Co-creation of Virtual Reality Re-usable Learning objectives of 360º video scenarios for a Clinical Skills course

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***Abstract*—This paper presents a new approach for teaching the clinical skills course by exploiting the potential of a Virtual Reality application utilizing 360° videos with medical content for an undergraduate level course. We discuss the methodology prospects and identify the potential role of Virtual Reality reusable e-resources into learning and practicing clinical skills and the concept of embedding these processes to a real assess-educate-assess cycle that uses digital tools to optimize outcome. Scenarios, were developed in the context of the CoViRR Erasmus+ project, offering new insights for the digital integration in learning and teaching. The initial results of our analysis validated the effective design of a technologically enhanced learning tool as an addition to the existing methods used in medical education. Future work should integrate the application into the classroom and evaluate its effectiveness with real end-users.**

Keywords—360º videos, Virtual Reality, medical curriculum, eLearning.

I. Introduction

The increasing need to learn and practice or even design modern and enhanced technology for clinical environments has created nowadays a challenge for healthcare educators, teaching at either the undergraduate or postgraduate levels. Even more challenges are encountered by healthcare professionals who are responsible for "real patients" and must make critical decisions, taken often under high pressure. In this short paper, we propose a Virtual Reality (VR) application utilizing 360° videos as a reusable e-resource for complementing the curriculum of medical schools [1].

The exploitation of simulation in the clinical environment has been in use for the past 50 years, with the goal of preparing students and healthcare professionals in a safe environment to conduct sensitive caregiving procedures [2],[3]. Simulation based training is a successful way for students to learn new skills and gain new knowledge and experience through "learning by practicing". As a result, students need to understand and be able to apply the key principles that underlie the scientific basis of medicine, rather than trying to memorize ever-increasing quantities of data. The prerequisite for medical graduates is the ability to identify and solve new problems by gaining additional knowledge where appropriate and objectively analysing new information. The education process, therefore, needs to develop autonomous and driven learners who can recognise their skills, shortcomings, and gaps, and know how to enhance them. The best way to achieve this is to provide personalized learning opportunities that are focused on the student [4]. Consequently, we introduce the use of Reusable Learning objects RLOs as a form of Open Educational Resources (OER), which are self-contained user-friendly information nuggets, addressing practical cultural concerns, and highlighting best practice. Each tool represents about 15 minutes of learning, and focuses on achieving a specific learning target that can be used multiple times, and in various settings. Every information nugget is a Reusable Learning Object (RLO) [5].

The article is organized as follows: the following section entitled "Acquisition of Clinical Skills in Medical Education" provides some background about the use of simulations in medical education and related work in this field; Section "Methodology" describes the steps we followed to conduct our application. Section "The ASPIRE Framework applied on interactive 260 video" describes the various aspects related to requirements, design, and implementation of the 360º videos. Section "Release and Initial Evaluation" presents an initial evaluation of the application by experts in the fields of Computer

Science, Medical Science and Education. Section "Concluding Remarks" concludes the paper with an analysis of the observations, discussion, and a brief description of the future lines of research.

II. Acquisition of Clinical Skills in Medical Education

Simulated clinical skills in medical education can be performed in the following ways: (a) traditional exercises with mannequins or humans playing a role, or (b) computer-based exercises (Virtual Patients). The traditional exercises are the most common form of training in today's medical education. Simulation with mannequins allows students to confidently exercise, for instance, technical skills [6] and critical thinking abilities [7]. The development of computer-based simulations in medical education have increased during the last 10 years. Research results indicate that students can improve their knowledge using computer-based simulations [8], [9]. Moreover, this approach provides the instructor with detailed information about the students' performance, and it also contributes to a safe environment, where the students are allowed to make mistakes to improve their skills through detailed feedback. Technological components and approaches of such computer-based simulations include the following: (a) Virtual Patients (VP); and (b) virtual reality technology (VR). Using a simulation approach can help students increase their motivation and the ability to learn in a non-threatening environment [10].

III. Methodology

To develop the application, we used the ASPIRE development framework created at the University of Nottingham, UK and stands for "Aims, Storyboarding, Population, Implementation, Release, and Evaluation" [11], [12]. It is a participatory approach with the engagement of stakeholders in the design process. As stakeholders can be defined as anyone that has a potential interest on the resource or the topic. "Aims" refers to the discussion of which approach to follow and eliminate any distractions. "Storyboarding" refers to a reasonable chunk of material to study with involved focus groups. "Population" stands for specifications of the application and review. "Implementation" refers to piecing together what has been studied and start building the development of the application. "Release" reproduces the final version of the application, and whether the needs have been achieved. Finally, "Evaluation", involves the evaluation of application by the focus group and includes also feedback generation.

IV. The ASPIRE Framework Applied on an Interactive 360º video Application

A. Aim

The "Aim" procedure targets to identify the need for the creation of 360º videos in a medical school curriculum. In this step, the evaluation team identified and prioritised the clinical area of the application and how this will be evaluated. Firstly, a discussion was carried out whether medical schools are equipped with new generation technology to support this effort in their curricula. Furthermore, the following questions were investigated: (1) What is the potential role of VR in medical curricula and how reusable e-resources can aid in this direction? (2) Do VR applications have the potential to improve medical school curricula? At the end of this procedure application recommendations were prescribed.

B. Storyboards

A storyboard is a sequence of drawings, typically with some directions and dialogues, representing the shots planned for a video production. The storyboard procedure was carried out by a team of medical students studying at the Medical School of the University of Cyprus. Six medical students were recruited by our evaluation team for this storyboard and were assigned to carry out/practice 9 clinical skills scenarios as shown in Figure 1. In this short paper we present the following 2 scenarios (see Table I): (1) glove application and (2) subcutaneous injection. This group was a combination of 1st-year students who did not attend the course yet and 4th-year students who did. The reason that this procedure was followed was to get feedback on how students envision this and how to help the development team create a useful and interesting 360º video application.

Fig. 1. Medical students trying to create Storyboards from given scenarios.

C. Performance indicators

Following the completion of the storyboarding procedure, the next step focuses on identifying the specifications of the desired application and how to evaluate these. In this context, the performance measures or indicators were identified with the help of the evaluation team and the experts. The two teams worked collaboratively to identify performance indicators that were used to assess the scenarios' structure and process. Structure measures facilitate the evaluation of the means and resources used by scenarios to deliver e-resources [13].

D. Implementation

To implement the application, videos with various tasks were captured with a 360° camera. The camera was placed in the centre of the room to record the entire room. A 2nd camera was used to capture a close-up shot. All videos were uploaded on a YouTube channel. This was done to provide streaming videos from YouTube, while maintaining a much smaller (in memory size) and lighter application, and to allow easy modification and the reusability of the resources. This, of course, makes the application require on-line access, and may introduce some latency when playing the videos, depending on the network connection. The Android application was created with the Unity3D game engine [14] with the support for Google Cardboard [15]. The user interacts with objects using their gaze. The videos are rendered on a sphere surrounding the user, can since separate streams are used for audio and video, the two need to be synchronized at run-time. Screenshots of the application are demonstrated Fig. 2 and Fig. 3. The application can be found on Google Play by the name 'CoViRR' (https://play.google.com/store/apps/details?id=com.MariosHadjiaros.CoViRR_360).

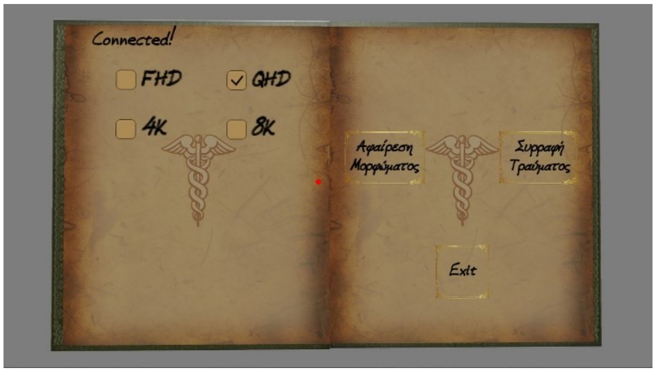


Fig. 2. Screenshot of the menu of the application.

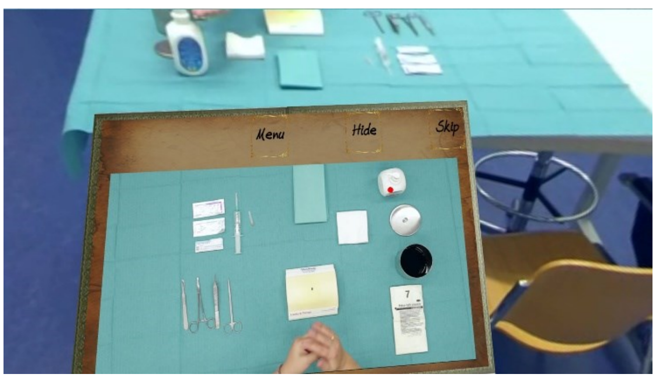


Fig. 3. Screenshot of a clinical skill scenario as seen through the application with the full 360º video in the back view and the close-up view.

E. Release and Initial Evaluation

An exploratory evaluation was performed to investigate the use of the interactive 360º video to support the learning experience regarding clinical skills. The aim of this assessment was to gain some insight from experts in the field regarding the system's usability and as to whether this kind of an approach has the potential to enhance a student's overall learning, and knowledge construction process, compared to traditional teaching approaches.

1) Participants

Fourteen males (n = 8) and females (n = 6), with a mean age of 32.43 years (SD = 9.51) participated in the study. Most of the participant's had a background in Computer Science (n = 12) while the rest expertise in medicine (n = 1) and education (n = 1).

2) Instruments

Two questionnaires were completed to capture the level of usability, presence and immersion of the application.

*a) **System Usability Scale (SUS)** [16] is a 10-statement self-report scale used to evaluate satisfaction and usability of the application. It is rated on a 5-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree.*

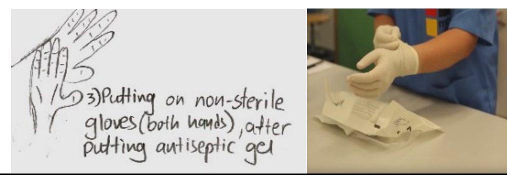
TABLE I.

Scenario 1: Glove Application

Students were asked to perform the procedure of a glove application by drawing and writing a step by step the procedure of how to put surgical gloves. The following steps describe the scenario but guided by their teacher:

Steps

a) After washing your hands, check the outer package for integrity and expiry date. If it is damaged or out of date, discard.
b) Open the package and carefully empty the contents into the middle of a clean dressing trolley, ensuring the outer packaging does not touch the trolley surface.
c) Carefully open the pack, ensuring that only the outer aspects of the packaging are touched.
d) Put the first glove on, making sure you only touch the inner aspect of the cuff.
e) Put the second glove on, making sure you only touch the outer aspect of the glove with your sterile gloved hand.
f) Sterile gloves should not come into contact with non-sterile surfaces or objects. If this does happen, then discard the gloves and start again.



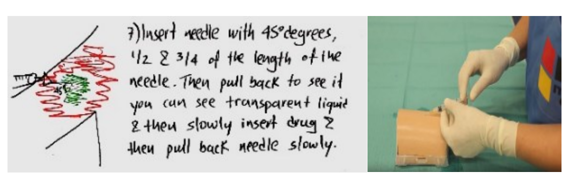
Scenario 2: Subcutaneous injection

Students were asked to perform the procedure of subcutaneous injection by drawing and writing a step by step the procedure. The following steps describe the scenario but guided by their teacher:

Steps

a) In order to ensure delivery into the subcutaneous layer rather than the muscular layer, the injection has to be given at a 45 degree angle with one third of the needle to be left exposed.
b) Once the site is located and prepared gently, pinch the skin and fatty tissue to raise the subcutaneous tissue from the underlying muscle.
c) Hold the syringe between the thumb and fingers keeping the forefinger free and clear of the plunger.
d) Insert the needle at an angle of 45 degrees and deliver the medication.
e) Release the pinched tissue and remove the needle quickly in a smooth motion and dispose immediately the equipment into a sharps container.

f) Wash your hands and document the injection.



*b) **Presence Questionnaire** [17] is a 6-item self-report scale used to evaluate: (i) the sense of "being there" in the scenarios as compared to being in a place in the real world; (ii) if the scenarios became the dominant reality and how intense it was, and (iii) the extent to which participants remembered the scenarios as a place visited rather than as a computer-generated text or image. Presence was rated on a 7-point Likert scale ranging from 1 = strongly disagree to 7 = strongly agree.*

3) Results

The overall application usability was considered to be above the average (M = 76.61, SD = 15.74). High rates of presence (max score of 7) were also reported by the participants (M = 4.88, SD = 1.01). The results suggest that the application is a usable and immersive solution facilitating the enhancing of the student's overall learning process.

V. Concluding Remarks

Integrating traditional scientific and clinical disciplines with progressive and continuous assessment, may be a better means of achieving the combined aims of clinically relevant curriculum design, vertical integration of medical knowledge, and facilitation of the continuum of training.

To summarize, we have presented the outcomes of our efforts in this paper, while developing a complete simulation solution that can provide easy access to learning content for medical students, anywhere and at any time. The proposed application, making use of the 360º videos, offers medical students the possibility to experience clinical skills needed for their practise.

The initial results of our analysis validated the effective design of a technologically enhanced learning tool as an addition to the existing methods used in medical education. Future work should integrate the application into the classroom and evaluate its effectiveness with real end-users.

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