VR4Learning

Título: Virtual Reality for Learning

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Summary

The scientific method and didactic research approach can merge well with Virtual Reality learning methodologies to enhance education attractiveness in a globalized world where knowledge transfer is exchanged and absorbed in a global Education industry that can convey knowledge and information at a long distance. Virtual Reality is part of a broader topic called digital transition, which has accelerated with the pandemic times. A wide range of advantages is enabling to conduct training at a distance facilitating the access and making it easier to explain the content using both audio and 3D images. Several laboratories of two universities have been used as case studies integrating virtual scenarios in a very appealing way, and several VR workshops have been conducted in groups up to 20 People. Companies interested in Virtual Reality have also participated leading to the creation of a virtual scenario in a factory.

Keywords: *virtual reality, 360º images, engaging education, digital learning, new learning methodologies, VR workshops*

1. Introduction

Research is rigorously based on scientific methods and has well-defined experimental steps according to protocols well thought out. Usually, a protocol is elaborated by experts in a certain field and discussed by a group of researchers that define the initial hypotheses and formulate the aims of the investigation. Additionally, a set of resources (human and technical) is necessary, and specific instrumentation shall be used to carry out the experience and to record the results. This could be referred to as the scientific research modus operandi. What happens when such scientific research modus operandi runs into a well-set didactic/educational research modus operandi? Is it possible to convey relevant information related to scientific research methodology in a didactic context for a well-defined group? This investigation aims to answer such questions by providing several case studies of the well-agreed on experiential learning methodology [1] applied to interactions using virtual reality and virtual scenarios designed specifically to enhance the learning path.

In a globalized education, technology plays a more and more important role, being at an early age where children and young adults are keen to learn by using new technology and devices, or bridging the gap and the distance between the teacher and the student. A powerful tool is Virtual Reality (VR) which clearly stands out to give the learning experience [2] a whole new view. It is an attractive way to bring new content into the classroom as well as in companies for specific training purposes. It is well aligned with the digital transition, allows learning at a distance and is a new methodology of knowledge transfer which is very appealing both to young and older generations. It can reach a global audience using personal computers and mobile phones connected to the internet. It is also possible to create a full immersion into the learning experience using Virtual Reality glasses where virtual scenarios are displayed in color on a 3D imaging in front of the eyes of the viewer, with a background that looks very real. Thus, all over the World the interest for VR is growing as a new learning methodology both in cases where and without a teacher giving additional information about the content.

The current investigation focuses on VR scenarios in a joint project being developed by 4 Partners within a European program to support education, the Project is called VR4Learning [3] and has the goal of creating videos that contain virtual reality that are helpful for online courses. These videos allow the user to be immersed into the VR experiences. Additionally, the project team created virtual and augmented reality content to be used in digital and VR learning. The new content can be used in training sessions with 3D glasses as well as for the creation of specific VR courses which will enable learning at a distance in an immersive environment. In this joint effort, youth from diverse backgrounds learned about green transition and sustainability efforts for our planet, making knowledge acquisition appealing and attractive. This new methodology is easy to apply in a classroom environment, as well as in a company or a short workshop for training purposes. Another possible application is within a multidisciplinary team, where a trainer leads the team through the scenarios to acquire specific knowledge in a specific field of activity, as it is the case in hospitals, where a surgery multidisciplinary team can be trained for a complex surgery using virtual reality. For young surgeons, virtual or mixed reality can reduce stress during medical interventions through exercises and visualising each medical procedure step by step. In the hospitality industry, an international chef can show how to prepare a special dish, and young professionals can exercise it using mixed reality. People with experience from hotels

can share their techniques with young professionals, and after these demonstrations, the young professionals can exercise in virtual or mixed reality. In general, in any field that requires different types of expertise that need to work closely together, virtual and mixed reality can be used for practice in that field. It might be a way to solve an issue about students' practice in a virtual environment, making them ready to work in a real and challenging environment. With climate change causing floods, landslides and other disasters, students could practice survival techniques in virtual reality. They can learn how to direct water flows with sandbags, what to pack and react when they hear a siren, and how to prepare them for a disaster to protect their valuable life. Psychologists can also use virtual reality to help treat some phobias by gradually exposing the patient to that stress by immersing them in a controlled environment close to the real one.

2. An Educational Experience

Education follows a general curriculum within every country, according to each national individual education system. However, general guidelines are followed with the European Union member states and projects within the Erasmus+ framework have the aim of achieving common goals for quality education and youth empowerment. The four European countries participating in the VR4Learning project were Sweden, Bulgaria, Portugal and Romania. Technology based education approaches and methodologies using virtual reality vary throughout each of these countries.

Using Virtual Reality (VR) to teach students from upper-secondary schools in Sweden has become more common in recent years [4]. VR equipment has grown to be more affordable and more user-friendly. Thus, it is foreseen that VR will be a more conventional learning tool in future schools [4], even in the early stages. Statistical data from a survey on VR in Sweden [5] shows which VR devices were used in Sweden in 2017 by activity. Virtual reality devices were most often used for watching videos (55%), followed by playing games (42%), virtual reality devices for professional purposes (11%) and others (18%).

Today, more frequent use of VR occurs in some adult education programs, such as engineering and medicine, because VR enables simulations and visualizations of various scenarios and phenomena.

In Bulgaria, the investments in VR, both in school education and higher education levels, are growing. The Ministry of Education and Science set up a national resources repository called the "Digital Rucksack", where students and teachers can access VR and AR materials [5]. Global industry leaders like EON Reality set up in partnership with "Prof. Dr. Asen Zlatarov" University the first XR laboratory in Bulgaria, aiming to enable over 5,000 students and 750 teachers and enterprise users to access EON-XR along with specialized software from EON Reality for the next five years [6].

Exploring VR in education within the Portuguese context reveals a focus on technological innovation transforming various sectors, including education. Various actors from the education and training sector are embarking on international partnerships to explore and test different modalities of VR in learning [7,8,9]. Tools like Augmented Reality (AR) and Virtual Reality (VR) are becoming central to the new period of exponential increase in information consumption and bring forward new, immersive formats for it [10].

In Romania, integrating VR into education is part of a broader trend towards embracing immersive technologies to enhance learning experiences. These technologies are being explored for their potential to increase students' engagement, improve knowledge retention, and make learning more interactive by allowing students to learn by doing rather than just observing, reading, or listening [11]. Educational establishments are urged to evolve and prepare the new generation for future technologies. The next generation of adults is considered to have a much stronger adaptation to virtual reality and digital content. This asset can contribute to smooth changes in the digital landscape. A recent study confirmed that the Z generation in Romania spends more time in the virtual world than older generations, interacting with metaverse applications more than their older friends, family, or teachers. Educators should consider these new technologies more when designing educational content [12]. At the same time, investment in teacher training is needed.

3. Methodology

The methodology that has been applied used two technologies to enhance learning: creating virtual reality scenarios and e-learning videos. The students can access these tools online at any time and location, thus facilitating and easy access to the educational materials.

The Virtual Reality scenarios are created using specific 3D cameras with a wide lens camera that can capture the reality of a certain location in a 360° perspective (Figure 1). The camera can be placed on top of a tripod and take several pictures using a time clock so that there is no need for the user to be close to the camera, thus avoiding to appear in the images taken. At a later stage, the images captured at several locations within the same room will be merged using an image editing software that can connect two different images from the same location and merge them based on the color of each pixel so that, ideally, there is no visual sensation of overlapping when looking at the final image.

Figure 1. Captured 360° images (©Insta360)

Figure 2. Cameras used to capture 360° images (©Insta360)

Special care needs to be considered for parameters like the level and brightness of the light, the position (height) of the camera, the capture mode, and the distance between different shots. Figure 2 illustrates the specifics of the 360° lens.

The images captured with the 3D cameras are uploaded to a specialized software and VR scenarios are created by linking spatially the pictures. Several icons and markings guide the user through the rooms of the scenario, from the initial entrance, as illustrated in Figure 3. The entrance of the VR scenario can also be a virtual image, as illustrated in Figure 4.

Figure 3. Entrance of the VR experience with 360° images (©Insta360)

Figure 4. Entrance of the VR experiences with computerized scenario

Another way to create VR scenarios is using a completely digital computed approach. In this case, objects exist in 3D mode in libraries that are used to create a virtual scenario where the user can move while in a room with windows, information on the walls and even TV screens where videos can be seen. Users can navigate through the virtual space of laboratories, as illustrated in Figure 5, and choose the content they want to learn more about by clicking on additional information "i", downloading files or seeing additional available videos (Figure 6).

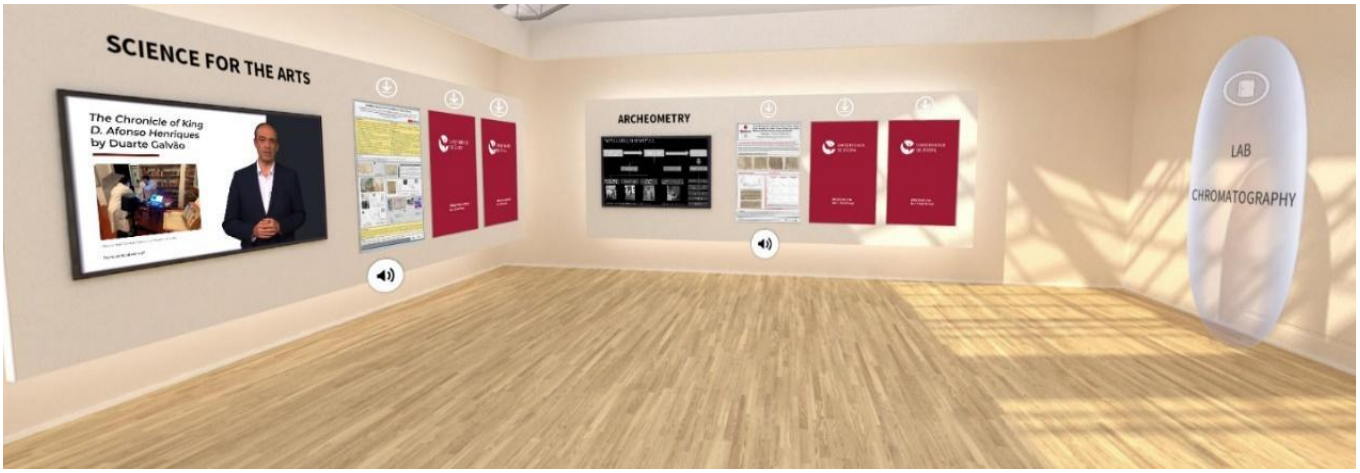

Figure 5. VR Scenario created for the Cultural Heritage LAB

Once the content had been created, the knowledge transfer experience was an integral part of the 1st-year course "Methods and teaching of the motor activities" ay University of Evora.

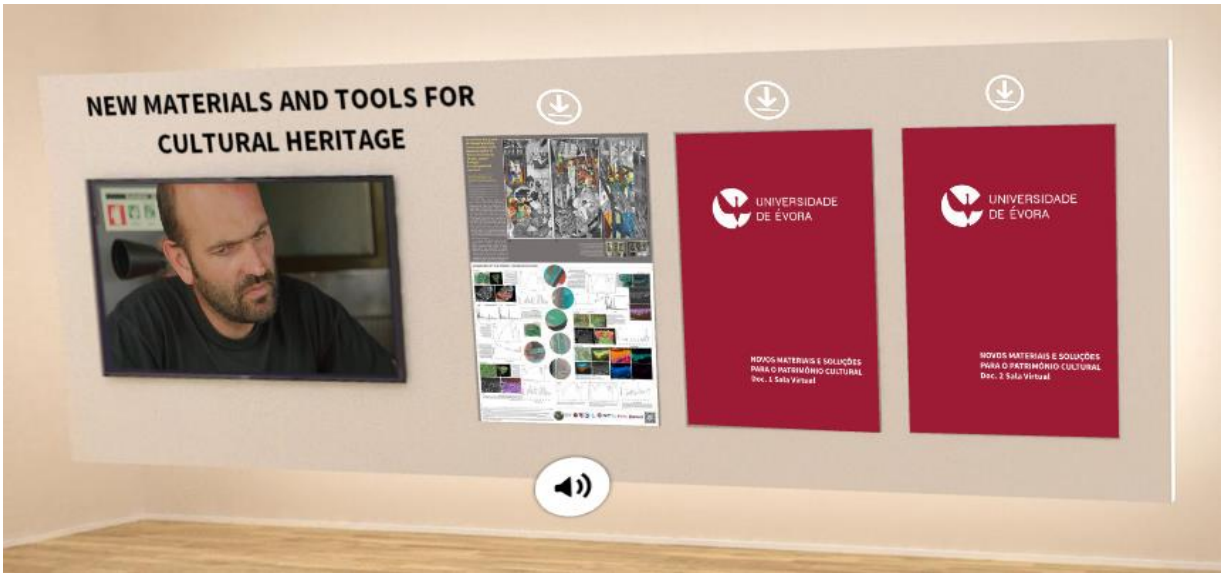

Figure 6. A detail of the VR Scenario Cultural Heritage LAB

The comparative research carried out to map the current national developments in the project partner countries showcases unique approaches and challenges in adopting VR technologies in educational settings, reflecting broader trends and national priorities in digital learning. Users can enter a VR Scenario from any location and be guided through the learning process. Short courses can be taught by experts from different countries without travel, thus facilitating access to information.

E-learning videos can be embedded into VR scenarios as well. The videos were produced in a professional Multimedia Studio (Figures 8 and 9) with the support of FCCN (Portuguese Foundation for National Scientific Computation), having a 4K image resolution and voice recording. The studio facilities allow the choice of content added to the e-learning videos: audio, lecturer presence, and 2D and 3D animations created during post-production.

Figure 7. Project Team in the Multimedia Studio

Figure 8. E-learning videos produced in the multimedia studio

Figure 9. E-learning videos: work in progress while recording

A library of 14 e-learning videos is currently available online on the project's YouTube channel [13], in English as the original version and with subtitles in all European Union languages (Figure 10). Engaging visuals, together with a captivating audio background, are designed to catch interest and raise awareness of sustainability topics. The lecturer's voice guides the students throughout the course content and can even appear at certain times, giving a personal perspective. The following e-learning videos have been produced:

- Journey to a Green Future: The Power of Sustainability
- Discovering Earth's Marvels Exploring Ecology
- Renewable Energy Resources
- Solar Energy
- Solar Thermal Market
- CSP Technology
- Solar Radiation
- Solar Collector Performance

- Solar Thermal Components
- Solar Thermal Storage
- Textile Pollution
- Waste Management
- Circular Economy
- Air Pollution

Figure 10. E-learning videos available online

4. Project Activities

The main activities of the VR4Learning project had the aim of creating new learning methodologies using virtual reality and digital learning within the expertise topics of each of the four partner projects. The project activities are connected to the research infrastructure and facilities of each partner, with the final objective for the project outcome to reach as many stakeholders as possible, both students/your professionals and teachers/researchers.
The main projects activities performed were the following:

- Creation of e-learning short videos on sustainability and environmental topics
- Creation of VR content and scenarios for laboratories, factories, and research facilities
- Creation of VR Videos for a quick overview of the VR Scenarios
- Creation of VR Courses on sustainability and environmental topics
- Event organization: online webinars, seminars as VR Workshops and short trainings
- Dissemination activities, both online (social media and webinars) and in-person events: interviews, attending conferences and education events.

4.1 Development of VR content

The two methodologies used in the VR4Learning project were designed to allow students to access these tools online and at any time and location, thus facilitating easy access to educational materials. Several VR workshops, short trainings and webinars were organized during the project duration. Some

users provided feedback on their experience for follow-up and improvement. As illustrated in Figure 5, participants from all four project countries were present in the virtual environment, following the guidance of the main trainer, who conducted a guided tour through the VR scenarios.

The testimonials of users participating in the VR workshops mention the ease of being immersed in a scenario they would not easily access otherwise. The work being performed integrates multimedia content with specific written information (in posters on the wall of the virtual scenarios) and audio information in a way that makes learning and absorbing new knowledge very attractive. Both audio and sound can be added in the VR Scenarios to fully captivate users' attention. Some benefits of VR scenarios include the ease of participating in immersive content and the possibility of training from a distance, with the trainer in one location and the trainees in another. Furthermore, it is possible to elevate the training level by involving experts who can record their voices in advance. New content on various topics, including state-of-the-art technologies, can be created in a way that is not technologically too complex.

Students can enter a VR Scenario from any location and be guided through the learning process. They can choose to self-study short courses or courses taught by experts from different countries. Access to information is widely increased and encouraged, allowing students to travel virtually. The E-learning videos and the VR Scenarios bring flexibility, wide accessibility, cost-effectiveness, engagement, and global reach. Students retain more information in digital learning than in traditional face-to-face courses [14]. Following the information and establishing a learning pace is more convenient, as the material can be visualised and revised according to individual needs and preferences. Furthermore, the CO_2 emissions are significantly reduced. A study from Britain's Open University [15] found that digital courses consume an average of 90% less energy and produce 85% fewer CO_2 emissions per student than conventional courses in the classroom.

After producing the VR scenarios, it is also possible to use this content to produce e-learning training courses, which typically vary from 5 to 15 minutes, focusing on interesting information delivered dynamically using images and audio that can be added a posteriori.

Figure 10. Chocolate Factory entrance captured 360º images and VR path

Figure 11. Chocolate Factory captured 360º images and VR path

Figure 12. Chocolate Factory captured 360º images and VR path

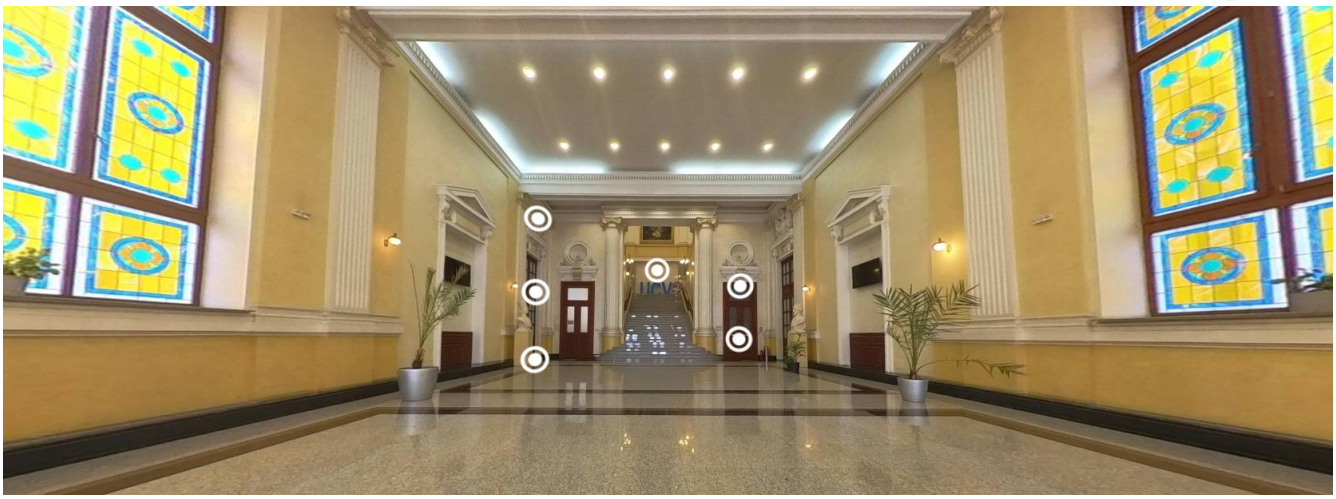

Figure 13. Entrance Hall at University of Craiova, captured 360º images

4.2 Creating VR content to be used in VR workshops, short trainings and webinars

During the VR4Learning project, students, teachers, and academics received the VR technology very well. They were open to using it, were curious, tested VR headsets, and expressed their perceptions of this technology. Virtual Reality has advanced over other digital technologies in recent years thanks to the realistic environment it presents through devices that create immersive simulated environments. Indeed, traditional education is changing, and the impact of new technologies is felt more intensely. VR technology helps teachers and academics to make the content more attractive and engaging for their students.

An important advantage of this technology is that it helps students create a more precise 3D overview of the systems they have learned about in theory using 2D images. Students can visualise 3D objects and complex concepts or processes using VR headsets. Their imagination is stimulated more in such an environment, and their comprehension is improved. VR technology allows students to visualise a series of teaching and research labs, places to go for internships and to visit a company or a university where the student wants to go for an Erasmus+ mobility. The student will adjust their expectations after such an experience and make informed decisions.

VR technology can potentially contribute to team spirit development because students can work in teams in a virtual environment, making collaborative learning with other colleagues. The technology for making videos incorporating 3D images is accessible and does not require complicated equipment (a 360º camera). This technology can potentially improve the efficiency of teaching and learning, facilitating individualised learning.

There is educational VR software dedicated to Astronomy, Anatomy, Computed Tomography, Radiotherapy, Nuclear Medicine, etc., which is still expensive because it requires a substantial human effort of experts from different fields of activity. From this point of view, this technology might create differences between those who can afford it and those from disadvantaged environments. The educational software for VR headsets generally contains at least two to three modules that can sometimes be

purchased separately (images, information about images, quizzes). Also, images can be decomposed and then recomposed to understand better the relation between different parts of a system or process.
Another disadvantage of VR technology is represented by the time spent by students in this immersive environment and the consequences. Some students might spend more time in VR than with colleagues, teachers, and friends, which affects their social relations and mental state. Moreover, some students said they experienced headaches and dizziness from VR headsets.

4.2.1 Dissemination activities

As part of the Dissemination strategy, the project team organized VR workshops and short trainings on using virtual reality in education on three levels: for high school students, teachers, students and academics.

4.2.1.1 VR Anatomy training

In June, 2023, the Romanian team organized a training in Anatomy during students' practice. Students actively learned about the skeletal system. They broke down the skeleton, put it back together, and learned how bones connect and what the role of each bone is. It was a three-dimensional puzzle solved by the students under the educator's guidance. The software also allows educators to evaluate students after each lesson. Students must answer quizzes within a specific time. As illustrated in Figure 14, the students simultaneously experienced many emotions, from surprise, excitement, and focus to the satisfaction that they have learned something useful for the profession they are preparing for. It was a successful trial to use virtual reality in studying anatomy, which will be implemented during project sustainability. The project team had the first experience using VR technology. Students' feedback encouraged the Romanian team to continue. During this training, the team used a free version of www.3dorganon.com software but 3D Organon represents a medical education platform that introduced a VR Network function in 2018.

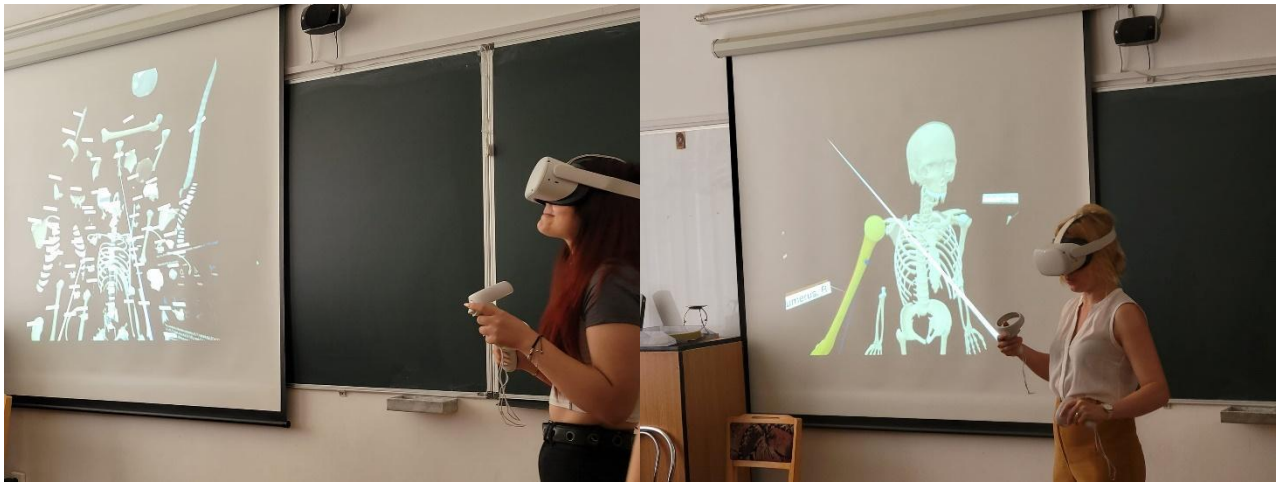

Figure 14. Images from the workshop at the University of Craiova during students' practice

The complete version is complex, with a huge educational potential. The software contains five parts: Ultrasound, Anatomy, XR Medical Imaging, Medverse and Quiz that can be purchased separately. Each

module contains images and theoretical information about all components of the anatomical systems. The relationships between components can be visualised. Moreover, each anatomical system can be decomposed and then recomposed.
The ultrasound module allows a theoretical and practical learning when the user can exercise how to use linear and convex ultrasound probes. It is a standardized training based on the simulation of the skills necessary for a person to perform in this medical field (Figure 15).

Figure 15. Images from the module Ultrasound (source: www.3dorganon.com)

The anatomy module (Figure 16) allows an approach based on an understanding of each anatomical system and gives users an overview and detail of the human body. Users gain an understanding of clinical correlations between anatomical systems.

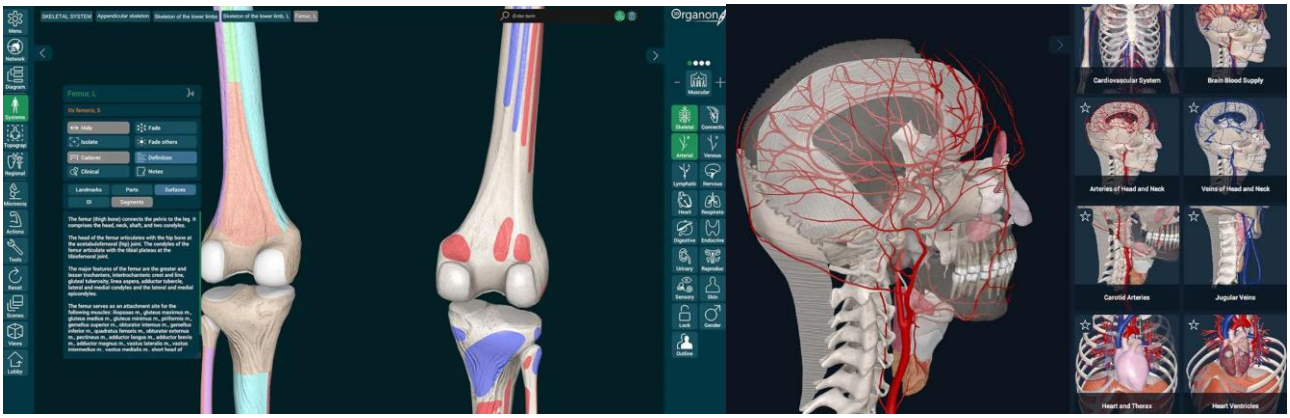

Figure 16. Images from the module Anatomy (source: www.3dorganon.com)

3D Organon's XR Medical Imaging Module (Figure 17) allows the user to upload a DICOM file from a patient and instantly access an immersive 3D visualization of their medical images. The module offers students and healthcare professionals a way to analyze and interpret complex medical data.

Figure 17. Images from the XR Medical Imaging Module (source: www.3dorganon.com)

Medverse module (Figure 18) is a medical metaverse network that helps participants to join multi-user online training sessions hosted by educators. The participants can create their own classes and invite other users to join.

Figure 18. Images from the Medverse Module (source: www.3dorganon.com)

The Quiz module (Figure 19) offers a formative assessment. It contains an impressive number of clinical anatomy tests. Students and educators can go through the material at their own pace and when they can, making the learning experience individualized.

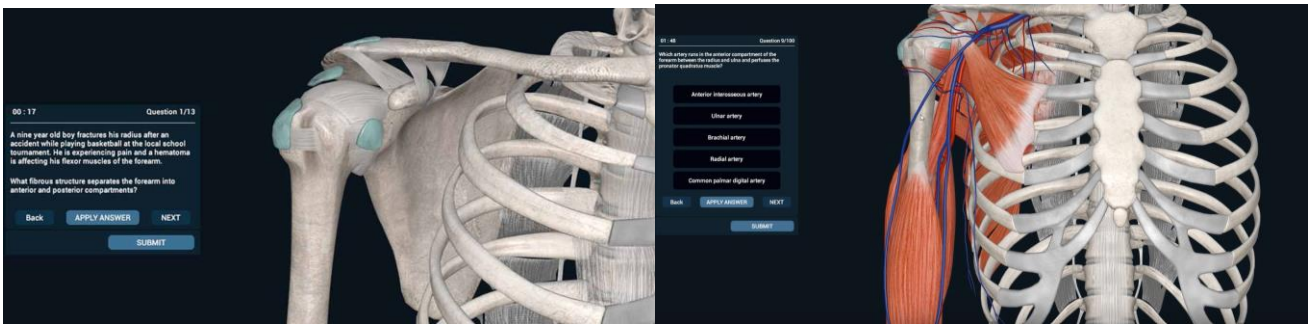

Figure 19. Images from the Quiz Module (source: www.3dorganon.com)

Also, there is a mobile version of this software (Figure 20) that allows students to use it simultaneously with their teacher or whenever needed.

Figure 20. Images from the Mobile version of this application (source: www.3dorganon.com)

There are many other applications that are designed for educational purposes. The educators can decide which of them is more appropriate for their students, according to their resources and needs.

4.2.1.2 Training for teachers

In November 2023, a Virtual Reality training for teachers from local high schools was organized at Academics' House in Craiova (Figure 21). If there was some reluctance at the beginning, later, everyone relaxed and tried the VR glasses. Each teacher received guidance from the project team, so in the end, everyone became independent in choosing the software they wanted to try. The teachers were excited about this technology because they saw its potential. It could help them get students out of the social media mirage of the cell phone.

Figure 21. Images of teachers trying VR technology in Craiova

4.2.1.3 Training for students

First-year Medical Physics (MP) experienced VR technology (Figure 222) on November 27, 2023. They were able to try different applications for educational purposes and visualised physics, astronomy, chemistry and biology experiments. After a simple demonstration, they could work independently. This underlines once again how digital-ready this generation is. At the same time, it shows the need for teacher training to cope with this changing environment. They would have liked to spend more time in virtual reality, meaning the teacher has to plan and control the time dedicated to some digital sequences of the lesson very well. This generation spends a lot of time on social media and needs to realise that time is very important.

Figure 22. Images of MP students trying VR headsets

4.2.1.4 Training for local community

On November 28, 2023, the University of Craiova organised an event for the local community (Figure 23). It was an opportunity to present the experience acquired in the project VR4Learning. Those students who were trained one day before this event on how to use the VR goggles provided training to those who expressed a desire to try the technology. Students have learned better by explaining to others what they have to do. More than 1000 people attended the event. Students have also learned to be patient, adapt to the level of the person they are training, and communicate better.

Figure 23. Main hall of Craiova University, event organized for the local community

4.2.1.5 VR workshop for Physics students

In February 2024, Medical (MP) and Computational Physics (CP) students from the University of Craiova tested the VR technology (Figure 24) in one of the library rooms. The group included an Erasmus+ student. All students were eager to try this new technology, asked questions, and had the patience to wait until a trainer had time to explain. Students expressed their positive thoughts and perceptions. For most of those present, it was the first time they had tried this technology in an educational context.

In the first phase, the students virtually visited the University of Craiova, the main hall, the festivities blue room, some laboratories, and the sumptuous building of the Academics' House. In the second phase, students saw how easy it was to learn anatomical systems using VR technology. The software www.organon.com is a complex software that combines 3D images of anatomical systems with written and audio information about the importance of each component and its relationship to the others. The CT imaging allows students to recognize organs in the sections provided. This will later allow them to recognize abnormal structures in a CT section and correctly calculate radiation doses in the treatment plan, considering the organs at risk. Finally, they tested the feeling of weightlessness in a space shuttle by trying to manipulate various objects on the space shuttle or simply moving from one module to another.

Figure 24. Images from a workshop organized in Craiova for MP and CP students

4.2.1.6 VR Webinar in Drobeta Turnu Severin, Romania

On April 24, 2024, a webinar was organized for 20 students and 17 teachers from Drobeta Turnu Severin (Figure 25). Students and teachers had a virtual tour of the University of Craiova. They learned about the technology used to make VR scenarios and videos. It was exciting for the high school students to see how the academic space looks and the teaching labs where Medical Physics students study medical imaging and radiotherapy. They could see an ultrasound scanner, a CT scanner, a human anatomy model and treatment plan simulators. Their teachers recalled the places where they had studied; they were overwhelmed by the memories of how the university space had changed.

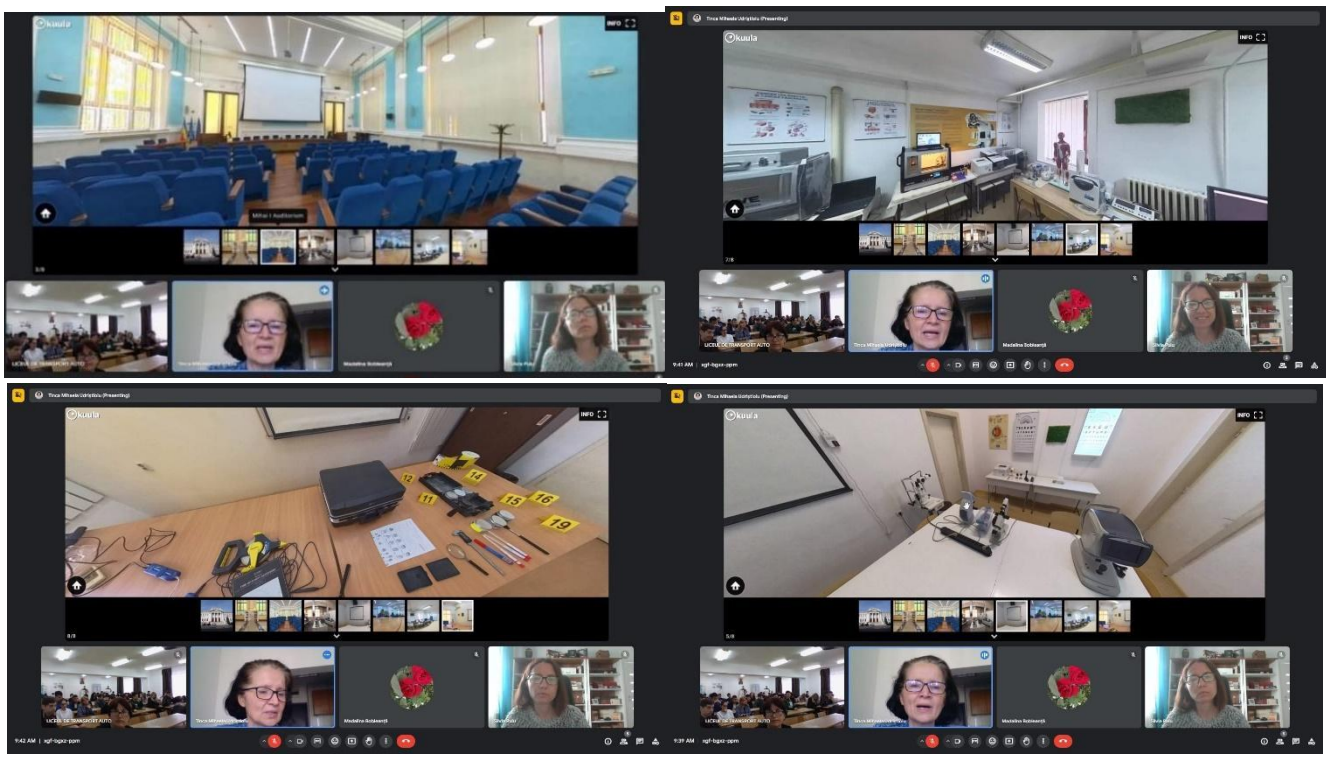

Figure 25. Images from an online training with students and teachers from Automotive Transportation High School, Drobeta Turnu Severin

4.2.1.7 VR Workshop in Pitesti, Romania

On May 8, 2024, 66 students and four teachers from "Alexandru Odobescu" High School (Pitesti) participated in face-to-face training about the importance of lab activities in teaching Science. It allowed students to understand higher education opportunities and the benefits of a bachelor's diploma in science. Starting from the forensic kit, students understood why it is necessary to study science (Figure 26.a). The discussion started with the police profession and from which subjects should have skills a police officer who uses a forensic kit. Math will help them later construct logical reasoning; physics will let them understand how a magnet can be used to remove excess magnetic powder from fingerprints, a magnifying glass will magnify fingerprints lifted from the crime scene, and ultraviolet waves will tell the difference between real and fake money. Biology makes students understand why biological samples contain information about each person's DNA. Chemistry helps them understand how the films used in fingerprinting are made.

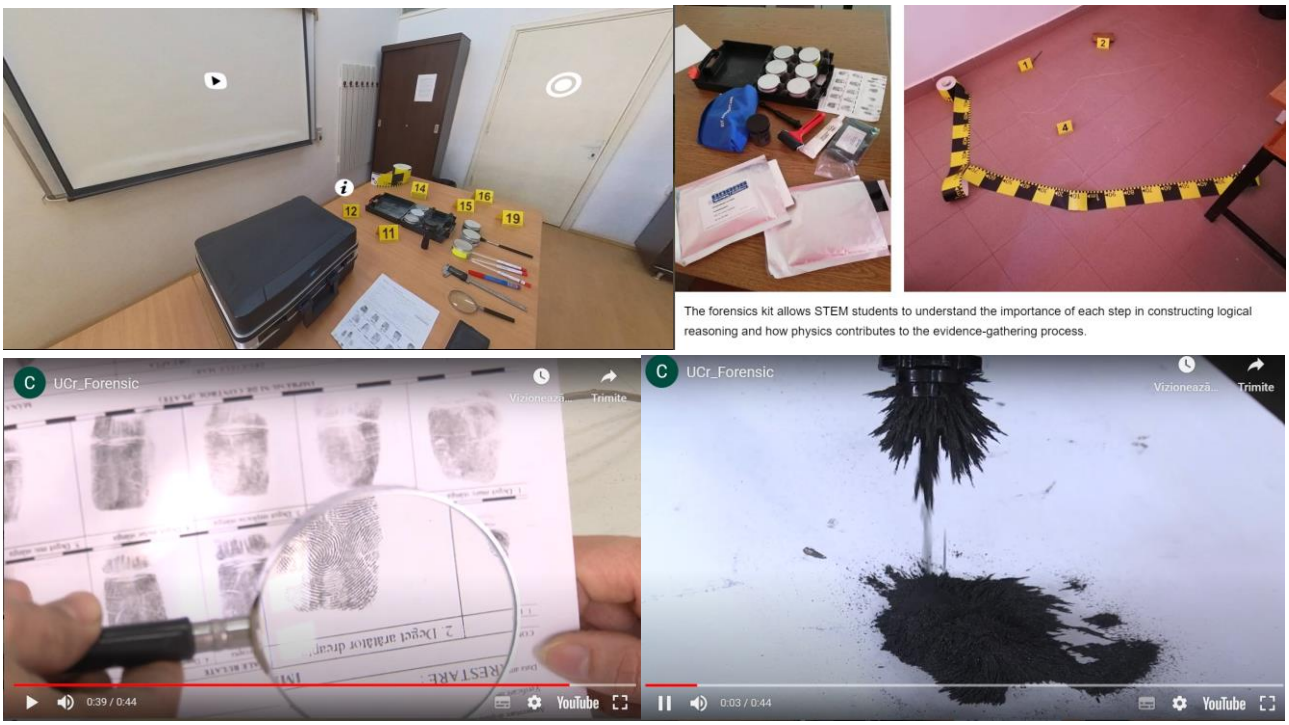

Figure 26.a Forensic kit images

After this demonstration, students participated in four virtual visits to the laboratories of the Department of Physics (Optics, Newtonian Mechanics, Optometry, Medical Imaging and Radiotherapy) (Figure 26.b). It was a chance to discuss future professions with students and why it is vital to study sciences.

Figure 26.b Images with students and teachers from Al. Odobescu high school

4.2.1.8 VR Workshop in Craiova, Romania

On May 24, 2024, 20 students from "Charles Laugier" School, Craiova, received training in VR (Figure 27.a) technology and how this technology can be used in physics promotion. Using VR glasses and software in astronomy, space reveals its planets, satellites, and galaxies. It was an exciting trip into space.

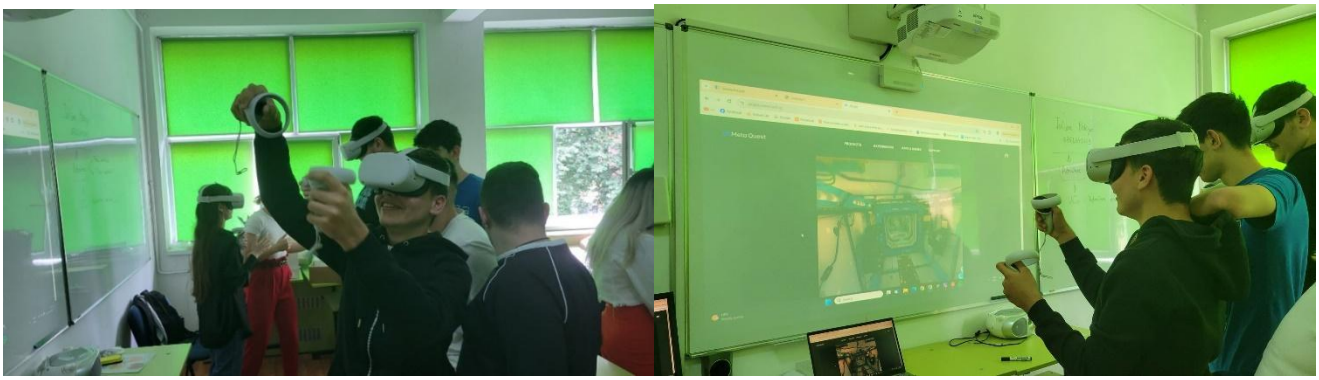

Figure 27.a Images from the "Charles Laugier" high school

On the same day, more than 30 students and three teachers from the "Fratii Buzesti" high school (Craiova) participated in a different training session about VR technology (Figure 267.b). They discovered how difficult it is to keep the balance in a spaceship or to manipulate different objects. They also discussed how Physics can be taught more attractively to students. One high school student who wants to attend medicine said that using VR glasses helps him understand anatomy better because he can see each anatomic system. Another student who wants to attend architecture states that VR glasses help to see every corner of the designed buildings. The VR glasses help him to imagine certain spaces more easily, to see how the spaces of a building are connected, how they can be landscaped or which garden is more suitable for a house. It was also interesting for this student to collaborate with colleagues on the same project.

Figure 27.b Images from "Fratii Buzesti" High School

4.2.1.9 VR Workshop at a local highschool, Craiova

On May 28, 2024, at "Voltaire" high school (Craiova), a training on how VR glasses are used in Medicine was organised (Figure 28). Also, students and teachers saw science experiments. These students visited an oncological hospital, too. It was an opportunity for them to see the linear accelerator. The linear accelerator is in a safe space related to ionisation radiation. Also, they can see how the control room looks, how welcoming the reception area is, and the room where medical physicists collaborate with radiotherapists to make the best treatment plan for oncologic patients. The students said that they had never imagined how the place where cancer patients receive their treatment with ionisation radiation looks.

Figure 28. Images from the "Voltaire" high school

4.2.1.10 VR webinar about practice at "Sf. Nectarie" hospital, Craiova

On May 10, 2024, an online training session was organised for Medical Physics students in their second year at the University of Craiova. Students from the second bachelor's academic year visited laboratories from the third year of the bachelor's program that they did not have access to. They visited the hospital where the clinical practice is organised (Figure 29). They saw for the first time the place where the linear accelerator is, saw the control room and the room where medical physicists collaborate with radiotherapists and make the treatment plans for oncological patients.

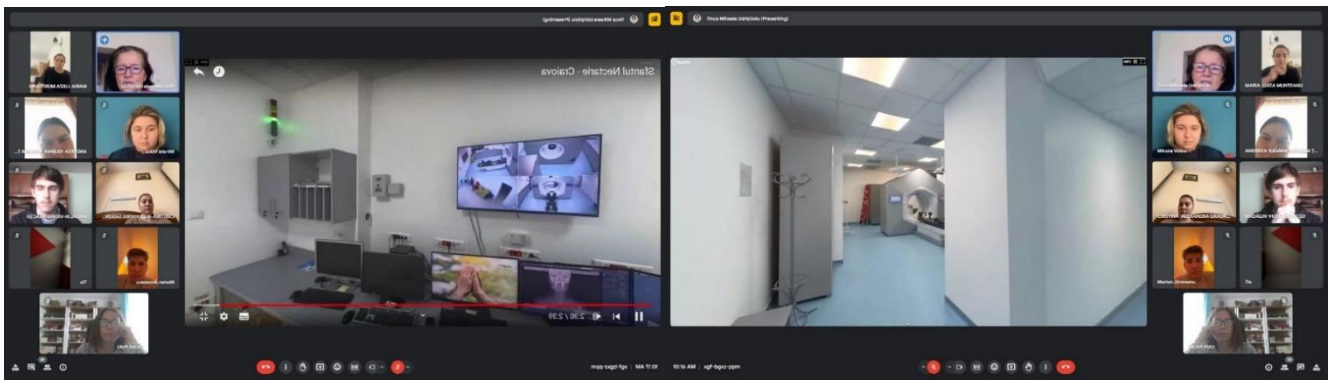

Figure 29. Images from the Saint Nectarie oncological hospital

One of the Erasmus+students in Craiova appreciated the VR headsets as an absolute revelation because it is possible to see in advance some laboratories, classrooms, and dormitories. Another one said the images from the University of Craiova and St. Nectarie Oncology Center were realistic. His feeling was like he was being teleported to those places. The experience was impressive and made him feel connected to these environments profoundly. Another one said, "I highly recommend these glasses to anyone who wants to explore virtually different places of the world, with incredible image quality". Students had exciting suggestions for museums and the hospital industry, where VR glasses might be a valuable tool. For those who cannot afford to travel, virtual scenarios can present different rooms with exhibits like paintings, sculptures, and old furniture. Hotel rooms can use this technology to offer a unique experience

to their guests. Through VR goggles, guests can virtually explore hotel rooms and facilities before making reservations, giving them more confidence in their choices."

Students had the chance to visit a special building that belongs to the University of Craiova, Academics' House, a place with a long history where Ph.D. and habilitation thesis defenses. Also, some academic meetings or meetings with employers and decision-makers are organised there (Figure 30).

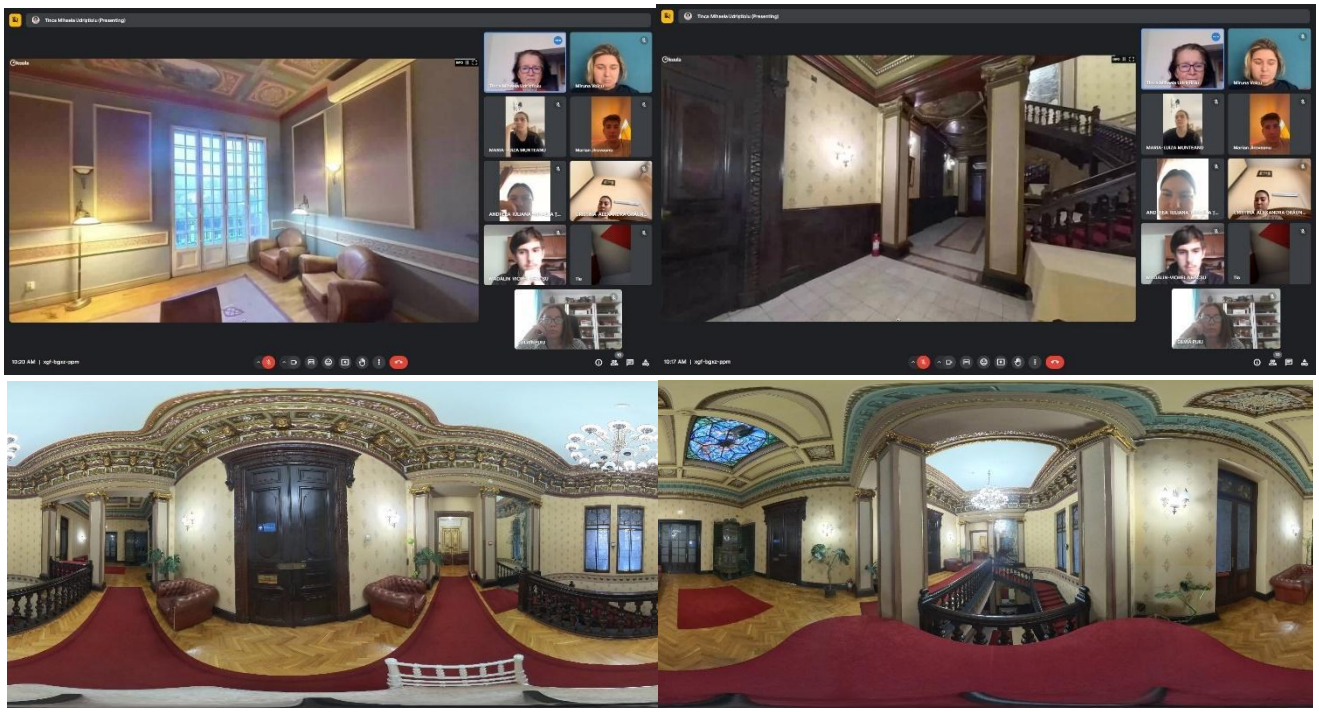

Figure 30. 3D Images from Academics' House

Another surprise was offered to the second-year undergraduate students. They visited the Optometry laboratory, where students of this postgraduate course learn how to identify refractive errors and measure diopters (Figure 31). Students saw in this space equipment used by optometrist and ophthalmologists to help the patients with eye issues. They have the chance to notice an auto kerato refractometer that automatically determines diopters and curvature of the corneal surface, a biomicroscope that allows visualisation of some eye structures, an automatic lensmeter that measures lens convergence and a synoptophore. In the same laboratory, there is an automatic lensmeter which is an instrument used by an optometrist to measure the patient's eyeglass lenses. The biomicroscope allows microscopic investigations of the anterior pole, vitreous and posterior pole. A number of lesions of the eyelid, conjunctiva, sclera, cornea, iris and lens can be detected with this equipment. Synoptophore is an orthoptic instrument used to diagnose strabismus. It allows a complete assessment of binocular vision, trains the ocular muscles, and projects visual stimuli onto each eye. Students saw different types of lenses made by different manufacturers, different frames for glasses, and contact lenses. They also saw how the measurements were determined using the lens kit.

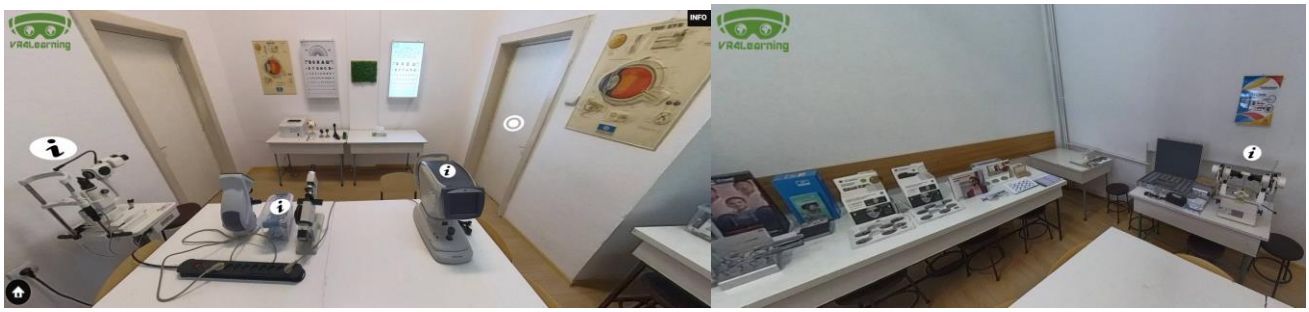

Figure 31. Images from the Optometry laboratory

4.2.1.11 Project Results Dissemination in Timisoara

From May 30 to June 1st, 2024, the West University from Timisoara organised a conference in Physics (TIM24 International Physics). More than 100 researchers and academics participated in this conference, which had five sections, including Education in Physics. The presentation given by the project team from the University of Craiova was named "Immersive Content for Education" (Figure 32). It was an opportunity to share the project experience using virtual reality and project results with colleagues from other European universities. None of the present academics used this technology in the teaching process. The questions were focused on students' perceptions of VR technology, the efficiency of this technology in the teaching process, software availability, and prices for VR headsets and software for education.

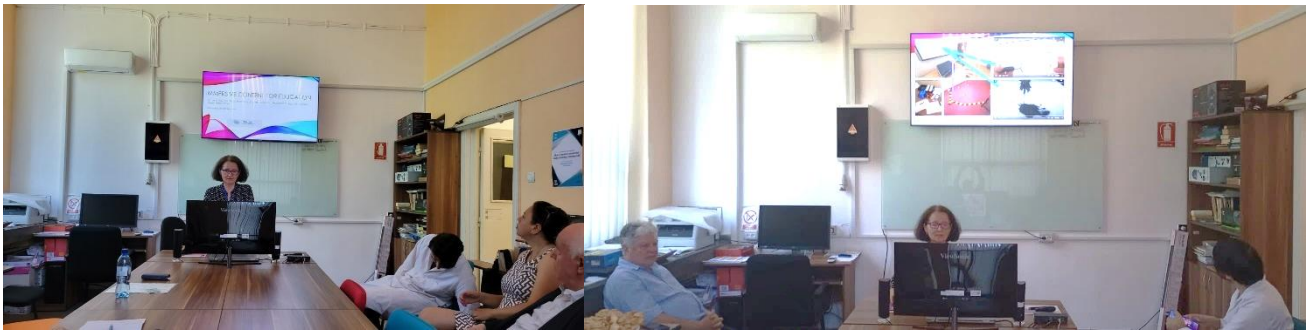

Figure 32. Images from the Physics conference TIM24

4.2.1.12 Closing the VR4Learning project in Romania

On November 29, 2024 it was organised the last activity of the VR4Learning project in Romania. The activity took place within the Research Gala, University of Craiova. As the VR4Learning project started in Craiova in the framework of an event for the local community, it was only natural to end with a similar event for the community's benefit.

Children, parents and grandparents had the chance to use the VR headsets. Complicated technologies, formulas and equations were explained in an easy-to-understand way by students and researchers from the University of Craiova, pole of change in the Southeastern region of Romania. Students and teachers from the local highschools came to see new experiments, robots, drones, VR headsets and other research equipment used in laboratories of the University of Craiova, as illustrated in Figure 33.

Figure 33. Images from the closing project activities in Romania

4.2.2 VR Workshops and trainings in Sweden

The project team from Sweden focused on introducing Virtual Reality and its application in a wide range of domains through workshops, training and webinars organized for students and young professionals.

4.2.2.1. VR Workshop In Sweden

In May 2023 an International Seminar and Online Webinar was held in Uppsala, Sweden. The event gathered more than 20 students and young professionals from different backgrounds from Environmental science to Mechanical Engineering and Business Management.

The discussion topics were focused on introducing VR and AR, how each is defined and applications these technologies are employed for. Participants learned that augmented reality alters one's ongoing perception of a real-world environment, whereas virtual reality completely replaces the user's real-world environment with a simulated one and visualized several examples of these technologies.

A specific topic in the seminar was VR for Environmental Application, as well as advantages for using VR In Education and Training. Several examples were discussed regarding the use of VR in Environmental Sustainability, Climate Change Sustainable Development by engaging users to change behavior and perspective (Figure 34). This was a particularly important focus as the project prepares to use the new technologies for advancing the Green Transition and awareness in environmental applications.

Figure 34. Discussions on VR applications at MG Sustainable Engineering

4.2.2.2 VR Workshop and Webinar in Uppsala

In November 2023, an International Webinar followed by an VR workshop was held in Uppsala, with participants both online and physically present. The main topic was Artificial Intelligence and Virtual Reality led by an VR expert - Invited speaker - Joao Rosa, FaunaLAB (Portugal). The discussion was focused on how AI and VR can be used in various applications, from digital twins to smart buildings.A few examples from the webinar content are illustrated in Figure 35.

The workshop part focused on exploring some of the VR content created in the project up to this point, particularly virtual laboratories from Evora University. The participants were immersed in the virtual labs (Figure 36) and provided feedback on the existing VR scenarios.

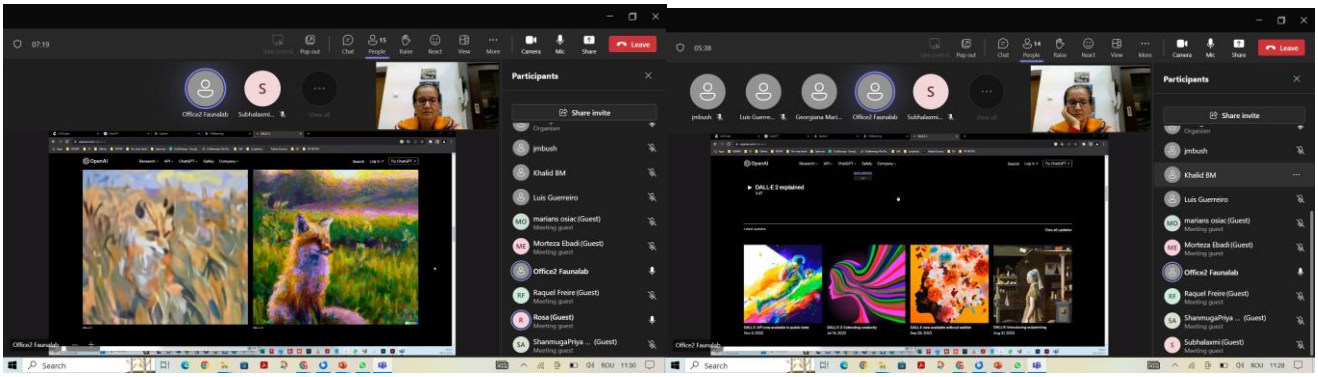

Figure 35. Images from the webinar from November 9, 2023

Figure 36. International VR workshop (image captured with 360º camera)

4.2.2.3 VR Webinar in Sweden

Again in November 2023, a webinar and feedback session was held online, experimenting the VR scenarios that were created at Evora University (Figure 37)

Figure 37. Feedback session on recently created VR Scenarios

4.2.2.4 VR Workshop in Gävle

In April, more than 20 international students participated in a VR workshop organized by MG Sustainable, held at Gävle University, Sweden. Students from seven different European countries (Sweden, Portugal, Spain, Romania, Bulgaria, Netherlands, Latvia) have participated in the workshop. The workshop started with a discussion about the potential of Virtual Reality to transfer knowledge in a very appealing way specially when thinking about young generations. The participants also had the

opportunity to try the VR glasses and enter into virtual scenarios in an immersive way (Figure 38). Afterwards, they have exchanged ideas in a discussion with experts in the field of virtual reality. The focus of the event was on sustainability, with participants sharing their ideas and experiences in a way that encourages innovation and fosters creativity.

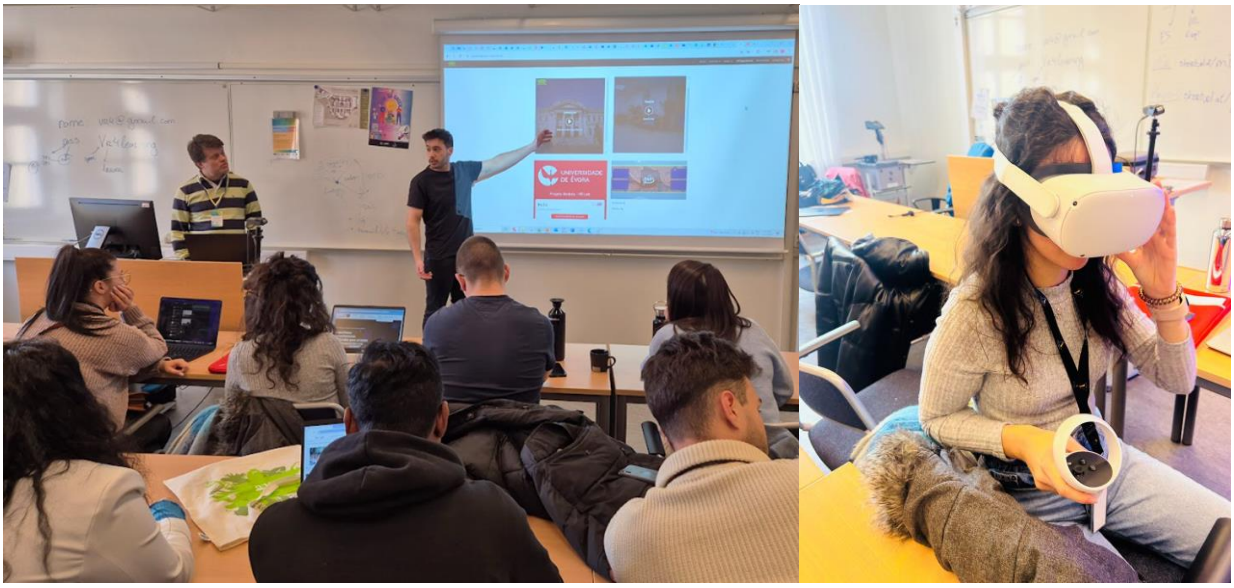

Figure 38. a) VR workshop Presentation. b) Exploring VR Scenarios by participants

4.2.2.5 VR Workshop in Sweden

A VR workshop focused on innovation and sustainability was held at Gävle University in September 2024. Participants had mainly an engineering background, from mechanical engineering to industrial engineering but also business management and Industrial Management and Innovation.
Participants experienced The VR content created up to date in the project and also provided feedback on their experience (Figure 39).

Figure 39. International VR workshop held in Gävle. Students immersed in the VR world.

4.2.3.1 VR Workshop in Evora, Portugal

A VR workshop took place in Evora and Montemor focused on innovation and sustainability, it was held in September 2023 and November 2023. Participants had mainly an engineering background, from mechanical engineering to industrial engineering but also business management and Industrial Management and Innovation. Participants experienced The VR content created up to date related to Manufacturing Processes at a Chocolate factory. Participants provided feedback on their experience.

Figure 40. VR workshop in Evora

Figure 41. Workshop held in Montemor, Portugal, September 2023

4.2.3.2 VR Workshop in Lisbon. Portugal

In the framework of the VR4Learning project, the project team from the University of Evora organized one workshop and one short training on the use of VR technology in education explaining how Virtual Reality can be relevant to facilitate the acquisition of new knowledge.

On June 27, 2023, a group of young professionals participated tested VR technology using 3D glasses that allowed them to have an immersive contact with some of the work already developed in the Project. They had strong expectations to test this new technology, listening on how VR can be applied to specific applications. There was also a specific slot for each participant to use the 3D glasses and to make questions about the ongoing development. For many it was the first time they have tried this technology. All of them think that it is an excellent way to transfer knowledge.

Figure 42. VR Workshop organized in Lisbon (Portugal) using 3D glasses

4.2.3.2 Short Trainings in Lisbon. Portugal

Figure 43. Short Trainings held in Lisbon, June 2024

On June 7th, 2024, a half day short training has held in Lisbon concerning the VR scenarios developed in the Project. The scenarios were explained in detail, as well as how to use 3D glasses in order to have an immersive knowledge acquisition.

As part of the Training events of the project, another Short Training was organized on 3rd December 2024 in Lisbon (Portugal) where VR content produced has been shown to an audience that was keen to learn more about Virtual and Augmented Technology. The course was organized by the University of Evora, one of the Project Partners, and one of the technological drivers. VR technology and its potentialities

within education was the core of the training, participants had the opportunity to be immersed into the VR scenarios and to profit from the acquisition of new knowledge in an appealing way.

Moreover, several participants gave testimonials of how they perceived this immersive experience and the potentialities they see in using such a technology.

Figure 44. Participants providing Testimonials

Participants mentioned the following:

"*It was understandable where I could go, into the laboratory, it was very instructive about the equipment and the functionalities*"

"*I have glasses and it was a bit difficult to manage with the VR glasses, however it was pretty interesting to see it in the computer*"

"*For me it was a good experience, it was the first time I had contact with Virtual Reality*"

4.2.3.2 Short Training Webinar

As part of the VR4Learning project, dissemination events across borders have been organized Online towards students and young professionals. On 20th May 2024 a Webinar about Virtual Reality took place Online, participants had the opportunity to try 3D Glasses and take advantage of the VR technology. Several scenarios already developed have been shown to participants. In the end, a discussion about the merit of this technology took place.

Figure 45. Image of some participants as part of the VR Webinar

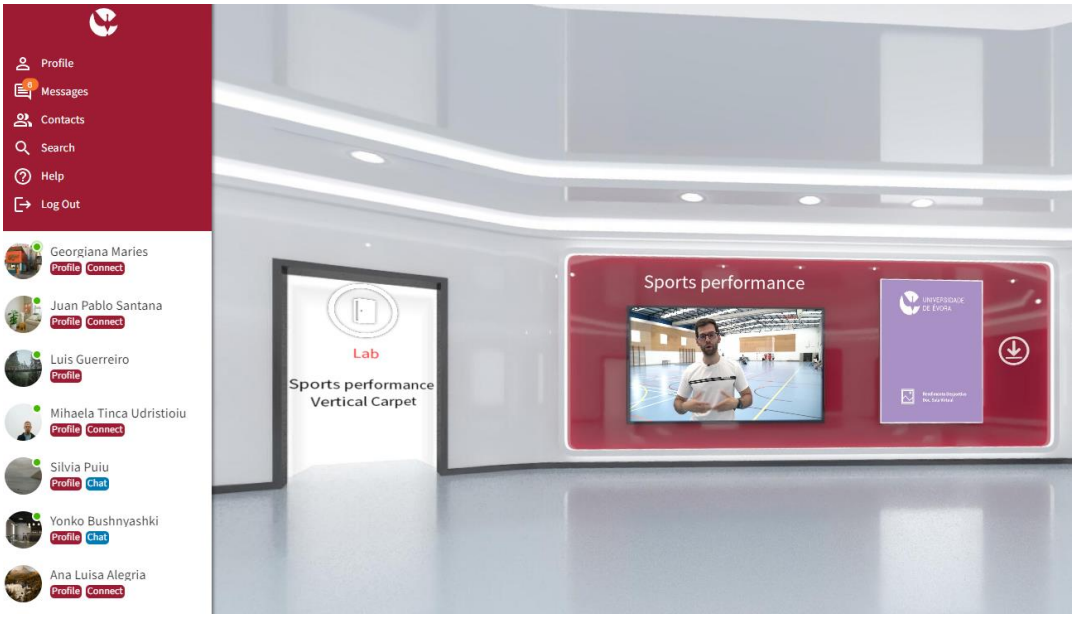

Figure 46. Image of one VR scenario as part of the VR Webinar

4.2.4 VR Workshops in Bulgaria

The team of the National Management School organized three workshops in Bulgaria in the period April – October 2024. These three events collectively advanced the adoption of Virtual Reality in Bulgarian education. They provided educators, students, and professionals with practical skills and insights, laying the groundwork for the broader integration of immersive technologies into teaching and learning processes.

4.2.4.1 VR Workshop in Bulgaria

A VR workshop was held in Sofia on 16th April 2024 at the National Management School, marked the beginning of an exciting journey into integrating Virtual Reality (VR) technologies into education. The workshop welcomed seven students and one mentor, many of whom were experiencing VR for the first time. This introductory session aimed to provide participants with a practical understanding of how VR can transform traditional educational approaches.

The workshop began with an engaging presentation on the VR4Learning project, offering an overview of its objectives, methodologies, and the educational resources developed as part of the initiative. This introduction was followed by immersive experiences using VR headsets, which included introductory VR videos showcasing real-world scenarios such as environmental sustainability and cultural heritage preservation.

Participants explored how VR could make complex subjects more accessible and engaging. For example, VR was demonstrated as a tool to visualize the impact of environmental decisions, making abstract concepts tangible and relatable. The session also introduced the idea of virtual campus tours, where participants experienced how VR could aid students in selecting universities. By simulating campus environments, classrooms, and even interactions with faculty, VR was seen as a means to help prospective students make informed decisions about their education.

The workshop also touched on the use of VR in teaching history. Participants discussed how immersive experiences, such as virtual visits to historical landmarks or recreations of historical events, could bring the past to life, making it more engaging for students. Additionally, participants explored the potential of VR to support young learners in transitioning from kindergarten to primary school through interactive games and environments designed to ease this critical phase in education.

The session concluded with a lively discussion where participants shared their impressions and brainstormed ways to incorporate VR into their teaching practices. The workshop left a lasting impression, with participants expressing their excitement about the transformative potential of VR in education.

4.2.4.2 VR Workshop in Bulgaria

The second VR workshop, held on 3rd June 2024, expanded on the themes introduced in the first session and brought together a more experienced group of seven graduating teachers and one trainer. Hosted again at the National Management School, the workshop provided a deeper dive into the applications of VR in both traditional and innovative educational settings.

The session began with participants engaging in immersive virtual tours of university campuses. These tours allowed them to explore various educational institutions, providing insights into how such experiences could enhance university recruitment and student decision-making. The participants noted

that offering virtual campus tours could significantly benefit students by allowing them to experience campus life, classrooms, and facilities remotely.

A key focus of this workshop was using VR to enhance subject-specific teaching methods. For history lessons, participants explored VR scenarios that allowed students to "travel" back in time, visit historical sites, and witness significant events. This immersive approach was seen as a way to spark curiosity and improve knowledge retention.

In mathematics, VR was presented as a tool for simplifying complex concepts. By enabling students to interact with three-dimensional visualizations of mathematical problems, VR can make abstract theories more comprehensible and engaging. Participants experimented with creating VR content, gaining hands-on experience with tools and techniques that could be adapted for classroom use.

The workshop also addressed how VR could aid young learners in developing foundational skills and preparing for school transitions. Participants discussed how interactive VR environments could foster cognitive and social skills in children, making learning a fun and impactful experience.

The day concluded with a feedback session where educators shared their thoughts on the applicability of VR in their own teaching environments. They emphasized the importance of teacher training to maximize the potential of VR and expressed enthusiasm for using these innovative tools in their classrooms.

4.2.4.3 VR Workshop in Bulgaria

The third and final workshop in Sofia, held on 26th October 2024, was hosted at the Social Innovators Bulgaria space and brought together a diverse group of 18 participants, including school students, university students, educators, trainers, and representatives from project partner organizations in Portugal, Sweden, and Romania. This session emphasised collaborative learning and advanced applications of VR in educational contexts.

The workshop showcased the VR scenarios developed through the VR4Learning project, focusing on their practical application in classrooms and training environments. Participants used VR glasses to immerse themselves in a variety of scenarios, including sustainability practices, cultural exploration, and complex problem-solving tasks.

Figure 47. VR Workshop in Sofia, Bulgaria

A unique aspect of this session was its emphasis on teamwork. Participants worked in groups to address challenges presented in virtual environments, such as managing natural disasters or conducting scientific experiments. This approach highlighted VR's potential to develop critical thinking and teamwork skills while providing a safe space for practising real-world applications.

Another focus of the workshop was evaluating the impact of VR on learning outcomes. Educators were introduced to tools and methods for assessing how VR enhances student engagement, knowledge retention, and overall educational effectiveness. Discussions revolved around best practices for integrating VR into curricula and the importance of aligning VR content with educational goals.

The event concluded with a reflective discussion where participants shared their experiences and insights. Many appreciated the immersive and collaborative aspects of VR and expressed interest in adopting similar approaches in their institutions. The presence of international representatives added a valuable cross-cultural perspective, enriching the discussions and showcasing the global potential of VR in education.

4.3 VR Courses

A set of VR courses were produced using the VR scenarios developed, namely the following VR courses:

- Newton Mechanics
- Optics
- Eye Anatomy

- Nursing Laboratory
- Manufacturing Processes
- Solar Laboratory
- Environmental Sciences

Figure 48. VR course "Newton Mechanics"

The methodology used was stepwise is the following manner:

1) Produce a text to be used as an audio
2) Generate Audio (via AI, for instance, or record voice)
3) Produce Video going through the Scenarios
4) Merge Video + Audio

Once the VR course have been produced, the content can be accessed digitally by any user, without the need of having a trainer.

5. Testimonials / Users feedback

Feedback gathered from students, teachers, and trainers during the VR4Learning events has highlighted the transformative potential of Virtual Reality in education. The following sections detail their perceptions, testimonials, and insights, demonstrating how VR technology has reshaped their approaches to teaching and learning.

5.1 Students' perceptions

Students were particularly enthusiastic about the immersive and interactive aspects of VR. For many, it was their first exposure to such technology in an educational setting. They expressed how the workshops expanded their understanding of VR beyond entertainment or gaming, showcasing its application in academic and professional contexts. They appreciated how VR made complex concepts tangible. One participant shared:

"The VR workshop helped me visualise things I've only read about in textbooks. Seeing a 3D model of the human anatomy made understanding the skeletal system so much easier."

Another student remarked: *"The VR4Learning workshop extended my knowledge of applying VR technology. It's usually used in labs for research and design, but now I see its potential for learning and even career preparation. I would definitely recommend VR to my peers."*

A high school participant reflected: *"Learning through VR doesn't feel like studying - it feels like exploring. I was much more engaged than in a typical lecture."*

This sentiment reflects the ability of VR to increase student motivation and curiosity about subjects they previously found challenging.

Several testimonials from students participating in VR workshops, are presented below.

Mariana Moreira, PhD in Chemistry, University of Évora, Portugal
"I had the opportunity to engage in the VR workshop. For me, it was the first time experiencing VR. I was surprised because I felt I was really immersed in the virtual places I visited. Particularly, since I'm studying at the University of Évora, I wanted to visit the Hercules laboratory they have there. It was surprising because the level of detail and the images were really well captured. We could even see things on the tables, hanging on the wall; we could read things there, and I think it really gave the feeling of being there. I think this is great for educational purposes, and I would recommend it".

Arturo Martinez, M.Sc. in Environmental Sciences, University of Gothenburg, Sweden
"I was a little skeptical at the beginning, but I really liked it because it was a new experience for me. Initially, it took me some time to set up the glasses, even though I was explained how to do it. However, thanks to our trainer and other participants who had previous experience with VR glasses, I managed to configure them and experience the virtual rooms, including one within the University of Craiova, Romania".

Satchi Sawhney, B.Sc. in Electrical science Riga Technical University, Latvia
"*I had the opportunity to participate in the VR4Learning workshop. The best part of this workshop is that we were all able to immerse ourselves in the digital ambiance while sitting in the classroom, and most importantly, we had a lot of conversations about how virtual reality can be used to enhance the*

learning experience of students. One of the ideas we came up with through the experience of this workshop is that virtual reality can be used to introduce students to certain inaccessible environments or labs. Some students may, for example, be interested in nuclear power; through VR, students can visit a nuclear power plant, which may not be accessible to them otherwise. This experience has really helped me understand the importance of VR in a learning environment, and if I had the opportunity, I would definitely use VR again for my university experience".

Mohammad Zubair, M.Sc. in Rural Development and Natural Resource Management, SLU - Swedish University of Agricultural Science, Sweden

"Using the VR tools was really cool in the workshop; the experience was amazing. I actually learned new things. For instance, I understood how VR technology would play a revolutionary role in educational methods. For example, students could better understand lectures in their classes, and it will provide better access to both students and teachers during the learning process. They can have a clearer and better understanding of what they are learning. I believe VR will be revolutionary in educational methods in the future. It will be a nice and effective technology for educational methods."

Marìa Silva Martìn, International Trade, University of Valladolid, Spain

"The VR workshop conducted during Innovation Week was quite interesting as we had the opportunity to visit different places, such as the University of Évora or the University of Craiova, and it felt like being there. Additionally, we were given information about the different places we were visiting and activities daily carried out in those places, which made the VR experience even more interactive. The development of the workshop was sometimes a little bit slow, even though we were divided into groups. We only had four VR glasses, and we also struggled at the beginning to set up the glasses and start the VR experience. Apart from those minor issues, which were easily solved, the activity was extremely interesting and entertaining".

Sara Hidalgo, Renewable Energy and Energy Efficiency, University of Zaragoza, Spain

Actually, my first experience with virtual reality was during the Green Week in Gävle with Carlos, who led an interesting workshop that was entirely practical. Therefore, all the students and participants were able to share and use virtual reality glasses to explore various places and scenarios prepared by Carlos and his team in their project. We could explore the Evora University, different locations and laboratories. The most impressive aspect, for me, is the level of detail you can observe during the virtual tour. You shouldn't forget that this isn't real; it's only virtual. However, you can explore and see things such as small laboratory equipment, people talking, and people walking in the corridor. It seems as if you're there, which is the ultimate goal of virtual reality. It's useful when you want to see a place without physically being there. For me, the workshop was absolutely successful because it allowed exploration of a place without actually being there.

Kaloyan Georgiev, Physics, American University in Sofia, Bulgaria
"The VR4Learning workshop during the Innovation and Entrepreneurship Week in Gavle was an interesting experience. I hadn't thought about the implications of VR in education before that but now I'm very optimistic and I think that VR will probably change the future of education".

5.2 Teachers' perceptions

Educators were initially curious about how VR could fit into traditional teaching methods but left the workshops with a sense of excitement about its potential to revolutionize their classrooms.

Many teachers observed how VR captured students' attention and helped them retain information. A participant noted,

"The workshop demonstrated how VR could make subjects like history or physics come alive. Imagine students virtually walking through ancient Rome or visualizing magnetic fields in a 3D space - this could transform how we teach."

Teachers highlighted VR's ability to adapt to a variety of subjects. One teacher shared:

"I've never seen a tool that can seamlessly integrate into so many disciplines—from humanities to STEM. It's truly versatile."

While excited, some educators acknowledged the need for institutional support to implement VR. As one teacher explained:

"This technology is groundbreaking, but we need proper training and funding to use it effectively in our schools."

Teachers also saw the potential of VR in supporting early education transitions. A primary school teacher said,

"Interactive VR environments can help ease the shift from kindergarten to primary school, making children more comfortable and confident."

5.3 Trainers' perceptions

Trainers facilitating the workshops were impressed by the enthusiasm and adaptability of participants, particularly those with little to no prior experience with VR.

Trainers observed that both students and teachers quickly became comfortable with the technology. One facilitator remarked,

"Even those who were initially hesitant ended up enjoying the experience and seeing its potential in their fields." They also noted how VR encouraged teamwork and creativity.

"Watching participants collaborate to solve virtual challenges was inspiring. It shows how VR can foster critical thinking and group dynamics," one trainer said.

Trainers emphasized the importance of follow-up sessions to ensure the sustained use of VR in educational settings. *"These workshops are a starting point. Continuous support and updated resources will be key to fully realizing the potential of VR in education,"* another one pointed out.

5.4 Highlighted testimonials from events

Testimonials from participants, published on the VR4Learning website and YouTube channel, provide additional insights into their experiences:

One teacher highlighted the environmental benefits of VR, stating,

"The event was very informative on how VR could be used in training and education, and it addressed the innovation aspects of the technology. The emphasis on sustainability and environmental benefits was enlightening."

A student commented on the novelty of the experience:

"The VR technology felt like something out of science fiction, but it was right there in front of me, making learning fun and immersive."

5.5 Summary of feedback

The feedback collected during the VR4Learning workshops and webinars reflects a shared enthusiasm for the transformative power of VR in education. Key takeaways include:

- VR captivates students' attention and sustains their interest in learning.
- The immersive nature of VR helps learners grasp abstract or complex topics more effectively.
- Teachers and trainers see VR as a versatile tool adaptable to multiple disciplines and age groups.
- While participants are keen to implement VR, they highlight the need for training, funding, and institutional support.

These testimonials demonstrate that VR is not merely a novelty but a powerful educational tool capable of revolutionising traditional learning methods. The insights gained will inform future training and development efforts, ensuring VR continues to make a meaningful impact in education.

6. Outreach and Impact

In today's digitally connected world, the success of educational initiatives often hinges on their ability to communicate effectively with a broad audience. The VR4Learning project has demonstrated the importance of leveraging digital platforms for dissemination. Through a focused strategy, the project has engaged educators, students, and professionals across diverse geographies, offering a model for evidence-based communication in education.

The VR4Learning website has functioned as the cornerstone of its outreach strategy, offering a central point of access for project materials, updates, and resources. Between January 2023 and November 2024, the site recorded over **2,300 page views**, with **594 active users** engaging with its content.

Most visitors came from the **USA, Sweden, and Bulgaria**, reflecting the project's international scope. Notably, the website's high-traffic areas - such as the Home page - highlighted user interest in VR tools and sustainability-focused educational content. These metrics underline the site's role as a dependable and effective resource hub.

Social media platforms were employed to expand VR4Learning's reach and build community engagement. However, the success across channels varied:

- **Facebook** emerged as the most active platform, recording **213 followers**, over **8,300 impressions**, and **1,100 visits**. Majority of visitors were from Bulgaria, Sweden, and Portugal.
- **LinkedIn**, with **139 followers**, positioned itself as a valuable network for engaging professionals, fostering partnerships, and highlighting research outputs.
- **YouTube**, featuring **34 video clips** and gathering **1,201 views**, effectively showcased the immersive potential of VR in education.

A critical success factor for the VR4Learning project was its ability to interpret audience behavior through data analytics. Metrics such as **click-through rates**, **session starts**, and **page scrolls** provided actionable insights into user preferences. For example:

- The project recorded **1,600 user engagements** across its platforms, demonstrating active interest.
- Analytics-driven content adjustments led to higher retention rates and more meaningful interactions, showcasing a thoughtful, audience-centered approach.

Additionally, the project's virtual and in-person events as highlighted in previous chapters significantly enhanced its visibility. The final project's event - the **EdTech Innovators Forum**, held in Sofia in October 2024, directly engaged over **70 stakeholders** and reached an estimated **2,300 individuals** through media coverage. This event not only showcased VR4Learning's work but also served as a platform for networking and feedback, vital for refining project offerings.

The media played a key role in amplifying VR4Learning's message, with **12 articles** published in prominent outlets, including *Economy.bg* and *BTA News*. These articles reached a broad audience, creating additional touchpoints for stakeholders interested in educational innovation.

From an academic standpoint, VR4Learning contributed significantly to the discourse on VR in education. Publications in international journals and conferences detailed the project's application of VR in teaching sustainability and examined behavioral adoption models. These contributions strengthened VR4Learning's reputation and established it as a thought leader in the integration of technology in education.

7. Project Partner Meetings

The four project partners had regular online meetings on average twice a month and several transnational meetings, held by each participating organization in Sweden, Portugal, Romania and Bulgaria.

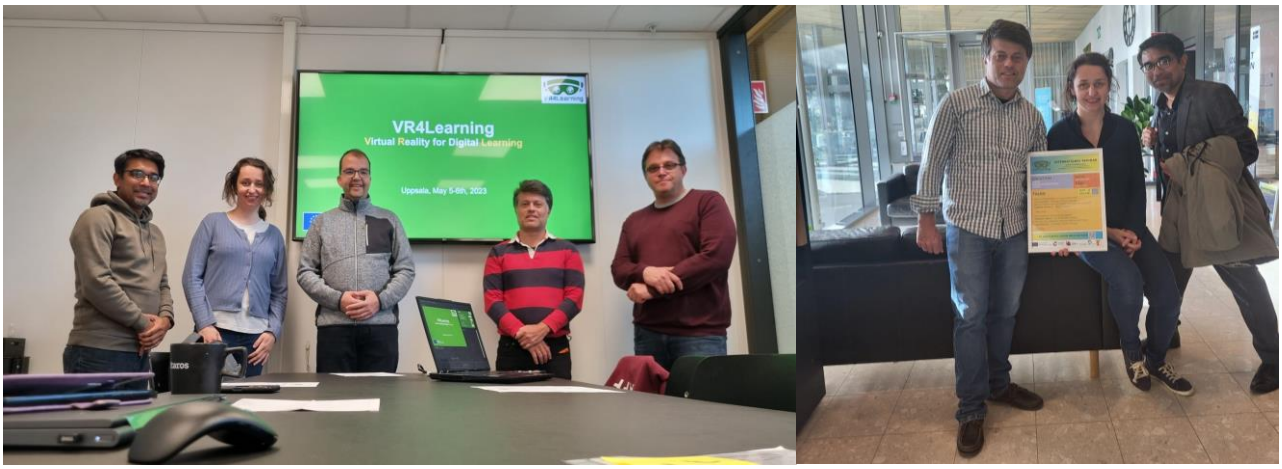

Figure 49. Transnational Meeting held in Sweden, May 2023

Figure 50. Transnational Meeting held in Portugal, September 2023

Figure 51. Transnational Meeting held in Portugal, September 2023

Figure 52. Transnational Meeting held in Romania, February 2024

Figure 53. Transnational Meeting and Project results Presentation held in Bulgaria, October 2024

8. Conclusion

Virtual Reality is part of a broader topic called digital transition, which has accelerated with the pandemic times. A wide range of advantages is enabling to conduct training at a distance facilitating the access and making it easier to explain the content using both audio and 3D images.

Along with the dissemination activities held in 4 different countries (Sweden, Portugal, Romania and Bulgaria), it became clear the benefits of using Virtual Reality for knowledge transfer is evident and is suitable to be interesting for all ages, but particularly to young students, nowadays more inclined to experiment digital learning and virtual environments. The ease of access also online makes the content reachable worldwide enhancing the globalization of knowledge. This new methodology can be easily applied in a classroom environment as well as in a company or a workshop for training purposes. It can also be used as a way to transfer knowledge in a multidisciplinary team as it is the case in Hospitals with surgery teams with professionals of different expertise.

Several laboratories of two universities have been used as case studies integrating virtual scenarios in a very appealing way, and several VR workshops have been conducted in groups up to 20 People, both with students and young professionals providing their testimonial. Moreover, companies interested in Virtual Reality have also participated leading to the creation of a virtual scenario in a factory.

Virtual Reality scenarios created were used in Webinars, VR Workshops, VR courses and short trainings. A Project Website allows an easy assess to the content produced.

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