https://doi.org/10.36315/2024v2end065
Education and New Developments 2024

VIBE – VIRTUAL REALITY IN STEM EDUCATION

Joana Carrilho[1,2,3], Daniela Melo[2], Margarida Borges[2], Luis Midão[1,2,3], Matuz Andras[4], & Elísio Costa[1,2,3]

[1]CINTESIS@RISE, Biochemistry Lab of the Faculty of Pharmacy of the University of Porto (Portugal)
[2] Department of Biological Sciences, Faculty of Pharmacy, University of Porto (Portugal)
[3]Porto4Ageing - Competences Centre on Active and Healthy Ageing, Faculty of Pharmacy, University of Porto (Portugal)
[4] Department of Behavioural Sciences, Medical School, University of Pécs (Hungary)

Abstract

In the XXI century, information technology and, more recently, the Covid-19 crisis have reshaped our educational system. Distance learning has proven to be an effective, reliable, easily standardized and generally economical form of learning. Internationally recognized e-learning platforms have been widely used in education. However, the use of digital and virtual reality (VR)-based platforms is still not generally accepted, despite offering multiple advantages. The current challenge is not to invent new technologies, but to ensure that educators can develop effective ways to deliver curricula in high-quality VR environments. This immersive and innovative means of visualization, interaction and flexibility means that virtual reality systems are unrivalled in terms of engagement and motivation with education, and also provide a scalable platform and a relatively easy-to-share solution for massive online learning. At a European level, there is a demand for healthcare providers, scientists, qualified engineers and informatic technologies (IT) specialists. Employers are continually seeking a highly qualified workforce and lifelong learning is also essential for the development and progress of our society. This project aims to revolutionize and reshape medical and STEM education. The main objective of the V.I.B.E project is to enhance this digital transformation and develop the digital skills of participants and other stakeholders, using innovative VR-based IT methods and solutions, with the aim of establishing a link between medical and STEM skills.

Keywords: *Virtual Reality, STEM, biomedical skills, digital health, innovation.*

1. Introduction

In the XXI century, the rapid development of informatic technologies (IT) based solutions is reshaping our world, in our social life, work environment and education. The digital transformation has been especially apparent over the last decade and restrictions resulting from the Covid-19 pandemic have significantly accelerated this process. Well-established digital competences to a satisfactory level are very important to broad range of social groups of different ages (Hamilton, McKechnie, Edgerton, & Wilson, 2020). In the field of higher education, e-learning methods can provide an effective, standardized and relatively easy-to-share solution for teachers to share knowledge and provide tools for co-creation and collaboration. Digital education tools are also important for engaging younger generations in higher education, and can serve as a means of communication with citizens and the wider community (Timotheou et al., 2022).

On the other hand, medical and STEM education is essential for the continuous progress of our society through greater innovation, research and science activity, and the development of regional, national and international healthcare systems. The lack of medical professionals and healthcare providers is a national and international phenomenon. STEM skills combined with medical training results in the concept and professional field of "biomedical engineering" that generates solutions for multidisciplinary medical issues. Biomedical engineering represents one of the most rapidly growing branches of industry in the developed world and aims to provide revolutionary and innovative healthcare professionals that operate beyond the bounds of classical treatment. These specialists use their expertise to develop novel technical solutions, for example, using robotics in medicine.

Virtual reality (VR) technology has been found to be a highly effective, reliable and interactive method for a wide range of education. VR technology offers a unique and modular training environment

for both commonplace and specialised situations. It allows participants to gain practical skills in a safe, replicable setting, supporting functional competence to an advanced level (Oyelere et al., 2020).

However, there are several challenges regarding this immersive and innovative e-learning tool, VR based platforms are not readily accessible, potential users do not have the proper knowledge and information about the technology, and in most cases, the stakeholders do not have the necessary digital competencies to successfully implement VR technology in everyday teaching. Preliminary needs analyses show that PhD courses, joint degree programs and part-time education programs have not yet been developed in VR spaces before, despite the large number of students involved in this sector. Distance education methods can be used not only in teaching theory, but can also be useful in developing practical skills in a non-invasive environment. It is also important that in practice-orientated education of medical and STEM science, an innovative, reliable, and accessible tool is needed to enhance interdisciplinary project work, which is especially important in the field of biomedical engineering.

As such, a group of institutions came together to clearly define the needs in terms of digital transformation of the educational system, committing to reshaping online and distance education using innovative technologies and good practice guidelines through the V.I.B.E. project, involving the target groups and wider public. This consortium was formed by the collaboration between 3 renowned Universities – University of Porto (Portugal), University of Pécs (Hungary) and Silesian University of Technology (Poland) – and an Innovation Centre – DEX Innovation Centre (Czechia).

2. Objectives

The goal of the V.I.B.E. project is to develop and strengthen the digital competencies and educational cooperation of the participating organisations, as well as to share the knowledge and good practice guidelines with the wider community. The stakeholders include young people interested in medical and STEM higher education, university students and staff, and citizens who are interested in this field. By implementing the project, we aim to attract and retain students and encourage them towards ongoing, life-long education with practice-oriented tuition.

Building on previous data and experience, our aim is to establish VR based BSc and MSc training, as well as a joint degree program in collaboration with our partners. PhD courses and part-time courses will be organized for lifelong learning, along with sustainability and continuous improvement of the project. Moreover, V.I.B.E. aims to open new horizons in education for part-time learners, upskilling within companies, retraining or group building activities, providing an innovative solution for life-long learning. As a result, we expect an increased level of digital competencies in the participating higher education institutes, a growing number of students interested in applying to the STEM and medical fields, and a communalisation of the usage of VR as an educational tool. We believe that the results of the project will create a new, immersive and inclusive digital environment for all stakeholders.

3. Activities / methods

The first step was a detailed analysis regarding digital competences and preferences. Surveys were created and conducted among students and professionals from the academic field, companies and industrial partners, inspired by the main categories for VR user experience assessment introduced by Tcha-Tokey et al., 2016: presence, engagement, immersion, flow, emotion, skill, judgement, and technology adoption. Next, we developed a benchmarking activity of existing online VR educational contents platforms, using available published data to compare their success in competence-building. The results of the benchmarking and the surveys then led to the creation of a handbook in VR, including an overview about available platforms, use cases related to the medical and STEM field and good practices related to course and curriculum development. Lastly, the project culminated in the conceptualization and creation of contents in VR to be implemented. The main criteria for these contents were the need to be innovative, practice-orientated and adapt to distance education. The effectiveness of the V.I.B.E. project on education was measured by the number of attendees in the online courses, as well the involvement of faculty staff and high school students at virtual and personal events.

4. Outputs / results

Outcome 1 - Results of the benchmarking activities related to VR and digital based e-learning platforms were made available to all stakeholders through a handbook on VR technologies. The handbook is available for free download and showcases several success stories.

Outcome 2 - Three courses in medical and STEM education available via Massive Open Online platform. These courses were titled “Exploring the Mysteries of Life: An Introduction to Cell

Biology", "The psychology and physiology of Stress" and "Introduction to the use of Virtual and Augmented Reality in STEM Education". the first course had an average of 150 users in the first month of being available online, with a 87% completion rate.

Outcome 3 - a PhD course in biomedical engineering. Based upon the information collected and learning from the best practices, an entire online VR-based PhD course was created to advance the quality of the education available for future biomedical engineers.

Outcome 4 - A **new curriculum for a Biomedical Engineering BSc** was developed using the VR platform as a co-creation and collaboration tool. The implementation of this system allowed us to use VR as a tool for project management and project support, meaning that the development and trial of at least three different projects using the platform is possible.

Outcome 5 - A protocol of one hands-on laboratory skill development course in surgical techniques was developed and used in the context of the teaching curricula at the University of Pécs.

Outcome 6 - A simulation online course in 3D visualization and printing techniques was created and piloted with several groups of students from the partner Universities.

5. Discussion and conclusions

The V.I.B.E. project is expected to achieve its objectives by not only developing digital competencies but also fostering educational collaboration. The project's impact is expected to resonate at both regional and international levels, influencing the education landscape in medical and STEM fields.

The initial surveys provided a foundational understanding of the landscape, aligning with established categories for VR user experience assessment. The subsequent benchmarking activity evaluated existing online VR educational platforms, enabling the project team to draw insights and best practices. This data informed the creation of a VR handbook, a valuable resource outlining platform, use cases, and course development practices tailored to the medical and STEM fields.

The diverse outputs, including a handbook on VR technologies, three MOOC courses, a PhD course in biomedical engineering, and a new curriculum co-created through the VR platform, showcase the breadth and depth of the project's impact.

The quantifiable outcomes, such as increased attendance in online courses and active participation in virtual and personal events, indicate the project's effectiveness. The creation of a VR handbook and the development of courses and curricula demonstrate a commitment to providing accessible and practice-oriented learning experiences.

The V.I.B.E. project has not only responded to the immediate needs of higher education institutes, students, and professionals but has also set the stage for ongoing initiatives in lifelong learning. The incorporation of VR as an educational tool has the potential to create an immersive and inclusive digital environment, thereby contributing to the evolution of educational practices in the medical and STEM domains. The project's legacy lies not just in the achieved results but in the transformative potential it brings to the future of education.

Acknowledgments

This publication has been co-funded by the Erasmus+ Programme of the European Union (Cooperation partnerships in higher education, 2021-1-HU01-KA220-HED-000032251). This publication reflects the views only of the authors, the National Agency and European Commission cannot be held responsible for any use, which may be made of the information contained therein.

References

Hamilton, D., McKechnie, J., Edgerton, E., & Wilson, C. (2020). Immersive virtual reality as a pedagogical tool in education: a systematic literature review of quantitative learning outcomes and experimental design. *Journal of Computers in Education*, 8, 1-32

Timotheou, S., Miliou, O., Dimitriadis, Y., et al. (2022). Impacts of digital technologies on education and factors influencing schools' digital capacity and transformation: A literature review. *Education and Information Technologies, 28*, 6695-6726

Oyelere, S. S., Bouali, N., Kaliisa, R., Obaido, G, Yunusa, A. A., & Jimoh, E. R. (2020). Exploring the trends of educational virtual reality games: a systematic review of empirical studies. *Smart Learning Environments, 7*, 31

Tcha-Tokey, K., Christmann, O., Loup-Escande, E., & Richir, S. (2016). Proposition and validation of a questionnaire to measure the user experience in immersive virtual environments. *International Journal of Virtual Reality, 16*(1), 33-48.