Evaluation of Virtual Reality via 360° videos Reusable e-Resources Embedded in Healthcare Curricula

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***Abstract*— Recent advancements in Virtual Reality (VR) immersive technologies provide new tools for the development of novel and promising applications for Medical Education courses. This paper presents an evaluation process 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 evaluation process, results 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. The development of VR technologies in recent years has resulted in more accessible and affordable solutions that can still provide promising results. The 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. Ultimately, the CoViRR analysis on the feasibility and acceptability of reusable virtual reality e-resources will serve as an example to other higher education institutions and faculty on techniques and topics for effective resource creation. Concluding, VR and interactive devices resulted in the development of holistic, portable, accessible, and usable systems for medical education.**

Keywords—Medical education; 360º videos; Virtual Reality;

I. INTRODUCTION

The use of VR in healthcare education has become increasingly popular, with studies [1], [2] demonstrating improved learning outcomes, increased student engagement, and better retention of knowledge compared to traditional methods of teaching. Implementing VR resources, however, requires significant investment and careful planning. To ensure that these resources are effective, it is essential to evaluate their usability, acceptance, and impact. This paper presents an evaluation of VR reusable e-resources embedded in healthcare curricula using a range of evaluation instruments.

II. BACKGROUND

Medical education and training have traditionally been imparted through textbooks, lectures, and hands-on experience in clinical settings. However, the advent of digital technologies has revolutionized the way medical education is delivered, with 360° videos and virtual reality being at the forefront of this transformation.

360° videos offer a new way to experience immersive learning, where the learner is placed in a real or simulated environment with a 360° view of the surroundings. By using a headset, learners can explore various scenarios and interact with them as if they are present in that environment. For medical education, 360° videos can be used to simulate complex medical procedures, allowing students to experience practical, hands-on training without the risk of harming patients. This type of training equips medical students with the skills and confidence necessary to handle real-life situations. VR, on the other hand, immerses the learner in a fully virtual environment allowing for deeper levels of training and experience. VR enables students to gain experience in multiple scenarios which are difficult or impossible to simulate in real-life training. Additionally, VR-based medical training is highly cost-effective, as it facilitates unlimited repetitions with no additional costs for equipment or materials.

The use of these innovative technologies in medical education has been shown to enhance students' knowledge retention, engagement, and interactivity. 360° videos and VR

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can bridge the gap between theoretical knowledge and practical application, making it easier for students to learn and retain complex medical information.

Moreover, these technologies are highly advantageous for distance learning, especially during the COVID-19 pandemic [3]. Educators can deliver high-quality medical training to students across geographically distant regions, making high-quality medical education more accessible and inclusive. This has proven to be highly useful in enabling continuity of medical education amidst travel restrictions and social distancing protocols.

The use of 360° videos and virtual reality in medical education has proved beneficial for medical students, lecturers, and practicing medical professionals. It offers a safe, efficient, and cost-effective way of delivering impactful medical education that can simulate real-life medical scenarios [4]. While there is still a long way to go in implementing these technologies on a broader scale, 360° videos and virtual reality are poised to shape the future of medical education, and revolutionize the way medicine is learned, taught, and practiced.

In this paper we created randomized two-groups pre/post-evaluation to examine the effective use of VR in medical education. Prior to the beginning of the evaluation, all students had received a clinical skills (OSCEs) lecture from their teacher. A week later we started the evaluation process with CYENS CoViRR application, and the first group was assigned to use the application and watch a clinical skill scenario and answer to a questionnaire (Learning Objectives Evaluation). The second group did not participate in the use of the application and answered the same questionnaire (Learning Objectives Evaluation) based on the knowledge they had from the lecture.

III. Overarching Findings

A. Learning Objectives Scenarios

The following four scenarios were developed and implemented via VR and 360° videos (see Fig. 1):

1) Wound suturing is a procedure performed to close surgical wounds. The goal of suturing wounds is to stop bleeding, reduce pain and infection, repair the skin wound, minimize scarring, and maximize wound healing.

2) Hand sterilization is a procedure to get rid of gems in most situations, through washing of hands with ordinary soap and water that is sufficient to decontaminate them. The use of germicidal soaps is recommended in high-risk situations and prepare their hands to wear surgical gloves.

3) Wound Sterilization and Local Anesthetic constitute the procedures to sterilize the wound and prepare it for surgical procedure with local anesthetic. For wound sterilization it is needed to remove any soiled dressing, inspect the wound and clean it. A local anesthetic usually follows in a single injection of a drug that numbs a small area of the body. It is used for procedures such as performing a skin or breast biopsy, repairing a broken bone, or suturing a deep incision.

4) Skin lesion removal is a procedure or surgery to remove growths on your skin. The skin lesion needs to be grabbed with small forceps and lightly pull up. Small, curved scissors will be used to carefully cut around and under the lesion. A curette (an instrument used to clean or scrape skin) maybe used to cut any remaining parts of the lesion.

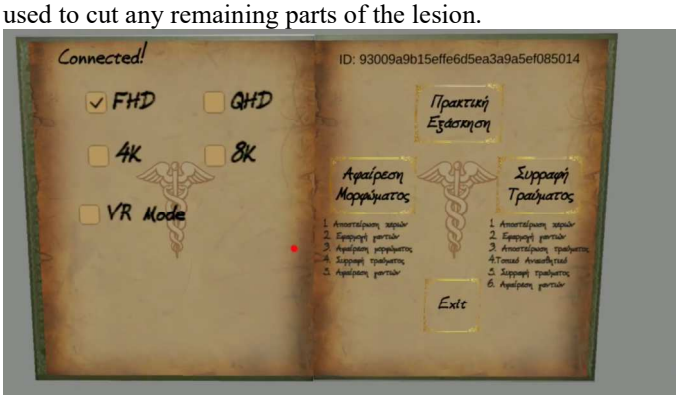

Fig. 1. CYENS CoViRR application menu. Left part: video resolution selection via FHD: 1920x1080, QHD: 2560x1440, 4K: 3840x2160, 8K: 7680x4320, VR Mode.Right part: Practical Training, Tissue Removal, Wound Stitching.

B. Evaluation Instruments

The following is a brief description of the evaluation metrics along with their role in the CoViRR evaluation effort.

1) System Usability Scale (SUS) is widely used as an extremely poweful measure of the usefulness of software systems and/or devices [5]. In CoVirr, SUS wasutilized as a testing instrument for the usability of the user experience of the educational resource.

2) Technology Acceptance Model (TAM) was specifically developed with the primary aim of identifying the determinants involved in computer acceptance in general; secondly, to examine a variety of information technology usage behaviors; and thirdly, to provide a parsimonious theoretical explanatory model. TAM was used in CoViRR to evaluate, the perceptions, acceptance and engagement potential of the users with VR resources [6], [7].

3) Learning Objectives Evaluation was used to measure the expected behavioral outcomes of the medical students at the end of a certain instructional process via gathering evidence or information about the students' learning to check whether or not the students achieved the stated learning objectives. More specifically *Objective Structure Clinical Examinations* (OSCEs) are designed to test clinical skill performance and competence in a range of skills. Building on this standardized concept, members of the CoViRR team developed an extension of OSCEs in digital format using a scenario based, branching narratives approach, leading to more usable and widely accessible assessment instrument [8].

In practical terms e-OSCEs were well designed, standardized virtual patient cases, which could assess in meticulous step by step detail all skills and competences needed for clinical work. While formal accreditation is not

possible with e-OSCEs because there is no manual assessment of skills, the ease of use and immediate access provided by these virtual patient cases make them highly relevant to the CoViRR evaluation approach. Specifically, e-OSCEs can be the core assessment tool for knowledge retention regarding the project's VR resources.

C. *Evaluation Results*

There were 26 participants in total (12 males and 14 females). Average age was 21.6 years (SD = 4.32, Mode = 20, Median = 21). Therefore, participants were Generation Z, described as 'digital natives' [9].

1) System Usability Scale (SUS) Scores

The SUS score average for all data was 86, which is above the range of average usability. This is a good indicator as the resources were early demos and had reduced beta alpha testing due to time constraints. It is expected that future updates can improve this metric.

2) Technology Acceptance Model (TAM) Scores

The TAM evaluation was carried out under 3 different sections (Ease of Use, Perceived Usefulness, and Intention of Use). All had positive mean ratings from approximately 90% of the participants. Therefore approximately less than 10% of the participants gave neutral or disagreeing scores for each question. The corresponding student responses are illustrated in Fig. 2, Fig. 3, and Fig. 4.

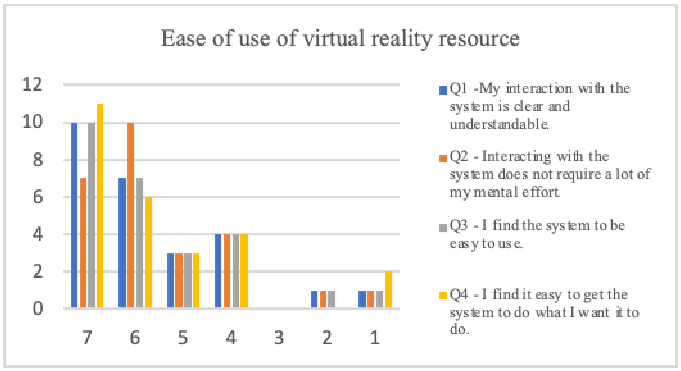

Fig. 2. 1st Section TAM evaluation scores – Ease of use of virtual reality resource

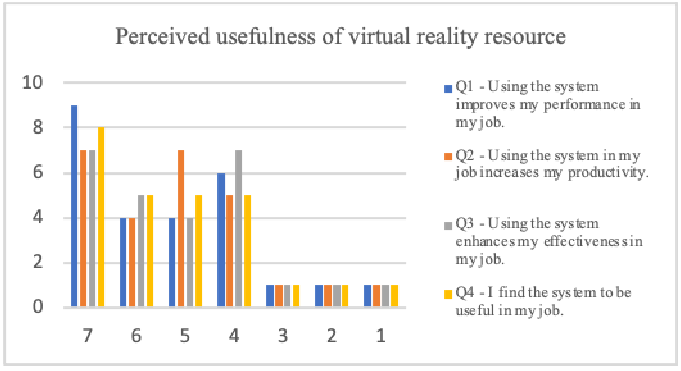

Fig. 3. 2nd Section TAM evaluation scores – Perceived usefulness of VR resources

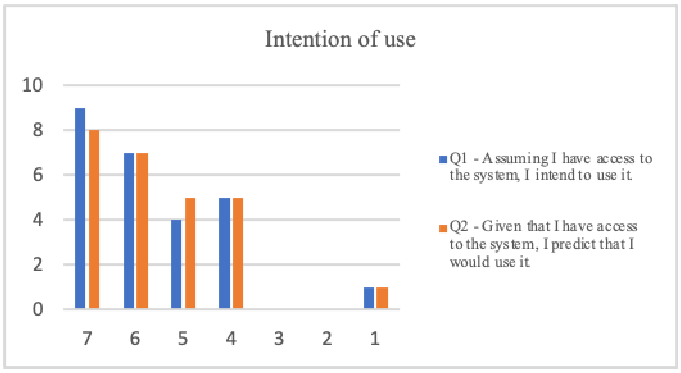

Fig. 4. 3rd Section TAM evaluation score – Intention of use

3) Learning Objectives Evaluation Scores

The e-OSCEs were used to assess the scenarios of: Wound suturing, Hand sterilization, Wound sterilization and local anesthetic, Skin lesion removal. There were no significant findings for changes in learning objectives. Around 80% of the students scored full marks (see Fig. 5, and Fig. 6). The reason for this could be attributed to the fact that the questions were too easy so we couldn't record differences between pre and post evaluation.

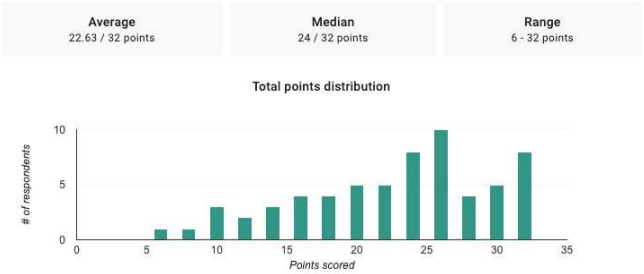

Fig. 5. Post-Wound Suturing evaluation score

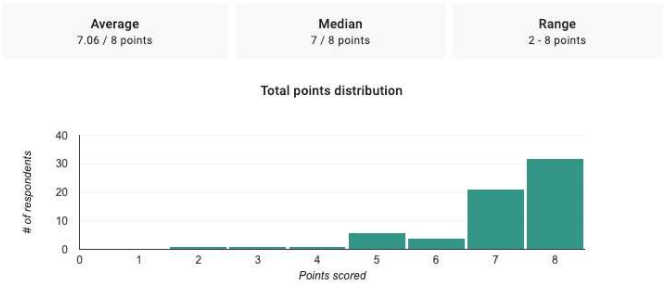

Fig. 6. Post-Skin lesion evaluation score

IV. Evalutation Conclusions

To evaluate the effectiveness of the VR reusable e-resources, a comprehensive suite of evaluation instruments and methods were used. The SUS was utilized to test the usability of the user experience of the educational resource. The TAM was applied to examine the determinants involved in the acceptance and usage of VR technology. The e-OSCEs were

used to assess knowledge retention and clinical competence. The results of the evaluation revealed that the VR resources demonstrated a high level of usability with an average SUS score of 79 out of 100. The TAM showed positive attitudes towards the use of VR, with perceived usefulness and ease of use being the strongest determinants of acceptance. The e-OSCEs demonstrated that the participants showed a significant improvement in knowledge retention even if the questions were too easy.

V. Lessons Learned/Recommendations/Conclusion

The evaluation of VR e-resources is vital to understand their effectiveness in healthcare education. The use of SUS, TAM, and e-OSCEs provided a comprehensive evaluation of user experience, technology acceptance, and knowledge retention, respectively. Our study revealed that VR resources have the potential to improve student learning outcomes and engagement. We recommend that further research focus on the impact of these resources on clinical outcomes, such as patient safety and quality of care. Overall, VR technology has shown to be an effective tool in healthcare education, and its implementation should be considered in future curricular designs.

Acknowledgment

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