ARTTE
Applied Researches in Technics, Technologies and Education
Journal of the Faculty of Technics and Technologies, Trakia University
https://sites.google.com/trakia-uni.bg/artte/

VIRTUAL REALITY TECHNOLOGY - THE FUTURE OF LEARNING

Liliana Indrie[1], Daiva Mikucioniene[2], Simona Tripa[1], Pablo Diaz-Garcia[3], Raquel Belda-Anaya[3], Tudor Caciora[4] & Nefeli Dimopoulou[5]
[1] University of Oradea, Department of Textiles, Leather and Industrial Management, 410087, Universității str. no. 1, Oradea, Romania, e-Mail: lindrie@uoradea.ro, tripasimona@yahoo.com
[2] Kaunas University of Technology, Department of Production Engineering, Studentu str. 56, LT 51424 Kaunas, Lithuania, e-mail: daiva.mikucioniene@ktu.lt
[3] Universitat Politècnica de València, Departamento de Ingeniería Textil y Papelera, Plaza Ferrándiz y Carbonell s/n, 03801 Alcoi, Spain, email: pdiazga@txp.upv.es, rebelan@txp.upv.es
[4] University of Oradea, Department of Geography, Tourism and Territorial Planning, Universitatii str. no.1, 410087 Oradea, Romania; e-mail: tudor.caciora@yahoo.com
[5] IDEC S.A., 96, Iroon Polytechniou Avenue, 18536 Piraeus, Greece, e-mail: nefeli@idec.gr

Abstract: *This article discusses the benefits of virtual reality use on the teaching and learning, within the context of the CircuTex Erasmus+ project, with reference number 2021-1-ES01-KA220-HED-000032075. One of the outcomes expected from this project is an online course on the circular economy of fiber composites and technical textiles will be offered to students at HEIs with the goal of enhancing their knowledge of the circular economy methods specific to these two industries. In order to test and apply experiments relating to the circular economy of fiber composites and technical textiles, a virtual laboratory for the implementation of virtual experiments was established. Virtual "digital twins" of genuine laboratory equipment are present in the lab, each augmented with 3D visuals and virtual movement. Through the virtual reality glasses, students will have access to the online virtual laboratory, which will provide a 360-degree learning experience.*
The participants to the online course will have the opportunity to test and carry out experiments related to the circular economy of fibrous composite and technical textiles through the virtual laboratory. The way to access the virtual laboratory of CircuTex project is through the Meta Quest virtual reality headset. The virtual laboratory comprises 11 experiments where the students will learn through experience.
Keywords: *Virtual reality, Virtual laboratory, education, CircuTex project, results.*

1. INTRODUCTION

Throughout the past ten years, several institutions have made investments in centers for educational innovation, with a focus on emerging technologies [1-2]. Blockchain, the internet of things, artificial intelligence and Virtual reality are some of the most well-liked upcoming educational technologies [3-5]
The Virtual reality (VR) can be used in engineering [6], computer science [7], medical [8] and other fields [9-11]. In order to increase students' involvement in teaching-learning activities, virtual reality is used in education also. The learning outcomes, motivation, and attitude of students when utilizing VR are the subject of numerous studies about its usage in science education [12]. Learning benefits have been reported in the literature when comparing the use of VR with conventional methods [13].
Through the use of virtual reality a three-dimensional environment is simulated. Using virtual reality glasses, a computer, or a mobile device, the students enter a three-dimensional virtual environment while still physically present in the real world [14].

Students who use virtual reality can better visualize angles and components and can test out scenarios that would be risky or difficult to do so in the real world [15].
The VR:
- improves students' memory and boosts retention of information;
- enhances students' engagement and excitement during learning activities;
- increases learning outcomes;
- provides new opportunities and makes learning accessible to all students;
- increases understanding of challenging, conceptual subjects;
- develops emotional intelligence, awareness, and understanding;
- improves communication and teamwork skills;
- raises students' comprehension levels;
- enhance the teaching abilities of teachers using virtual reality (VR) by providing a 360-degree learning experience;
- ensures accessibility for disabled students.

2. MATERIALS AND METHODS

The purpose of this article is to present the results of the Erasmus+ project "Circular Economy in Fibrous Composites and Technical Textiles Through the Use of Virtual Laboratories", under reference number 2021-1-ES01-KA220-HED-000032075: E-learning course on circular economy of fibrous composites and technical textiles, Virtual laboratory for the implementation of virtual experiments and Roadmap to micro credentials.
The project has a consortium of five European partners being implemented within 2 years (28.02.2022-27.02.2024):

- UPV - University Polytechnic of Valencia, Spain
- KTU - Kaunas University of Technology, Lithuania
- UNIWA - University of Western Attica, Greece
- UO - University of Oradea, Romania
- IDEC - a consulting company, Greece

The CircuTex project's objectives include developing an online course on the circular economy for technical textiles and fibrous composites as well as a virtual lab that will simulate a real lab environment for students. The development of a roadmap for course validation and certification will also result in a collection of policy recommendations for the adoption and recognition of micro-credentials in the universities of the project partners [16], [17].
These days, it is extremely difficult for teachers to engage their students in meaningful learning. We firmly believe this aspect will completely vanish with the introduction of virtual reality technology in the laboratory activity of CircuTex project because most students would be tempted to discuss their virtual reality experiences.

3. RESULTS

3.1. E-learning course on circular economy of fibrous composites and technical textiles

The need for universities to offer e-learning platforms to students is growing as the benefits exceed the drawbacks [18], [19]. Our educational system is being completely transformed by the usage of digital learning tools. The days of traditional classroom instruction are gradually being replaced by high-speed internet and technological innovation. With better organization and high-quality courses, electronic learning aims to enable students to study without physically being present in a classroom. Through the online courses, students can view the lectures whenever it is most convenient for them and go over material as many times as they want.

To achieve this goal, the CircuTex project's first output was to create the e-learning course titled "Circular Economy of Fibrous Composites and Technical Textiles". The course comprises 5 modules that are already posted on the e-platform of the project:
Module 1. Circular economy for technical textiles and fibrous composites
Module 2. Sustainable resourcing for technical textiles and fibrous composites
Module 3. Sustainable processes used in manufacturing of technical textiles and fibrous composites
Module 4. Quality and waste management
Module 5. Recycling of fibrous composites and technical textiles: possibilities and challenges
The course's primary focus is on technical textiles and fiber composites as part of the circular economy and aims to increase the competency of HEI students in the creation, production, usage, and recycling of fibrous composites and technical textiles using circular economy and sustainability techniques.

Figure 1. E-platform of CircuTex project

3.2. Virtual laboratory for the implementation of virtual experiments

For the second intellectual output, a virtual laboratory has been created to support the learning process. Participants in the online course will have the opportunity to test and carry out experiments pertaining to the circular economy of fibrous composite and technical textiles through the virtual laboratory. The way to access the virtual laboratory of CircuTex project is through the Meta Quest virtual reality headset.
The virtual laboratory comprises 11 experiments where the students will learn through experience:
Experiment no.1. Fiber identification - Solubility test Identification of fibers through the behavior of different fibers in certain solvents.
Experiment no.2. Fiber identification - Pyrognostic test: Identification of fibers through their behavior when exposed to fire.
Experiment no. 3. Identification of fibers-Melting point: Identification of synthetic fibers by specific melting temperature.
Experiment no. 4. Identification of fibers-Optical microscope: Identification of fibers by the

morphological characteristics presented by the fibers under the optical microscope.
Experiment no. 5. Quantification of fiber mixtures by chemical procedures: Determination of the composition of a fabric with a binary mixture of fibers.
Experiment no. 6. Fiber-matrix adhesion - Stress-strain curve analysis and microscopic analysis: Determination of fiber-matrix adhesion by identification of delamination failure under tensile loading and SEM image analysis.
Experiment no. 7. Mass loss after the Martindale abrasion test: Determination of the loss in mass of samples subjected to the abrasion resistance test.
Experiment no. 8. Laminated structures of technical textiles: identification on the microscope of the structures of knitted, woven and non-woven fabrics.
Experiment no. 9. Tensile strength of recycled fibers: Comparison of the tensile strength of recycled fibre yarns vs. virgin fibre yarns.
Experiment no. 10 Different bleaching methods for recycled fabrics: Comparison of the bleaching system by different methods.
Experiment no.11. Dissolving pulp from viscose waste.

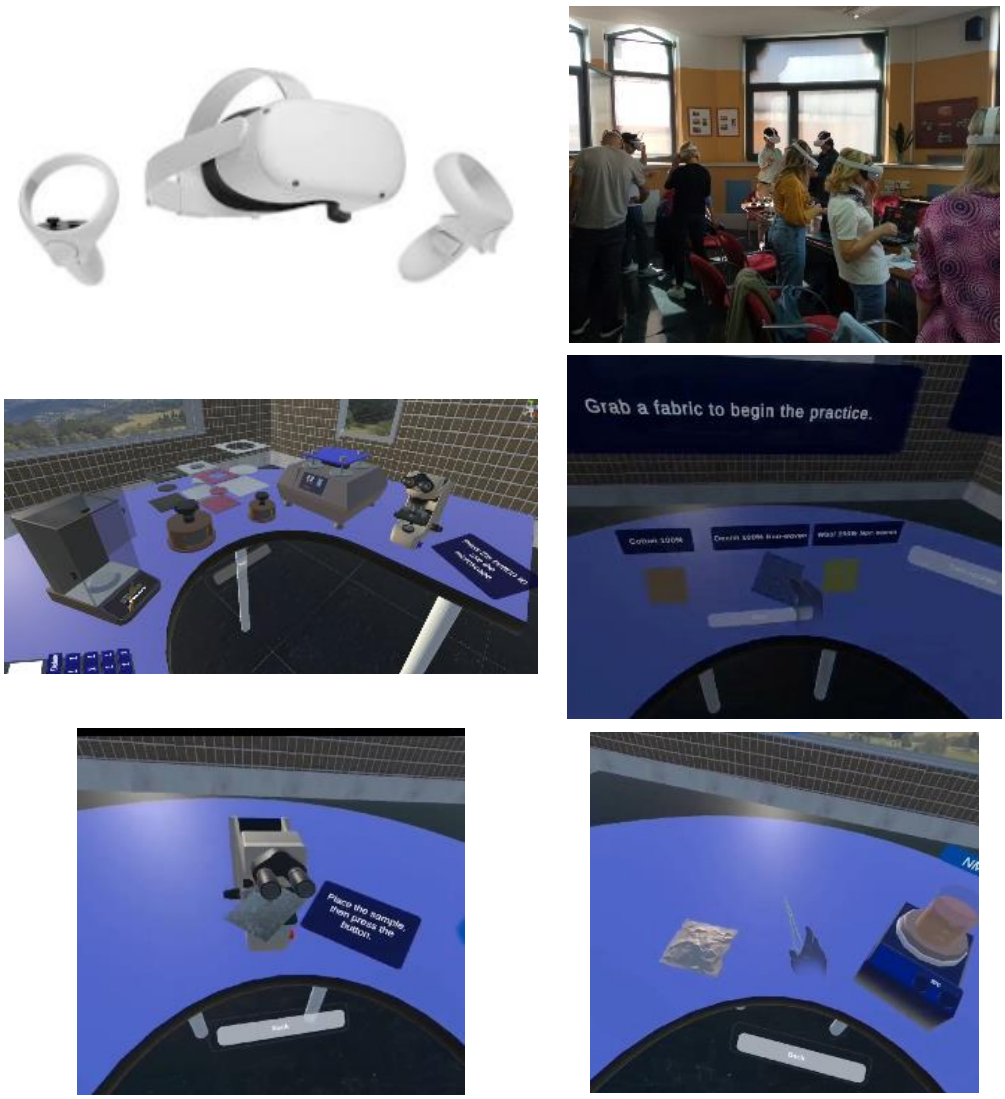

Figure 2. Experiments of the virtual laboratory

The students will be able to conduct the virtual experiments without actually having to be in a lab and also will have the possibility to delve deeply into complex subjects as fiber identification, fiber-matrix adhesion, mass loss after the Martindale abrasion test, laminated structures of technical textiles, tensile strength of recycled fibers, bleaching methods for recycled fabrics, and study by using virtual reality as immersive learning tools—all from a safe, secure, and comfortable setting: the classroom.

3.3. Roadmap to micro credentials

Partners will make an attempt to validate the course and provide digital certificates that may be used in the new "Europass Digital Credentials" format at the European level. Partner organizations will conclude by presenting a set of policy recommendations in support of the European approach to micro-credentials.

4. CONCLUSIONS

The world of virtual reality is always changing. Nearly any field might reap dozens of advantages from it. Virtual reality is the future of education and a remarkably effective teaching tool. Modernizing education through the use of virtual reality can be a very successful achievement. By using the virtual reality (VR) in the CircuTex laboratory activity, the ways of teaching will become more productive, the students will definitely feel more motivated to learn by using this technology, they will develop social and interpersonal skills that they will need in the future, including empathy and teamwork. Also, virtual reality allows for the implementation of any language imaginable within the software. Thus, in CircuTex project, language will no longer be an obstacle to students' goals for a quality education.
To conclude, virtual reality can revolutionize teaching and learning process.

5. ACKNOWLEDGEMENTS

The CircuTex project is funded by the Erasmus+ programme of the European Union under project reference number 2021-1-ES01-KA220-HED-000032075. The European Commission support to produce this publication does not constitute an endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

6. REFERENCES

[1] Hidrogo, I., Zambrano, D., Hernandez-de-Menendez, M., and Morales-Menendez, R. (2020a). Mostla for engineering education: Part 1 initial results. *Int. J. Interact. Des. Manuf.* 14, 1429–1441. doi: 10.1007/s12008-020-00730-4
[2] Caciora, T.; Herman, G.V.; Ilieș, A.; Baias, Ș.; Ilieș, D.C.; Josan, I.; Hodor, N. The Use of Virtual Reality to Promote Sustainable Tourism: A Case Study of Wooden Churches Historical Monuments from Romania. Remote Sens. 2021, 13, 1758.
[3] Herman, G.V.; Caciora, T.; Ilies, D.C.; Ilies, A.; Deac, A.; Sturza, A.; Sonko, S.M.; Suba, N.S.; Nistor, S. (2020). 3D Modeling of the cultural heritage: Between opportunity and necessity. J. Appl. Eng. Sci. 2020, 10, 27–30.
[4] Albu, A.V.; Caciora, T.; Berdenov, Z.; Ilies, D.C.; Sturzu, B.; Sopota, D.; Herman, G.V.; Ilies, A.; Kecse, G.; Ghergheles, C.G. (2021). Digitalization of garment in the context of circular economy. Ind. Text. 2021, 72, 102–107.

[5] Nedeva V., Z. Zlatev, S. Atanasov, (2013). Virtual lab for system modeling and simulation, ARTEE, Journal of Faculty of technics and Technologies, Trakia University, Vol1, N1, pp26-30, 2013, ISSN 1314-8796
[6] Häfner, P.; Häfner, V.; Ovtcharova, J. (2013). Teaching methodology for virtual reality practical course in engineering education. Procedia Comput. Sci. **2013**, 25, 251–260.
[7] Broisin, J., Venant, R., and Vidal, P. (2017). Lab4CE: A remote laboratory for computer education. *Int. J. Artif. Intell. Educ.* 27, 154–180. doi: 10.1007/s40593-015-0079-3.
[8] Chou, C., Tsai, C., and Tsai, H. (2001). Developing a networked VRML learning system for health science education in Taiwan. *Int. J. Educ. Dev.* 21, 293–303. doi: 10.1016/S0738-0593(00)00003-1.
[9] Mortara, M.; Catalano, C.E.; Bellotti, F.; Fiucci, G.; Houry-Panchetti, M.; Petridis, P. (2014). Learning cultural heritage by serious games. J. Cult. Herit. 2014, 15, 318–325.
[10] Guttentag, D.A. Virtual reality: Applications and implications for tourism. Tour. Manag. 2010, 31, 637–651.
[11] Büyüksalih, G.; Kan, T.; Özkan, G.E.; Meriç, M.; Isın, L.; Kersten, T.P. (2020). Preserving the knowledge of the past through virtual visits: From 3D laser scanning to virtual reality visualisation at the Istanbul Çatalca ˙Ince ˘giz Caves. J. Photogramm. Remote Sens. Geoinf. Sci. 2020, 88, 133–146.
[12] Arici, F., Yildirim, P., Caliklar, Ş., and Yilmaz, R. M. (2019). Research trends in the use of augmented reality in science education: Content and bibliometric mapping analysis. *Comput. Educ.* 142, 103647. doi: 10.1016/j.compedu.2019.103647.
[13] McElhaney, K. W., and Linn, M. C. (2011). Investigations of a complex, realistic task: Intentional, unsystematic, and exhaustive experimenters. *J. Res. Sci. Teach.* 48, 745–770. doi: 10.1002/tea.20423.
[14] Frost, M., Goates, M. C., Cheng, S., and Johnston, J. (2020). Virtual reality. *Inf. Technol. Libr.* 39, 1–12. doi: 10.6017/ital.v39i1.11369.
[15] Campos E, Hidrogo I and Zavala G (2022). Impact of virtual reality use on the teaching and learning of vectors. *Front. Educ.* 7:965640. doi: 10.3389/feduc.2022.965640.
[16] Díaz-García, P., Capablanca-Francés, L., Belda-Anaya, R., Mikucioniene, D., Indrie, L., Dimopoulou, N., Priniotakis, G. (2022). *Circular economy of fibrous composites and technical textiles e-learning*, ICERI2022 Proceedings, 15th annual International Conference of Education, Research and Innovation, Seville, Spain. 7-9 November, 2022. pages: 4090-4094, ISBN: 978-84-09-45476-1:2340-1095, doi: 10.21125/iceri.2022.
[17] Indrie, L., Tripa, S., Diaz Garcia, P., Mikucioniene, D., Belda, R. (2023). A European perspective on circular economy for fibrous composites and technical textiles. Annals of the University of Oradea. Fascicle of Textiles, Leatherwork, 24 (2), 2023, pp. 51-56.
[18] Blaga M., A-M. Grundmeier, D. Hofer, Z. Kazlacheva, J. Strahle, Z. Zlatev, D. Koksal (2021). e-Learning as a tool for implementing a sustainable fashion curriculum in textile universities in Europe. Proceedings of The17th eLearning and Software for Education Conference - eLSE 2021, April 22-23, 2021, Bucharest, Romania, pp.107-113. DOI: 10.12753/2066-026X-21-153.
[19] Nedeva V., Zlatev, Zl. (2013). Quality of the services provided by a university web portal, ARTTE, Vol. 1, No.3-4, 2013, ISSN 1314-8796, pp.173-180.