Mem. S.A.It. Vol. 96, 17

Memorie della

University Research and Teaching in Virtual Reality

The LabVR UNISI Experience

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Received: 07-11-2024; Accepted: 12-12-2024

Abstract. This paper presents the EL-VR project, which aimed to develop Virtual Environments (VEs) to enhance training innovation through the implementation of the "flipped classroom" pedagogical model (Thomann 2024). The project resulted in the creation of VR simulations designed for workplace safety training. These simulations focus on interactivity and a structured, sequential learning process, serving as a digital self-training tool. By leveraging high levels of interactivity and immersive multiplayer capabilities, users can engage with the content, progress at their own pace, and deepen their understanding of key concepts. This approach encourages active learning, allowing users to later share their insights and experiences with instructors and peers in a classroom setting.

Key words. Virtual Reality, Learning, Education, Work Safety

The problems posed by the health emergency have led the university and training institutions to start a process of change that has led to the experimentation of all innovative digital technologies to support training and teaching. In this perspective, which has actively involved all levels of our training system, particular attention has been paid to the combination of Virtual Reality (VR) and Artificial Intelligence (AI), which offers numerous opportunities in many disciplinary fields for the innovation of educational methodologies and learning systems. Its characteristics of immersion, interactivity and multisensoriality appear in fact capable of allowing a radical change not only in the remote fruition of training contents (Harrison, Haruvy, Rütstrom et al. 2011), but also of profoundly transforming training and teaching in the classroom, fully realizing the flipped classroom model and exploiting the availability of advanced digital contents to allow the acquisition of knowledge independently and then deepening it in the classroom through shared experiences with the trainer (Innocenti 2017). In this perspective, the Virtual Reality Laboratory of the University of Siena (LabVR UNISI) launched the EL-VR pilot project in 2022 for the creation of tools for training and teaching in VR. The EL-VR project aimed to create Virtual Environments to support training innovation with the aim of implementing the pedagogical model of the "flipped classroom"

Fig. 1. Virtual environments for training on work safety.

Fig. 2. A virtual laboratory

(Thomann 2024). The activity carried out led to the creation of VR simulations that can be delivered in the courses offered for training on workplace safety. These simulations were built around the idea of interactivity and sequentiality of the exposure and represent a digital tool for self-training for the user. By exploiting the high level of interactivity and immersion in multiplayer mode, the user has the opportunity to be involved, deepen and therefore learn at his own pace a series of fundamental notions and then share them in class with the trainer and other users. Fig. 1

The basis of the experiences created is the context in which the user's senses are effectively stimulated by digitally reproduced artificial stimuli. To date, visual and auditory stimuli have been administered, but in the near future, kinesthetic and tactile feedback will also be possible. The environments or contexts used for a training session are 3D modeled environments or reproductions based on three-dimensional drawings produced by a technical artist. The advantage of this approach is its extreme versatility, which allows the reproduction of digital content at simplified resolutions and therefore in shorter times. Environments acquired with 3D scans and photogrammetry have also been reproduced, which today allow for rapid results with very high graphic quality. The virtual environments contain the objects of the training path, also these modeled three-dimensionally or acquired through scanning. During the modeling the different parts were put in hierarchical relation with each other, allowing subsequent automatic shots and isolation of parts to which multimedia and didactic elements were added. Furthermore, the various parts that make up an object are ”exploded” and ”recomposed” automatically or manually, allowing for high interactivity. Again thanks to three-dimensional geometry it was possible to create a variety of animations that illustrate mechanical, biological or logical processes. For the user, observing the interaction of the various parts in motion, from various points of view, is an increasingly effective training possibility than static images in sequence. Fig. 2 The second phase of the flipped classroom model was implemented using one of the most interesting possibilities of multiplayer virtual environments: being able to collaborate in the same space, both remotely and in person (Marougkas 2024). The trainer can frame and view each element during the training course, while users immersed in the same experience have a perception of his position and the focus of his actions. The trainer can grant control to users in turn, ask them to perform specific actions and answer pre-set questions or quizzes through artificial intelligence software. The same method of use can be applied by introducing an avatar that, adopting machine learning software, dialogues with the user making the comparison with the training contents interactive. The main feature of the simulations created for training on safety at work, which are available on the platform made accessible by the University of Siena, is their high degree of innovation. The technique mainly used for prevention actions of material and psycho-social risks in the workplace is to introduce a “field” detection system into the company, typically based on conducting ad personam interviews or on the administration of anonymous questionnaires to a large number of employees. The latter is still considered the “main” tool of the methodologies in use both by companies that have already implemented a safety management system tout court, and by those that have not yet addressed the issue of updating their assessment to psychological and social risks. However, as highlighted by the most recent theories proposed within cognitive economics and cognitive sciences, the perception of risk and stress in a work activity involves various individual cognitive dimensions, which depend both on emotions and on rational calculations. Experimental studies have provided ample empirical evidence that there is a clear divergence between the subjective perception of risk and its objective assessment (Slovic 2001). The main consequence of this difference is that individuals tend to make systematic errors in assessing non-stressful or dangerous activities and to remain almost indifferent when faced with activities that could have dramatic consequences. The main result achieved was to highlight a series of automatic and intuitive mechanisms (called heuristics), which unconsciously determine individual behavior in risk situations and which can seriously distort the perception of risk and stress. The set of heuristics causes individuals to perceive the relationship between risks and benefits of an activity differently from how it would be assessed on the basis of a probabilistic calculation. Their subjective perception can be so distorted as to make traditional survey methods such as questionnaires inadequate and can be modified and corrected through the interactive experience typical of virtual reality simulations. For this reason, through subjective and interactive virtual reality simulations, effective training is possible in which those work activities most at risk are reproduced (not reproducible in reality without exposing those receiving such training to the related risks) in order to ”emotionally train” the subjects involved in good practice and safety procedures and to make them understand, thanks to this innovative methodology, what the actual risks are, their extent and the behaviors to reduce them. The other important feature of the project is that of being able to reproduce, through virtual reality, emergency situations and therefore verify the response times and procedures implemented by workers for their resolution and for the possible activation of external rescue. This pilot project has demonstrated the potential of VR to the trainers and users involved in the tests carried out. The advantages of virtual reality in training are appreciated by many trainers, but some are still reluctant to use it in their classrooms. The reasons range from high costs to resistance from company managers. Others see the value of VR as entertainment, but not as an effective training tool for workplace safety training. Other concerns for trainers include equipment size, operational issues, and the quality and availability of content. Despite these challenges, it is easy to foresee that the use of VR in the education and training sector will grow in the coming years. This means that trainers will need to become familiar with virtual reality and how to use it in the classroom. This process requires a careful assessment of the costs and benefits of introducing VR into our training system, also in light of the investments that will need to be made to enable rapid and effective implementation. Building and managing a hosting and delivery platform Fig. 3 is essential both to allow users to download and run simulations via headsets and to meet the tracking and scoring needs of VR courses.

This corresponds to creating a real metaverse, which requires radical changes in the methods adopted by trainers. The combination of VR and AI technologies based on immersive environments must in fact be adapted to the abilities and interest of users by making training less structured, with more flexible rules that allow for immersive and interactive use. For example, metaverse users are not only recipients of content, but active par-

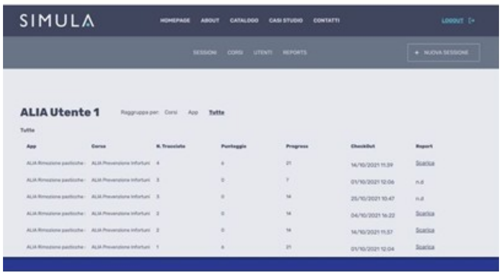

Fig. 3. Delivery platform

ticipants in VR simulations. This approach requires significant changes not only to training but also to assessment and monitoring processes. Traditional tools such as exams or written or oral tests are not appropriate to evaluate the individualized and unstructured learning experiences offered in the metaverse. Through the platform made available by the University of Siena (Fig. 1), a wide range of virtual simulations can be provided that include already used teaching tools and other completely innovative ones:

• Learning courses based on learning by doing
• Virtual field trips
• Peer-to-peer meeting spaces
• Shared frontal training courses
• 3D visualizations
• Personalized learning experiences
• Accessible learning experiences for people with physical disabilities

However, creating a metaverse is not necessarily an expensive operation to do from scratch, considering that among the available resources there are accessible applications at low fees or even free that allow teachers to create teaching programs in VR. The main challenge in building a VR training program is not to equip institutions with these new technologies. While VR is already in use in school education training in the United States, in Italy VR has yet to become a familiar tool for those working in the training and education system. Although the perception that VR offers valuable learning opportunities for subjects traditionally difficult to teach in a manual or textbook is widespread, we are still in the initial phase of communicating and sharing the potential of the tool and therefore must be addressed with adequate resources and programs. Training trainers and training institutions to incorporate virtual environments and simulations in the classroom is perhaps the most difficult task to address at this stage. The first step is to provide trainers and users with a virtual classroom, allowing them to connect online with consultants, experts and entrepreneurs. In this training space, which can be created in the virtual spaces just listed, trainers must be able to explore the use of virtual technologies in training. Each platform offers a unique set of features for educators, entrepreneurs, creators and users to discover and allow them to create and customize the space, using libraries of models, images and videos or to create digital tools to support training in real time. This program requires an investment in specialized teaching staff who provide VR trainers with the skills needed to tackle this commitment in a multidisciplinary way. The training course should be aimed at the use and implementation of the platform used. For each trainer involved in the training, 4 modules should be provided:

• Training module on the technologies and platform used to promote and improve training in virtual reality.
• Module aimed at acquiring the digital skills needed to use the platform both to deliver courses and to produce and archive teaching materials.
• Module dedicated to the application of what is learned in the classroom directly on the platforms and within the systems that will be used in the training.
• Final module for sharing and comparing all trainers who took part in the course to exchange ideas and feedback useful for increasing the impact of the course and the active involvement of users.

The course should alternate virtual classroom lessons with group or individual work in which the trainers involved will create a DAD project starting from the definition of the contents, up to their translation for delivery via the platform. The business models of companies that develop technologies in the metaverse are based on the collection of detailed personal data from users. VR headsets can collect highly personal and sensitive data such as location, physical characteristics and movements of students and voice recordings. Meta, the manufacturer of the Quest headsets, has not promised to keep this data private or to limit the access that advertisers may have to it. Meta is also working on a high-end virtual reality headset called Project Cambria, with more advanced features. Sensors in the device will allow a virtual avatar to maintain eye contact and create facial expressions that mirror the user's eye movements and face. Such data insights can help data owners measure user attention and target them with personalized advertising. Educators and users cannot freely participate in classroom discussions if they know that their every move, speech, and even facial expression is being watched by the university and a large tech company. The virtual environment and its equipment can also collect a wide range of user data, such as physical movement, heart rate, pupil size, eye opening, and even emotional signals. Cyberattacks in the metaverse could even cause physical harm. Metaverse interfaces provide input directly to users' senses; thus, they effectively trick the user's brain into believing that the user is in a different environment (sense of presence). The metaverse can also expose students to inappropriate content. For example, Roblox launched Roblox Education to bring 3D, interactive, and virtual environments into physical and online classrooms. Roblox claims to have strong protections to keep everyone safe, but no protection is perfect, and its metaverse involves user-generated content and a chat feature, which could be infiltrated by predators or people posting pornography. This problem needs to be addressed in advance at a legislative level and by educational or university institutions.

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