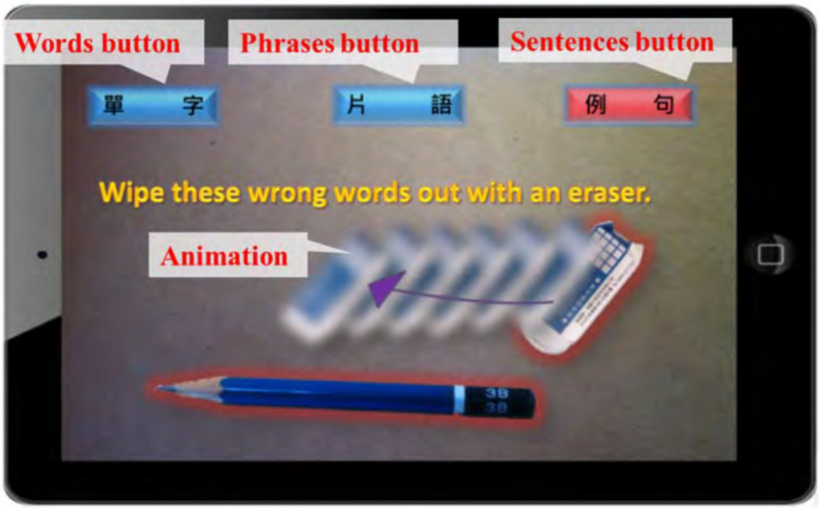

Figure 10. The function of “sentences” button.

4. Conclusions and Future Works

This study proposed a customized AR English learning system. The system provided 3 learning scopes (phrases, sentences, and related words) and 2 modes (the easy mode and the advanced mode). By AR technology and customized design, the learning motivation and effectiveness of learners are expected to be enhanced.

In the future, we will invite 2 teachers in an elementary school in the central region of Taiwan to provide 100 English vocabularies suitable for grade 5 students and to conduct experimental teaching. The experimental subjects are 100 students of 4 classes. All the operation process will be recorded in database, so that further personalized preference analysis can be conducted.

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References

Amir, H. B., & Vineet, R. K. (2012, November). *A framework for utilizing context-aware augmented reality visualization in engineering education*. Paper presented at the 12th International Conference on Construction Application of Virtual Reality, Taipei, Taiwan.

Azuma, R. (1997). A survey of augmented reality. *Presence: Teleoperators and Virtual Environments*, *6*, 355-385.

Billinghurst, M. (2003). *Augemented reality in education*. Retrieved on Dec. 27, 2013 from http://www.newhorizons.org/strategies/technology/billinghurst.htm.

Billinghurst, M. (2003). *Augemented reality in education*. Retrieved December 27, 2013 from http://www.newhorizons.org/strategies/technology/billinghurst.htm.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated Cognition and the Culture of Learning. *Educational Researcher*, *18*(1), 32-42.

Chang, Y. J., Chen, C. H., Huang, W. T., & Huang, W. S. (2010, December). *Application of Augmented Reality on Implementation of the English Vocabulary Learning system*. Paper presented at the 16th Conference on Information Management & Practice (IMP 2010).

Chen, C. M., Tsai, Y. N. (2013). Interactive Augmented Reality System for Enhancing Library Instruction in Elementary Schools. *Museum News of Taipei Public Library*, *30*(3), 29-49。

Chen, Y. H., Lien, C. J. & Lu, Y. L. (2009, May). *Influences of different learning preferences on learning achievement in E-learning*. Paper presented at the 13th Global Chinese Conference on Computers in Education (GCCCE 2009). Taipei, Taiwan.

Chen, Z. Y., Zhao, Z. Y., Liu, C. X., Lin, K. Z., & Lu, G. F. (2013, May). *Development and Design of Gear Unit in Game-based Interactive Teaching Materials Using Augmented Reality Technology*. Paper presented at the 17th Global Chinese Conference on Computers in Education (GCCCE 2013). Beijing, China.

Chu, H. C., & Lin, C.-W. (2013, September). *The development and application of a repertory grid-oriented ubiquitous augmented reality learning system*. Paper presented at the 2nd IIAI International Conference on Advanced Applied Informatics (IIAI AAI 2013) Conference, Kunibiki Messe, Matsue, Japan.

Dünser, A., & Hornecker, E. (2007). Lessons from an AR book study. *Proceedings of the First International Conference on Tangible and Embedded Interaction*, 179-192.

Fink, J. & Kobsa, A. (2000). A Review and Analysis of Commercial User Modeling Servers for Personalization on the World Wide Web. *User Modeling and User-Adapted Interaction, 9*(34), 209-249.

Hsieh, M. C., Lin, H. C. (2009, September). *Employing augmented reality to promote English vocabulary learning*. Paper presented at the 5th Taiwan E-Learning Forum (TWELF 2009), Tainan, Taiwan.

Hwang, G. H., Lee, C. Y., Hwang, H. L., Huang, G. L., Lin, J. Y., & Cai, J. J. (2013). *Using augmented reality to assist an interactive multi-language learning system in an elementary school.* Proceedings of the 21st International Conference on Computers in Education. Bali, Indonesia.

Kuo, S. W. (2008, December). Preliminary study on the application of augmented reality in museum exhibition. *Technology Museum Review*, *12*(4), 25-37.

Lai, Q. L., Hwang G. J., Chen, H. L. (2012, May). *The learning effectiveness analysis of teaching imported augmented reality*. Paper presented at the 16th Global Chinese Conference on Computers in Education (GCCCE 2012). Kenting, Taiwan.

Landt, J. (2005). The history of RFID. *IEEE Potentials, 24*(4), 8-11.

Lin, H. C., Tang, K. W. & Peng, Y. Y. (2011). Effectiveness analysis of integrating augmented reality into learning domain of arts and humanities: A Perspective of user playfulness. *International Journal on Digital Learning Technology, 3*(3), 39-56.

Looi, C. K., Seow, P., Zhang, B., So, H. J., Chen, W., & Wong, L. H. (2010). Leveraging mobile technology for sustainable seamless learning: a research agenda. *British Journal of Educational Technology, 41*(2), 154-169. doi:10.1111/j.1467-8535.2008.00912.x.

Lu, C.M. (2012). *Application of Simple Quasi-markless Augmented Reality: A Case Study of English Conversation* (Unpublished master’s thesis). National Taipei University of Education, Taipei City.

Mayer, R. E. (2009). *Multimedia learning, second edition.* Cambridge University Press.

Milgram, P., Takemura, H., Utsumi, A., & Kishino, F. (1994). Augmented reality: a class of displays on the reality-virtuality continuum. *Proceedings of Society of Photo-Optical Instrumentation Engineers (SPIE), 2351*, 282-292.

Mitchell, T. J. F., Chen, S. Y. & Macredie, R. D. (2005). Cognitive Styles and Adaptive Web-based Learning. *Psychology of Education Review, 29*(1), 34-42.

Savignon, S. J. (1988). In second language acquisition/foreign language learning, nothing is more practical than a good theory. *Issue and Developments in English and Applied Linguistics*, *3*, 83-98.

Sejin, O., & Woontack, W. (2009, January). *CAMAR: Context-aware Mobile Augmented Reality in Smart Space*. Paper presented at the 3rd International Workshop on Ubiquitous Virtual Reality (IWUVR 2009), Adelaide.

Tsai, Y. S., Li, L. M., & Wu, A. H. (2011, November). *Augmented Reality Applications in Chinese Digital Teaching Materials: On Chinese Cubes*. Paper presented at the 7th Taiwan E-Learning Forum (TWELF 2011), Taipei, Taiwan.

Wernhuar, T., & Ou, K. L. (2012, March). *A study of campus butterfly ecology learning system based on augmented reality and mobile learning*. Paper presented at the 7th IEEE International Conference on Wireless, Mobile, and Ubiquitous Technologies on Education (WMUTE 2012), Kagawa, Japan.

Wu, M. N., Li, M. H., Yao, Y. J., & Pai, T. F. (2012, October). *Interactive digital teaching for chemistry experiment using augmented reality*. Paper presented at the 8nd Taiwan E-Learning Forum (TWELF 2012). Tainan, Taiwan.