Mobile Augmented Reality in Nursing Educational Environments

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***Abstract*—The possibility of using Augmented Reality (AR) in learning and training has become more straightforward than before, as a result of the extensive use of Information and Communication Technologies (ICT) in the computer and mobile industries. Even though AR is used in education, and it is generally acknowledged that it has a positive impact on learning outcomes, the value of integrating AR applications into learning environments has not yet been fully investigated** [1]**. This in progress work considers the integration of AR technology into nursing clinical lab training, introduces new ways of interacting with manikins, and allows students to view patient scenarios instead of relying on teacher explanations. AR allows students to visualize hidden objects such as internal organs, which makes simulations more realistic and immersive. The study investigates the potential of this technology in terms of enhancing nursing students' self-regulation skills.**

Keywords— Augmented Reality; Mobile Learning; Nursing; Higher Education; Self-learning; Self-Regulation; Clinical skills

I. INTRODUCTION

Nowadays, the world is getting smarter than before. Smart devices surround us and humanity is becoming dependent on them. Smart devices have the major advantage of providing access to the Internet anytime, anywhere and for any purpose. One of the new technologies is Augmented Reality (AR), which creates virtual extra layers on physical objects. It allows digital information to be incorporated into the real environment by blending those two worlds together [2]. AR offers new learning opportunities, integrated with mobile applications, and smartphone devices can be used as AR tools to support interactive learning. Increasing interactivity as an individual AR benefit introduces new ways of interaction between learner and learning tools [1]. Radu [3] explored how the positive learning effects of AR in education increase content understanding, improve long-term memory retention, and increase student motivation and self-learning

II. SELF-REGULATION LEARNING

Self-regulated learning is an active, constructive process whereby students set goals for their learning based on past experience and the contextual features of the current environment [4]. The individuals take responsibility to manage their personal learning processes. Researchers have shown that self-regulation is the predictor that best explains both learner achievement and the learning environment [5]. Furthermore, self-regulated students are more inclined to transfer successfully their knowledge from an e-learning system into real-world situations. Zimmerman [6] indicated that students with poor self-regulation skills are not as academically successful, whereas successful students are more likely to be self-regulating. So, integrating AR within the learning process will enhance reality rather than completely replace it, and display useful information that is not directly detected by students' senses in real time (such as human organs for nursing students). This will also help them to perform real-world tasks, and facilitate their understanding of complex scenarios independently. Together, those benefits lead to improved student self-regulated skills. However, there has been a lack of studies determining the relationship between AR technology and students' self-regulation. This in progress study will address this gap by investigating nursing students' experiences with AR on mobile devices (Mobile AR - MAR) and its influence on their self-regulation in clinical lab skills.

III. AUGMENTED REALITY DEFINITIONS

The most common definition of AR is a mixed environment that integrates digital information with physical objects in a meaningful way [7]. However, El-Sayed and Sharawy favoured another definition of AR, and emphasized, that "AR enables the addition of missing information in real life by adding virtual objects to real scenes" [8]. Chen [9] also agreed on this definition by pointing out that AR allows for interaction with 2D or 3D virtual objects integrated into a real-world environment. Wojciechowski and Cellary [10] defined AR as an extension of virtual reality with some advantages over virtual reality. According to Azuma,

instead of replacing reality, AR supplements it. All these definitions are based on AR features which allow supplying virtual information such as 2D, 3D images, texts, videos, or audios on top of the real object.

IV. Mobile Augmented Reality in Nursing Education

The goal of clinical practice in nursing education is to prepare students to develop, apply and practice the necessary theoretical knowledge and skills as safely and effectively as professional nurses [11]. Consequently, the clinical lab is essential to nursing education in order to achieve the clinical learning outcomes and improving students' competence. Moreover, simulating a critical situation by blending digital elements with the physical in a learning lab creates a promising opportunity for the education of nursing professionals in a safe environment [12]. However, the importance of realism in a simulation lab cannot be neglected. A pilot study integrated AR (wearable google glass) on top of a manikin to project a simulated video of a patient's scenario into the student's field of vision. The result showed that enhancing realism in clinical simulation increased students' confidence to perform necessary tasks in a real clinical environment [13]. Thus, AR provides one of the best platforms for setting a real clinical or laboratory environment as a background to classroom activities [14]. However, developing practice knowledge in nursing education is a complex process and difficult to teach. Primary evidence in the literature states that integrating blended learning, which is utilizing technology-enhanced teaching beside traditional approaches, in clinical education offers opportunities to improve clinical competencies among health students [15]. This research integrates 3D models to support realism and blended learning concepts to achieve a connection between the theoretical explanations and the laboratory practices by using AR as a nexus.

V. Research Questions and Objectives

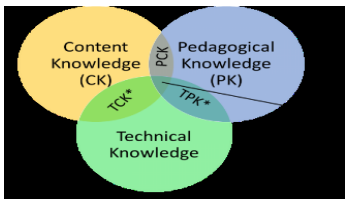

Figure 1 : TPACK framework

Overall, the technology integration in teaching is a complex interplay of three primary components – content, pedagogy and technology – as illustrated in Figure 1 (reproduced by permission of the publisher, © 2012 by http://tpack.org). Therefore, TPACK points out that balancing those components leads to successful teaching with technology. Thus, the main research question, which will be addressed by this work, is:

RQ: How does Mobile Augmented Reality enhance nursing students' self-regulation skills?

In order to answer this question, the study is divided into three sub-questions as follows:

RQ1: What are nursing students' perspectives about their current self-regulation skills in clinical labs?

RQ2: What are students' perceived enjoyment and usefulness, and students' satisfaction of using MAR in nursing clinical lab?

RQ3: What are the features of AR applications which motivate nursing students to learn independently in clinical lab?

VI. Methodology

This study will involve quantitative and qualitative approaches. In order to answer the research questions, the study is divided into three phases as shown in Figure 2. The data will be collected to measure four main aspects: perceived enjoyment, perceived usefulness, students' satisfaction and students' perceived self-regulation. Table 1 shows the methods chosen for each phase. The experiment and data collection will be held in the Nursing Department at Salford University in the UK.

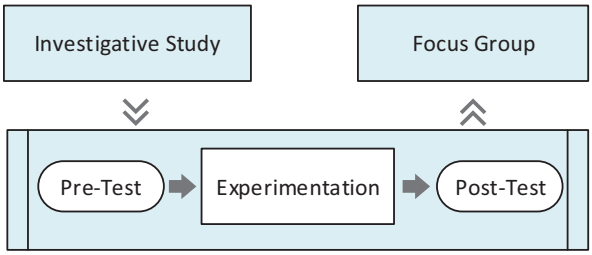

Figure 2: Research Methodology

Table 1: Data collection methods

Research phases	Aspects	Methods
Investigative Study	Current state of Self-regulation in nursing clinical lab	Questionnaire
Experiment	Perceived enjoyment	Questionnaire
	Perceived usefulness	Questionnaire
	Satisfaction	Questionnaire
Students' Feedback	Perceived Self-regulation	Focus Group

VII. Developing Mobile Augmented Reality Application

Before conducting the experiment, developing an MAR application that fits nursing clinical education is required. This section will discuss in detail the steps for developing such an MAR based on the waterfall model.

A. Requirements Analysis

Beside the literature review, the authors needed to deeply understand the limitations of current teaching methods and how students perform during nursing clinical skills labs at Salford University. To do so, five face-to-face discussion sessions were run with two nursing instructors and one nursing lab technician. Also, the authors observed sessions by attending actual clinical lab classes. The outcomes can be summarized as the following. In the current learning approach, students are not able to view

the internal organs of a manikin. Also, the manikin looks like a dummy and students have to deal with imaginary patients in order to solve patient scenarios and check their symptoms. In term of interaction, a patient's monitor parameters have to be updated manually by a lab technician based on the scenario. For most of the cases, students are working in groups, since the learning environment does not enhance working independently. Finally, the main challenge with practicing clinical skills is location restriction as a manikin is not a portable object. Hence, to overcome those limitations, the functional requirements for the application include:

RE1: It should be implemented on a smart device, so that most of the students can use it;

RE2: The application should represent the internal organs effectively;

RE3: Learners should be able to utilize it inside and outside the clinical lab classroom;

RE4: It should enhance students' self-regulation by allowing them to solve the patient scenario with or without teacher help.

B. Coding and Implementation

The implementation of the MAR application was divided in to two stages: the creation of the content itself, including video, audio, images, and the 3D model, and then its integration with the smart devices. In terms of the content, a 3D human heart model has been purchased from the Unity store. Moreover, the Salford lab technician played an actor role to simulate a patient; he portrayed specific physical symptoms in the scenario to fulfill the objectives of the learning outcome of the patient's scenario. TheVuforia SDK version 7.1.35 has been used with Unity game engine v 2017.3.0P4 in order to develop the MAR application. The AR application developed with Vuforia is compatible with variety of mobile devices such as iPhone, iPad, Android phones, and tablets running the Android OS.

C. Pilot test

The participants were undergraduate nursing students 1 male, and 3 female. They volunteered to test the prototype MAR application. The aim was to evaluate the technology and the application design. Students were to use the MAR application in order to solve a patient's scenario in the clinical labs. Firstly, the participants were asked to fill in a questionnaire related to their current learning methods in nursing clinical lab. Then, they performed tasks using the AR application individually. The participant has to solve the cardiovascular disease scenario while interacting with the manikin via AR application. The self-test function and feedback evaluate their answer and show it in percentage format. Finally, participants were interviewed about their experience with AR technology.

In terms of learning heart anatomy with the 3D model, before the experiment, all the students selected the video as preferred media form of learning anatomy instead of the 3D model. During the experiment their facial expression looked surprised smiley and they were saying words like "WoW, OMG". One student after finishing the tasks returned back to the 3D heart section and was enjoying [smile] interactive with the heart model. After the experiment, all the students mentioned they had never used a 3D model in learning human anatomy and they

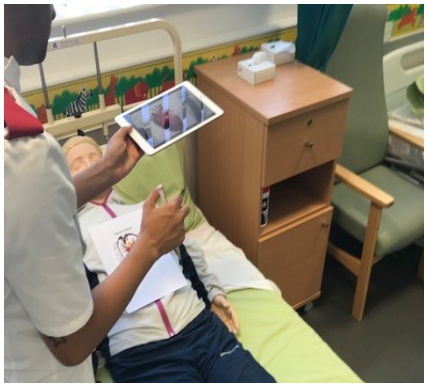

Figure 3: Viewing patient's heart

found it very useful. Additionally, they found real patient video very helpful one student said "written paper is not very clear normally, this application is better than paper to understand a patient scenario". Particularly interesting result was from a student who has Dyslexia diagnosis. She rated the application with the highest score 10/10 in supporting her independent learning. She stated that learning by doing with such an application is very useful and easy to use as she has dyslexia and faces difficulty reading. Her self-test result was 80%, but she was excited and tried solving the scenario again with an improved result of 100%.Table 2 shows participants' tests and their ratings out of 10. The participants were asked to rate the application in terms of enhancing their independent learning in clinical lab.

Self-test result	70%	80%	70%	80%,100%
Application Rate	8/10	8/10	9/10	10/10

Table 2: Result Summary

Overall, the students enjoyed using AR in the lab and were satisfied with the interactive 3D model. They found the application useful and that it enhanced their independent learning. Two students mentioned that they normally had to search for YouTube videos in order to understand the human anatomy, but the application combines video, 3D models and pictures in one place, which makes it easy for them to learn.

All the students agreed that solving a patient's scenario independently increases their confidence and competence in learning basic nursing clinical skills.

VIII. CONCLUSION

This work is in progress; the pilot test shows that there are many obstacles in current method of practicing clinical skills in terms of self-regulation. For example, location restriction – a student has to book the lab which is "too much hassle". Also, it is difficult to understand a patient's scenario without teacher explanation due to the manikin not representing real patient symptoms and students not having enough experience to create a clear mental image for a simulated scenario. All four students agreed that more interaction between manikin, monitor and scenario is needed in order to enhance their self-regulation skills.

According to the literature, learner characteristic, environmental characteristic and environmental satisfaction are

the predictable factors for self-regulation in E-learning system[16]. Future work will consider those factors and their impact on nursing students' self-regulation skills within an AR interactive system.

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