Virtual Excursions in Vocational Education and Training

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Abstract

In connection with the rapid development of modern means of communication, there is also a very rapid development of technologies using virtual reality as either a means of entertainment or modern education. The article discusses the possibilities of using virtual education or education based on the use of virtual reality in general. However, the primary attention is paid to analysing the use of virtual reality in the secondary vocational school environment. Additionally, it presents a concept of a virtual excursion aimed at the automated production process of processing aluminium profiles for the automotive industry.

Keywords: Virtual reality, Virtual Excursion, Vocational education and training

1 Introduction

Virtual excursions represent a dynamic evolution in education in general. However, they are an essential means of education, mainly concerning technical education and, specifically, for vocational education and training. The stated results are from the fact that they provide students with immersive and interactive experiences that transcend the boundaries of traditional learning. As the progress of technologies continues to advance, the potential of virtual education applications in vocational education and training is more and more vast and promising. Virtual excursions presenting manufacturing processes offer a unique and valuable opportunity for students to delve into the intricate world of industry without any constraints

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of their physical location. By leveraging digital technologies, students can virtually explore manufacturing facilities, witness complex processes, and gain insights into the nuances of production. One of the primary advantages of virtual excursions in manufacturing education is the ability to showcase real-world applications. Students can virtually step onto factory floors, observe the assembly lines, and witness the manufacturing of products from raw materials to finished goods. This immersive experience enhances their understanding of the entire production lifecycle, providing context to theoretical knowledge gained in the classroom. The fact that virtual excursions allow vocational school students to get to places and see work processes that they could hardly imagine increases the attractiveness of both the teaching and learning processes and vocational training. Hereinafter, at first, the theoretical background and specifics of virtual reality are described and analysed, and consequently, then pointed out on the virtualisation of the automated production process of processing aluminium profiles for the automotive industry.

2 Virtual Reality in Education

Concerning the use of virtual reality in education, two concepts arise, the meaning of which needs to be clarified: virtual *reality* (VR) and *virtual world.*

Virtual reality is a computer technology that, through hardware and software, makes it possible to create virtual models of objective reality and use them to generate people's perceptual feelings. On the one hand, virtual reality technologies can be used to create 3D spatial models, which can be used for 3D modelling and investigating the properties of real objects. On the other hand, it is possible to use virtual reality to create a "realistic" model spatial environment in which a person can virtually "realise" the desired activities (Hodge et al., 2007).

The virtual world is, according to Bartl (2004), a world implemented by using a computer (or using a computer network) that simulates an environment. Some, but not all, objects in this environment act or are under the direct control of individual humans. Since several people can influence the same environment simultaneously, we call such worlds *shared* or *multi-user*. While no users are connected to the environment, the environment continues to exist and develop internally (at least to a certain degree).

One of the primary advantages of integrating virtual reality into education is its ability to simulate real-world scenarios. For instance, students studying history can virtually step into historical events, witness them unfold, and gain a deeper understanding of the context. Similarly, in the field of science, virtual reality allows students to explore complex concepts through realistic simulations, making abstract theories more tangible and comprehensible. Moreover, virtual reality provides a personalised learning experience. Students can progress at their own pace, revisiting concepts or areas needing additional assistance. This adaptability caters to diverse learning styles and ensures students can grasp the material thoroughly (McGrath et al., 2023).

Collaborative learning is another dimension that virtual reality brings to education. Students from different locations can connect in a shared virtual space, fostering collaboration and teamwork. This prepares them for the collaborative nature of the modern workforce and promotes cultural exchange and understanding.

In 2015, Freina and Ott conducted a review study of what research was being done in 2013 and 2014 regarding the use of virtual reality in education. They found that 93 different studies were conducted in these years, with a decreasing trend over time, and the most significant number were conducted in the United States. Most of the research was related to using virtual reality in higher education, universities, and adult training. Only one was related to the use of virtual reality by children. The applications appearing in individual research were most often focused on the field of healthcare, medicine, and specific professional training for adults, in which, for example, situations that could be dangerous in reality were simulated. Based on their research, Freina and Ott (2015) have thought that the convenience of simulating dangerous or otherwise tricky, inaccessible situations was also the most common motivation for most research.

In addition to traditional subjects, virtual reality is making a significant impact on vocational training. Simulations in virtual reality enable students to practice and refine practical skills in a risk-free environment. This is particularly valuable in fields such as medicine, where students can perform virtual surgeries, or in aviation, where pilot trainees can undergo realistic flight training.

However, despite its potential, the widespread adoption of virtual reality in education faces challenges such as cost, technological barriers, and the need for specialised training for educators. Overcoming these obstacles will be crucial in unlocking the full potential of virtual reality as an educational tool. As technology advances, the integration of virtual reality in education is likely to become more commonplace, offering students an innovative and effective way to learn, explore, and interact with the world around them. The immersive nature of virtual reality has the potential to transform education into a more engaging and personalised experience, preparing students for the challenges of the future (Bao et al., 2016).

3 Virtual excursions in Education

Virtual excursions in education have emerged as a transformative and innovative way to broaden students' horizons beyond the confines of traditional classrooms. Leveraging the power of technology, virtual excursions enable students to embark on immersive journeys to destinations worldwide without leaving the comfort of their schools or homes (Kavanagh et al., 2017).

One of the key advantages of virtual excursions is their ability to break down geographical barriers. Students can visit historic landmarks, explore cultural heritage sites, or delve into the depths of ecosystems that may be otherwise inaccessible. This enhances their understanding of various subjects and fosters a sense of global awareness and interconnectedness (Christou, 2010).

The interactive nature of virtual excursions engages students in the assigned activities in a way that textbooks and lectures often cannot. Through virtual reality (VR) or augmented reality (AR) platforms, students can actively participate in simulations and educational games that make learning both enjoyable and memorable. For example, they can virtually dissect a frog in biology class, visit ancient civilisations in history, or explore the cosmos in astronomy. Furthermore, virtual excursions provide opportunities for real-time collaboration and interaction. Students can connect with experts, scientists, or guides who offer insights and answer questions, creating a dynamic and personalised learning experience. This collaborative aspect facilitates knowledge transfer and supports the development of their critical thinking and problem-solving skills.

Inclusive education is another area where virtual excursions can significantly support learning goals. Students with physical disabilities or those in remote locations can participate in these experiences on an equal footing with their peers. This inclusivity promotes diversity and ensures all students have access to a rich and varied educational experience (Fineman, 2017).

Those who play a crucial role in integrating virtual excursions into the curricula are teachers (educators). They can curate content, design learning activities, and facilitate discussions that align with the curriculum objectives. Additionally, teachers can use virtual excursions to spark curiosity, encouraging students to ask questions and explore topics independently. While virtual excursions offer numerous benefits, it is essential to strike a balance with traditional teaching methods. They should complement, not replace, face-to-face interactions and hands-on experiences. Moreover, considerations for the ethical use of technology, data privacy, and ensuring a safe online environment must be prioritised.

Virtual reality (VR) or augmented reality (AR) can simulate hands-on experiences, allowing students to virtually interact with machinery and equipment. This not only aids in visualising abstract concepts but also serves as a safe and controlled environment for learning about potentially hazardous processes. For instance, students can explore welding techniques, understand CNC machining, or witness quality control procedures. Collaboration and engagement are crucial aspects of virtual excursions in manufacturing education. Students can participate in virtual tours led by industry experts, engage in live Q&A sessions, and even collaborate on virtual projects. This exposure to real-world professionals provides valuable insights into industry practices, challenges, and innovation, fostering a bridge between academic knowledge and practical application. Moreover, virtual excursions open up possibilities for global connections. Students can explore manufacturing facilities worldwide, gaining an appreciation for diverse approaches to production processes and global industry standards. This global perspective is particularly relevant in a world where manufacturing is often an interconnected and international endeavour (Hashemipour et al., 2011)

4 Implementating Virtual Excursions into the Teaching Process

Virtual excursions are an innovative approach to learning that allows students to delve into various topics without leaving the classroom. Using virtual excursions, schools, mainly vocational schools, have a valuable tool for enriching the learning environment and evoking students' interest in learning and vocational training. Implementation of virtual excursions in teaching should follow the given steps (McGrath et al., 2023):

1. Identification of learning objectives:
   - Identification of subjects or topics that could benefit from virtual field excursions.
   - Defining educational goals that could be achieved through virtual excursions.
2. Selection of virtual excursions:
   - Exploring existing virtual excursions or platforms that offer relevant content to the given educational needs.
   - Selecting content relevant to the student´s program and learning standards.
3. Technical preparation:
   - Ensuring access to the necessary technical infrastructure, including computers, internet, and other devices (virtual reality headsets).
   - Ensuring teachers and technical staff know the necessary technology (Pavera, 2023).
4. Training of teachers and students:
   - Instructing teachers on how to integrate virtual excursions into teaching.
   - Ensuring that students are familiar with the use of the virtual technology.
5. Integration the virtual excursion into the teaching process:
   - Designing lesson plans that include virtual field trips and are included in the curriculum.
   - Discussions and student questions to ensure active involvement in the virtual excursions.
6. Monitoring and evaluation
   - Development of an evaluation method for measuring the impact of the virtual excursions on the students´ learning processes.
7. Maintenance of interest:
   - Diverse virtual excursions that relate to different subjects and interests of students.
   - Ensure that virtual field trips are relevant and up to date.
8. Consideration of safety:
   - Virtual excursions and their technology use comply with safety and ethical standards.
   - Guiding the safe use of technology, including time limits on exposure to virtual content.
9. Feedback from students and teachers:

- Obtaining feedback from students and teachers regarding experiences with virtual field trips.
- Adapting the implementation based on feedback.

10. Sharing experience:
    - Sharing projects created thanks to virtual excursions with other teachers and schools.
    - Creating a community where educators can inspire each other and share best practices (Šmidák, (2017).
11. Update and extension:
    - Regularly updating the content of the virtual tours to keep it current and relevant.
    - Extending virtual excursions to other subjects or grades (Virvou et al., 2005).

5 Creation of a Virtual Excursion in Automotive Industry

We intend to create a virtual excursion focused on the automated production process of processing aluminium profiles for the automotive industry. Potential usability of this teaching aid is within secondary vocational schools offering, e.g. such study branches as mechanic, mechatronic or metal worker (dealing with machining and processing of metals).

The main task of this excursion is to completely immerse students in the production process, which will enrich them with valuable information and enable them to gain innovative knowledge of the given field. The virtual excursion simulates the individual steps of the production process with precise descriptions, from the initial storage of raw material to the final product of aluminium profiles. Through this simulation, students can easily reach places not directly accessible in production. The virtual excursion helps to get an insight into the working spaces focused on welding, pressing, and milling, followed by the study fields of secondary vocational schools. The last but not most minor advantage of virtual excursions is usability for students from the comfort of home and students with special educational needs who are physically challenged. A secondary possibility of using the virtual excursion is its use for different companies to train and familiarise their new employees with the working environment and working processes they will be involved in (Walsh, K. 2017).

To create a virtual excursion, it is necessary to have the appropriate equipment capable of achieving all the necessary steps. The first is the camera with which we will capture the environment suitable for a virtual excursion. Here, we have two creation options. The first is the creation of photos that will be connected into whole sections in later post-production, which allows us to move freely in the virtual space. The second option is short spherical video sections that introduce the user, in our case, students, to the virtual environment of the real world. Our goal is to create a virtual excursion serving high school students for a better idea of the work processes taking place during a company's production for the processing of aluminium profiles. Our previous experience of creating virtual excursions has proven that we create individual exposures from 20 to 30-second shots. Images taken in closed spaces, including production halls and industrial lines, require the correct setting of ISO values on the camera due to poor artificial lighting and excessive distortion of dark places in these spaces. The beginning of the virtual excursion is the stocking of the material needed for production, called the input factors of the production process (Osman & Ismail, 2009).

A large number of these manufacturing processes are automated processes. Transfer aluminium columns to a considerable storage tank, where they wait to be cut to the required size and subsequent transport to a massive sheet that heats these cuttings and adapts them to the necessary profiles. Footage of scraps and scraps used in the recycling process and automated lines for safe transfer or preparation for export of the final product is recorded in our virtual excursion in 4K resolution. The height of the camera placement is also important; it should match the average height of an adult for a better visual effect. The camera, equipped with two 180° sensors, cannot have any obstacle in the angle of the shot to take full-value shots (Liu et al., 2017).

The prohibition of entry for persons limits some areas of the production process. We can capture these spaces and transfer them to our virtual excursion for a better idea for the student. The camera we used to make our virtual excursion is equipped with WIFI and a reliable mobile application with which we can check all settings and the camera's position before recording the premises. During the recording, it is necessary to follow all the safety instructions of the company or enterprise in which the recording is carried out. For the correct timing of shots during production, we must observe the accuracy of moving the camera every 4-6 meters. This distance allows us to connect shots due to focusing the camera at this distance. The recording is saved directly to the device's memory card or to the mobile phone, depending on what the user prefers. Moving the images to the computer and then using the Adobe Premiere PRO program allows us to edit and work with them, thanks to almost unlimited possibilities (Palmer & Williamson, 2017).

In this part of the editing, we can fine-tune the time interface of the sections and adjust the colourisation of these sections, which is essential for the final effect. After careful consideration, we define titles or descriptions for the individual points of the sections. In the meantime, metadata must be processed to properly combine the shots of both camera lenses. The entire processing of the virtual excursion must be of the highest possible quality so there are no imperfections, errors, or defects in the final state. Faulty data transfers between the camera, mobile device or computer often cause these errors. Video export takes place under the H.265 video standard, which has the necessary codec for playing these videos. We want to upgrade to 8K resolution and processing in the new H.266 standard. However, nothing ends with the export of our virtual excursion. Among the many available players and systems that will allow us an irreplaceable experience from a virtual excursion, we will limit ourselves to a minimum due to the charging of these platforms. YouTube is, therefore, also our choice from the point of view of sharing the excursion among students, even though recently, the conditions of use of this platform have rapidly changed to the disadvantage of the creators (Tse et al., 2017).

A big advantage is that this platform allows us to use a virtual excursion in a mobile device, in a virtual reality headset, and in laptops and tablets. This is an irreplaceable advantage for students regarding usability, whether regarding the equipment used or where they will want to participate in the virtual excursion. However, everything depends on the internet connection. This undemanding equipment suits schools and companies that want to train their employees. (Meta Quest Blog, 2021).

6 Conclusion

Virtual excursions offer a broad range of possibilities to enhance vocational education and training as students can, through them, be" involved" in different industrial and manufacturing processes, and they have a chance to observe and experience them. Although we are aware of the negatives connected with the creation and use of these didactic means (such as the high financial costs of the relevant hardware and software, the necessity to train the staff, problems with "lack of reality", possible students´ suffering from motion sickness), we believe that soon virtual reality technologies will be accepted into the educational processes at almost all levels and kinds of schools.

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References

Bao, Y., Wu, H., Zhang, T., Ramli, A. A., & Liu, X. (2016). Shooting a moving target: Motion-prediction-based transmission for 360-degree videos. *Big Data (Big Data). IEEE International Conference* (p. 1161–1170).

Bartle, R. A. (2004). *Designing Virtual Worlds*: New Riders Publishing

Christou, C. (2010). *Virtual Reality in Education.* In Tzanavi, A., Tsapatsoulis, N. (Eds.) *Affective, Interactive and Cognitive Methods for E-Learning Design: Creating an Optimal Education Experience*. IGI Global Cyprus.

Fineman, B. (2017). *TheFuture of Virtual Reality Applications in K-12 and Higher Education. The European Business Review.*

Freina, L., & Ott, M. (2015). *A Literature Review on Immersive Virtual Reality in Education: State Of The Art and Perspectives*. Genova: Institute for Educational Technology, p. 2-6.

Hashemipour, M., Manesh, H. F., & Bal, M. A. (2011). A modular virtual reality system for engineering laboratory education, *Computer Applications in Engineering Education*, vol. 19, no. 2, (p. 305–314) https://onlinelibrary.wiley.com/doi/10.1002/cae.20312

Hodge, E. M., Tabrizi, M. H. N., Farwell, M. A., & Karl, L. (2007). WuenschVirtual Reality and

Special Needs: Virtually Endless Possibilities. *International Journal of Social Sciences*, Volume 2, Number 2, (p. 105-108).

Kavanagh, S. et al.(2017). A systematic review of Virtual Reality in education. *Themes in Science & Technology Education.*, v. 10, no. 2, (p. 100-103). https://eric.ed.gov/?id=EJ1165633

Liu, X. et al. (2017). *360° Innovations for Panoramic Video Streaming*. Conference: the 16th ACM Workshop. New York: Association for Computing Machinery. https://conferences.sigcomm.org/hotnets/2017/papers/hotnets17-final39.pdf

McGrath, O., Hoffman, C., & Dark, S. (2023). Future Prospects and Considerations for AR and VR in Higher Education Academic Technology,' *EDUCAUSE Review*, April 20, 2023. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4431134

Meta Quest Blog (2021). What is virtual reality all about ? Facebook Technologies, 2023 Meta, LLC https://www.meta.com/blog/quest/what-is-virtual-reality-all-about/

Osman, A., Ismail, M. H., (2009). Development and Evaluation of an Interactive 360 Virtual Tour for Tourist Destinations. *Journal of Information Technology Impact*, Vol. 9, No. 3 (p. 173-182)

Palmer, C., Williamson, J. (2017). *Virtual Reality Blueprints, Create compelling VR experience for mobile and desktop.* Pakt Publishing Ltd Birmingham, (p. 250).

Pavera, L. (2023) Integrace AI do škol: Nová éra vzdělávacích metod pro 21. století. In *Média a vzdělávání*. Extrasystem Praha.

Šmidák, V. (2017). *Je pre nás virtuálna realita nebezpečná? TECHBOX* https://www.techbox.sk/je-pre-nas-virtualna-realita-nebezpecna

Tse, A., Jennett, CH., Moore, J., Watson, Z., Rigby, J., & Cox, A. (2017). *Was IT here?: Impact of Platform and Headphones on 360 Video Immersion.* CHI EA '17: Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems. Association for Computing Machinery New York. https://dl.acm.org/doi/10.1145/3027063.3053225

Virvou, M., Katsionis, G., & Manos, K. (2005). Combining software games with education: Evaluation of its educational effectiveness. *Educational Technology & Society*, v. 8, no. 2, (p. 54–65)

Walsh, K. (2017). *Real Uses of Virtual Reality in Education: How Schools are Using VR. Emergingedtech.*