Liu, C.-C. et al. (Eds.) (2014). Proceedings of the 22nd International Conference on Computers in Education. Japan: Asia-Pacific Society for Computers in Education

Incorporating augmented reality into learning practical skills for medical surgery

Ying-Shao Hsu[a], Yuan-Hsiang Lin[b], Beender Yang[c], Shih-Fan[b] Yang, Ya-Yen Chan [b], Zi-Hao Lin[b], and Yi-Sheng Chan[b]

[a]*Graduate Institute of Science Education, National Taiwan Normal University, Taiwan*

[b]*Department of Electronic and Computer Engineering, National Taiwan University of Science and Technology, Taiwan*

[c]*Saturn Imaging Inc., Taiwan*

*yshsu@ntnu.edu.tw

Abstract: In this paper, we demonstrate how to incorporate augmented reality (AR) into the learning of practical skills for medical surgery. We embedded AR in authentic inquiry activities so that students could experience when and how to carry out a certain medical surgical procedure. Two learning modules related to medical surgery were developed, "laparoscopic surgery" and "cardiac catheterization". Thirty-two senior high school students participated in this study and their perceptions of AR were examined. A survey of student perceptions included the three constructs of authenticity, engagement and motivation. The results showed that the students had positive perceptions (overall mean = 4.1) of AR after completing the two modules. However, AR authenticity was the concept perceived as having the lowest ranking (mean = 3.7). In contrast, both the motivation triggered by AR and engagement reached 4.3. This article provides a possible solution for the alignment among instructional approaches (authentic inquiry), technology design (AR) and learning experience.

Keywords: Augmented reality, Authentic inquiry, Practical skills

1. Introduction

Augmented reality offers a new form of interactivity between the physical and virtual worlds, and enhances users' perceptions of the real world (Kesima & Ozarslan, 2012). According to Wu et al.'s review (2013), AR allows students to develop important practices, and has become one of the key emerging technologies in education. Although AR may present opportunities for teaching and learning, do students perceive an adequate level of realism when they are immersed in such a learning environment? How can researchers and educators work together to advance learning by aligning instructional approaches, technology design and learning experience? This study aims to propose a possibility to embed AR in authentic inquiry activities for contextualizing student exploration of medical surgery.

2. The AR learning modules

Authentic inquiry refers to performing the complex process which scientists actually carry out (Chinn & Malhotra, 2001). Instead of the simple inquiry tasks seen in most science textbooks, authentic inquiry tasks allow students to interact with computer-simulated experiments or equipment so as to develop their inquiry skills. AR is a promising way to combine authentic contexts and simulated experiments for student exploration. Therefore, we incorporated AR with authentic inquiry to engage students in two surgical procedures, laparoscopic surgery and cardiac catheterization. The authentic inquiry activities were designed to facilitate the students' experience of the diagnosis of symptoms and to operate the laparoscopic surgery and cardiac catheterization simulators (Figures 1 and 2).

Originally, the simulated experiments in these two modules were designed for medical majors. For an outreach purpose, we invited senior high school teachers to design authentic inquiry activities for introducing metical practical skills to senior high school and helping them explore the possibility of their future career. A total of 32 senior high school students were grouped into eight groups, each of

which was provided with an Android tablet computer to interact with the simulators using the scanning function on the tablet. The tablet computer delivered an authentic context of a patient's symptoms, and the students were required to diagnose the possible disease using the data such as X-ray images and electrocardiograms on the tablet. Then, the students used the simulator to help the patient recover from the disease. We applied the role-play technique in these activities whereby the students were told that they were surgery interns who were required to learn practical surgical skills. The students spent 2.5 hours working in a group to complete these two learning modules, laparoscopic surgery and cardiac catheterization.

A survey was conducted right after the modules to elicit the students' perceptions of AR including the three constructs of realism, engagement, and motivation. Each construct consisted of six 5-point Likert-scale items modified from the study of Change, Lee, Wang and Chen (2010).

Figure 1. Laparoscopic surgery simulator.

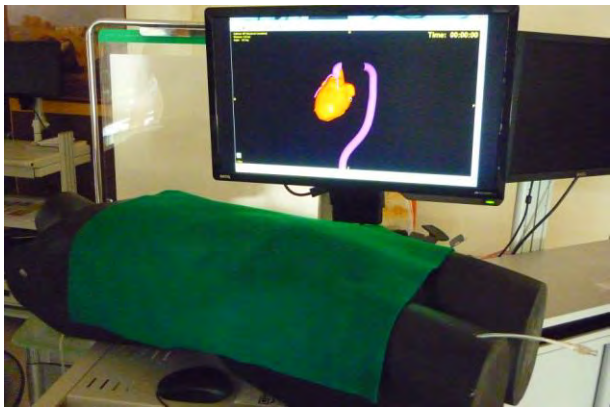

Figure 2. Cardiac catheterization simulator.

2.1 The laparoscopic surgery module

The students were told that they were to role-play surgery interns. Each group of students worked with a tablet and the simulator. First, a video clip on the tablet showed a patient describing his symptoms, and the students were required to diagnose the possible disease after checking the x-ray images. Second, some surgery options were shown to the students from which they were required to select the most appropriate procedure for the disease. Third, the students used the scanning function to activate the simulator, and operated the laparoscopic surgery simulator which displays 3D images for promoting practical skills (Figure 1). Finally, the students needed to reflect on the pros and cons of laparoscopic surgery and to offer their opinions regarding improvements to such surgery.

2.2 The cardiac catheterization module

The cardiac catheterization module was developed following a similar procedure to that of the laparoscopic surgery module. The students role-played surgery interns to diagnose a patient's disease from the electrocardiogram on the tablet. Then, the students used the scanning function to activate the simulator and carried out angioplasty by operating a catheter in the simulator. A 3D heart image was displayed synchronously on the computer to indicate the location of the catheter when the students moved it in the simulator. For some critical points, the computer provided a doctor's advice to help the students overcome their difficulties operating the catheter. At the end, the students needed to answer some questions related to cardiac catheterization.

3. Findings and Conclusions

As Table 1 shows, the overall average score of student perceptions of AR was 4.1. The average scores of student perceptions of realism, engagement and motivation are separately 3.7, 4.3, and 4.3. We found evidence that embedding AR in authentic inquiry promotes students' engagement and motivation in developing the practical skills for medical surgery. Although we used the same equipment as medical surgery, the students still perceived that the AR developed in this study was not as realistic as it might

have been. More improvements can be made to increase the realism of AR such as connecting surgical equipment to a human model which can react to students' operation synchronously through sensors. Future studies need to investigate other important aspects such as examining the benefits of AR for learning practical skills in authentic inquiry activities.

Table 1: Summary of student perceptions of AR.

Constructs	Mean	S.D.
Realism	3.7	1.1
Engagement	4.3	1
Motivation	4.3	0.7
Total	4.1	1

Acknowledgement

This research is partially supported by the"Aim for the Top University Project" of National Taiwan Normal University (NTNU), sponsored by the Ministry of Education, Taiwan, R.O.C. and the "International Research-Intensive Center of Excellence Program" of NTNU and Ministry of Science and Technology, Taiwan, R.O.C. under Grant no. NSC 103-2911-I-003-301.

References

Chang, C. W., Lee, J. H., Wang, C. Y., & Chen, G. D. (2010). Improving the authentic learning experience by integrating robots into the mixed-reality environment. *Computer & Education, 55*(4), 1572-1578.

Chinn, C. A., & Malhotra, B. (2001). Epistemologically Authentic Inquiry in Schools: A Theoretical Framework for Evaluating Inquiry Tasks. *Science Education, 86*(2), 175-218.

Kesima, M., & Ozarslan, Y. (2012). Augmented reality in education: current technologies and the potential for education. *Procedia - Social and Behavioral Sciences 47*, 297 – 302.

Wu, H.-K., Lee, S W.-Y., Chang. H.-Y., and Liang, J.-C. (2013). Current status, opportunities and challenges of augmented reality in education. *Computers & Education, 62*, 41-49.