

IDENTIFYING DIVERSE USES OF VIRTUAL REALITY IN HIGHER EDUCATION AND EXPLORING PERCEPTIONS OF VR IN THE CHOSEN FIELD

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Purpose: This scientific paper to present the results of the research on perception of the selected university in terms of using VR. Practical research was carried out during Researchers' Night 2022 and was concerned with the perception of university by event participants who tried virtual reality at that time. The participants assessed how virtual reality workshops influenced the perception of the university.

Design/methodology/approach: The article uses the method of literature review as well as the survey, conducted during virtual reality workshops on participants of the Researchers' Night 2022.

Findings: The results of the survey provide valuable insight into the impact of VR on university perception by participants, their assessment of its attractiveness, and their preferences for VR classes. The findings show the positive influence of VR usage on the university image.

Research limitations/implications: The most important research limitation was the research sample due to the time limit as the research was conducted during the Researchers' Night which had a limited duration – VR workshops lasted 3 hours. For this reason, research is planned on a larger scale in the future. However, these preliminary studies show a highly positive trend regarding virtual reality in education.

Practical implications: The paper contains practical results of research on virtual reality perception and insights that universities can use to expand the technical infrastructure in the form of virtual reality equipment and improve the educational offer and marketing activities.

Originality/value: The paper explores the perception and feedback on virtual reality of participants in Researchers' Night 2022 after VR workshops. It presents how virtual reality affects the perception and image of the university that offers it. The article also shows the attitude of people towards the implementation of VR in education. This approach distinguishes the paper from existing literature by fulfilling the gap between theoretical discussions and practical application.

Keywords: virtual reality, VR, education, Researcher's Night.

Category of the paper: Research paper.

1. Introduction

Virtual Reality (VR) has emerged as a transformative technology, revolutionizing the way people perceive and interact with the digital world. This rapidly evolving technology enables users to experience simulated environments that engage multiple senses, blurring the boundaries between reality and virtuality. In recent years, VR has witnessed an unprecedented surge in popularity, encompassing diverse fields such as education, medicine, entertainment, training, and social interactions. By employing specialized VR headsets, users can explore virtual worlds, manipulate objects, and interact with simulated elements in a remarkably lifelike and engaging manner. VR has found applications in diverse fields, including training (Fracaro et al., 2021), healthcare (Izard, Juanes Méndez, Palomera, 2017), architecture (Dinis et al., 2020), entertainment and many more. The usage of virtual reality in entertainment can be observed on many digital platforms where users, mostly gamers, can play VR games and applications. One of the example of such platform is Steam, where the number of games is more than 126,500, and among them almost 7,000 were VR games and applications, according to Stecula's paper from December 2022 (Stecula, 2022a). The most numerous groups of VR applications on Steam include action, and subsequently casual, simulation, and adventure. On the other hand, there are puzzle, fantasy, exploration, and anime apps. With its potential to revolutionize the way we learn, work, and socialize, VR represents a gateway to a new era of immersive experiences, pushing the boundaries of human-computer interaction and paving the way for innovative advancements in various industries. VR can also be applied at universities, including technical universities (Stecula, 2019). However, this usage can on a different scale, it may concern different areas of the university's activity as well as different people.

This scientific paper aims not only to discuss the potential areas of application of virtual reality at the university, but also to present the results of the research on perception of the selected university in terms of using VR. Practical research was carried out during Researchers' Night 2022 and was concerned the perception of university by event participants who tried virtual reality at that time. The participants assessed how virtual reality workshops influenced the perception of the university.

The paper consists of 5 chapters. Chapter 2 includes methods applied in the research. Chapter 3 includes the identification and discussion of fields of virtual reality usage in the university based on the literature review. Chapter 4 describes the results of experimental research on virtual reality perception, carried out during the Researchers' Night 2022 at the Silesian University of Technology. The last chapter of Conclusions summarizes the paper and the research.

2. Materials and Methods

This study is characterized by a mixed method approach that incorporates a review of the literature and a survey. The method used in the first part of the research is a review of the literature on different fields of usage of VR. The other part of the study was carried out using the survey, conducted during virtual reality workshops with participants of Researchers' Night 2022 at the Silesian University of Technology. This part is experimental research on virtual reality perception. The survey included seven questions plus a question about the age of the participants; however, in this paper only the answers for three of them (plus the age question) are presented and analyzed. Researchers' Night participants were able to try virtual reality during the workshops, which was for 3 hours – between 5 pm and 8 pm. Participants could play various VR games and applications. All people who left the VR laboratory were asked to complete the questionnaire voluntarily. Therefore, the research sample was limited by the duration of the event. Finally, the research sample included 35 people who completed the questionnaire.

3. Fields of Virtual Reality Usage at the University

Virtual reality has a great potential to be used for different purposes and in different fields of human activity. The most popular is entertainment. VR games and applications can be found on popular international digital platforms, in addition to regular games. Additionally, some games are dedicated in different modules, for example, the computer module but also a VR module. In the literature, there are many papers that discuss applying VR, despite entertainment, in the following: medicine (Li et al., 2017), architecture (Bashabsheh, Alzoubi, Ali, 2019), psychology (Parsons et al., 2017), military (Pallavicini et al., 2016), aviation (Fussell, 2020), rehabilitation (Smits, Staal, Van Goor, 2020), manufacturing (Roldán et al., 2019), automotive industry (Lawson, Salanitri, Waterfield, 2016), tourism (Beck, Rainoldi, Egger, 2019), marketing (Ozdemir, 2021), in therapy (Caponnetto et al., 2021), to overcome depression (Baghaei et al., 2021), and many others.

The investigation, presented in this chapter and subchapters, aims to discuss the roles that virtual reality can play in different fields of university's activity, contributing to a comprehensive understanding of its impact within the university environment. Based on the literature review and the author's own experience, the use of virtual reality at the university can be considered broken down into the following fields:

- education,
 - training for academics,
 - university marketing,
 - occupational and safety training,
- and others.

The following sections discuss each area of application of virtual reality at the university.

3.1. Education

Virtual reality can improve traditional teaching methods by providing immersive and interactive experiences. In order to conduct classes in the virtual world, it is necessary to develop a given subject from scratch. Then, it is necessary to identify learning outcomes. They can include improving the understanding of complex concepts, improving practical skills, or providing unique experiences. The content of the classes should be carefully planned. Other aspects to consider include the outline of classes, learning outcomes, the method of verifying the knowledge acquired by the students, and many similar aspects related to the preparation of the subject. It should also be noted that a very important element is to write class scenarios or select VR content, applications, or experiences that align with learning objectives. There are various VR platforms and educational applications available (di Lanzo et al., 2020), covering a wide range of subjects and topics; however, the more professional way would be to create the dedicated educational application from scratch. There are many companies on the market that can prepare virtual reality applications dedicated to a given subject, according to the teacher's need. VR can be used to conduct classes in the virtual world in its entirety, but also partially support them (Stecula, 2019). It can be used for subject-specific simulations, virtual field trips, and hands-on training in various disciplines. Figure 1 shows screenshots of different practical virtual laboratories used in mechanical engineering courses showing traction machine, Rockwell hardness tester, and industrial radiology equipment from a paper of (Vergara et al., 2022).

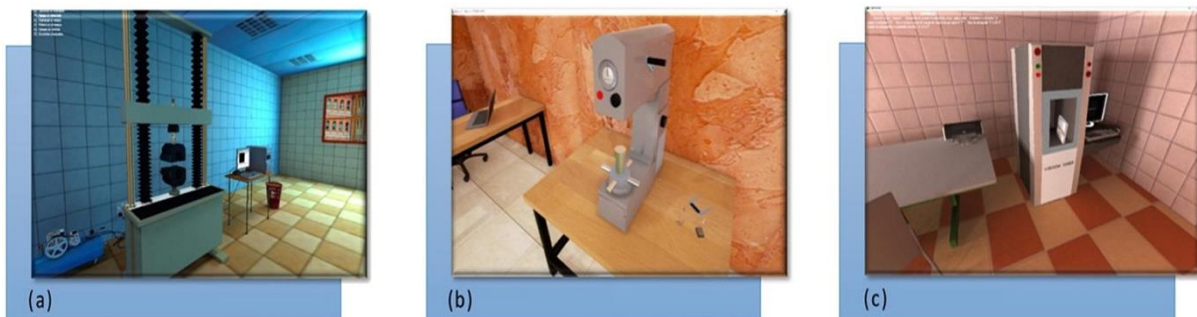


Figure 1. Different practical virtual laboratories used in mechanical engineering courses showing the following machines: a) traction machine, b) Rockwell hardness tester, c) industrial radiology equipment.

Source: (Vergara et al., 2022).

Another element connected with virtual reality is the VR headset and controllers (Angelov et al., 2020). To conduct virtual reality classes, the appropriate equipment must be purchased. On the market, there are many headsets available to users all over the world. The most popular headsets include the following: HTC Vive (Pro), HTC Vive Cosmos, Oculus Rift, Oculus Rift S, Oculus Quest, Oculus Quest 2, Valve Index HDM, Windows Mixed Reality, Sony PlayStation VR and many more (Valve Corporation, 2022). Lately, VIVE XR Elite were released in March 2023 (HTC, 2023b). Depending on the size of the groups, the university must decide how many virtual reality headsets it can purchase, considering that VR equipment is not cheap. Some academics set up virtual reality laboratories with multiple workstations (Zhang et al., 2018); however, it is not yet a common phenomenon. It should also be mentioned that there are many suppliers of virtual reality equipment on the market and the equipment differs in quality, cost, parameters, and elements of equipment.

It should also be remembered that the purchase of virtual reality equipment is not an investment for years because the modern technology industry is very changeable, and the technology that was on top, for example, 3 years ago, has now found its replacement. On the example of HTC Corporation, the following models were released in the following years: HTC Vive (2016), HTC Vive Pro (2018), HTC Vive Pro Eye (2019), Vive Cosmos (2019), Vive Focus (2019), Vive Focus Plus (2019), Vive Cosmos Elite (2020), HTC Vive Pro 2 (2021), Vive Focus 3 (2021), Vive Flow (2021), and Vive XR Elite (2023) as the newest (HTC, 2023a). Figure 2 shows some VR headset models from HTC Corporation.



Figure 2. Selected VR headset models from HTC Corporation.

Source: own preparation based on: (VRcompare, 2023).

Another important issue is also preparing the teacher to conduct classes in virtual reality, because not every lecturer has the knowledge and skills to conduct classes in such a modern style and with the usage of new technology. Preparing teachers to effectively conduct classes in virtual reality (VR) is a crucial aspect of integrating this modern technology into education. By providing adequate support, educational institutions can empower teachers to conduct classes confidently and effectively in virtual reality, ensuring successful integration of this modern teaching approach into the study program.

Universities should also pay great attention to safety issues during classes conducted in the virtual form. Ensuring the safety of both students and teachers is crucial. Efficient safety measures must be taken to protect participants from potential risks associated with immersive environments. There are many dangers to which VR user can be exposed. Generally, they can be divided into physical (for example hitting a wall, falling or getting tangled in a cable) and psychological (for example, stress, pressure, isolation) (Stecula, 2022b). Regular assessments of VR content for age-appropriateness, motion sickness prevention, and following ethical guidelines are essential. Additionally, educators must be trained to monitor and address any discomfort or distress experienced by students while engaged in virtual activities, promoting a secure and conducive learning environment.

Last but not least, it should be noted that VR promotes active learning by necessitating engaged participation and cultivating critical thinking (Fabris *et al.*, 2019). VR-based lessons require students to take an active role, forcing them to make informed decisions, solve complex problems, and often collaborate with peers within the immersive digital world. This interactive nature of VR not only stimulates cognitive processes, but also improves memorizing and then applying knowledge. Learners are encouraged to explore, analyze and manipulate virtual scenarios and due to this, develop a deeper understanding of the subject matter through direct experience (Hussein and Nätterdal, 2015). This active engagement results in a more dynamic and effective educational experience, where students become proactive learners rather than passive recipients.

3.2. Trainings for Academics

Another way to use virtual reality is for academic training. Universities should consider developing training programs to enhance skills and professional development of academics. The first type can be pedagogical training. It could include workshops and courses focused on teaching methodologies, study program design, assessment strategies, active learning techniques, and effective classroom management. Such an interactive training would bring many positive results for teachers. A similar type of training would be training to increase competences in the field of mastering online tools used for teaching. It can refer to the use of educational technology tools, online learning platforms, and multimedia resources.

Communication training would certainly help scientists work better with students and other academic teachers. Virtual reality training in this area would offer the enhancement of effective communication, presentation skills, and public speaking skills which is important especially in relation to giving interesting lectures (Khan *et al.*, 2017). It should be noted that sometimes teachers must deal with the difficult or challenging behavior of students. The results from the paper of Chen (Chen, 2022), revealed that the immersive VR training experience improved the speed and effectiveness of the participants' (they were preservice teachers) management of challenging behaviors of students and it enabled the teachers to transfer all of they learned to an actual classroom setting. Due to training, teachers were more confident in halting

challenging behaviors by approaching students, taking appropriate actions, and using oral commands.

In addition, effective communication skills empower academics to share knowledge, collaborate, mentor, and contribute meaningfully to their field and society. They enable academics to bridge gaps between experts and non-experts, fostering a greater understanding of research and its implications. This, in turn, concerns another type of training, which is research skills training. Universities should consider VR workshops on research methods, data analysis, grant writing, literature review techniques, academic writing, and publishing in peer-reviewed journals. This is highly important for academic teachers as well as for the entire university. Supporting academic staff in this regard would be beneficial to both.

As academics participate in VR training, they unlock a sphere of possibilities that go beyond traditional teaching and research methodologies, shaping the future of education and scholarship. Additionally, VR training lets academics explore new research paths, enhancing their ability to investigate complex phenomena and contribute to cutting-edge advancements in their respective fields.

3.3. University Marketing

Virtual reality can be a powerful tool for the marketing of a given university. There are many ways to use it. First, the university can develop special 360-degree movie for the VR headset, available on the Internet, which presents the entire campus, its location, dormitories, and other elements such as offer, student events, benefits of studying in the given faculty, and other advantages. Through VR, potential students can virtually explore campus facilities, academic departments, student accommodation, recreational spaces, and other key areas. Such movies allow them to "walk" around the campus, interact with virtual guides, and gain a realistic sense of the university's atmosphere and environment. VR can also showcase special events, student activities, and campus life, providing a comprehensive preview that helps potential applicants make informed decisions about their educational journey. This type of modern marketing can attract many future students, because generation Z searches for information on the Internet (Desai, Lele, 2017), and videos and photos attract attention and allow to remember things that one saw to a greater extent than what one read. Young people often make decisions based on information found on the Internet, which is an inseparable element of the life of the modern generation. According to research by Shen et al. (Shen et al., 2020), in which many future students experience a virtual reality tour through the university campus, telepresence is positively correlated with intentions to recommend the visited campus to others. Therefore, the opportunity to visit the university campus would certainly attract many new students, allowing the university to develop and increase its market position.

Another way to use virtual reality for university marketing is to provide VR equipment for visitors (future students and their relatives) during various events, for example, open days of the university. Virtual reality can be used to present the campus and the university's offer to visitors if the university has a movie or application like this. Additionally, virtual reality equipment can be presented as one of the technologies that are used at the university during classes. Showing something attractive like a new educational application to future students is certainly very beneficial for visitors and especially for people who want to decide whether to study at a given university. Modern technologies and their presentation during important university events certainly contribute to improving the image and the attractiveness of the university. This innovative use of VR not only shows the university's commitment to modern technology but also enriches the open-day experience, leaving a lasting impression on potential students as they start a new phase within education.

3.4. Occupational and Safety Training

Virtual reality creates the opportunity to conduct health and safety training. In the university, both staff and students must undergo occupational health and safety training (OHS). On the market, companies offer applications that allow participants to be trained in this field. An example of a company that offers services for the preparation of a dedicated virtual reality application is Epic VR (EpicVR, 2022). This company developed an application for a production company with four modules that contain the following areas: occupational health and safety engineering, hazards within production plants, personal protective equipment (PPE) and fire hazard. Figure 3 shows a screenshot of the mentioned application – the moment of putting out a fire. The company offers the service of developing different types of applications; therefore, ordering a dedicated application written for a given scenario is possible. On the market, there are more and more companies offering such a service.



Figure 3. A screenshot of the occupational health and safety training by EpicVR.

Source: (EpicVR, 2022).

OHS training in virtual reality offers several advantages. Firstly, it provides a safe and controlled environment for employees to perform hazardous tasks without exposing them to real-world risks. Secondly, VR allows for realistic simulations of various workplace scenarios, enhancing employees' situational awareness and decision-making skills. Thirdly, interactive VR training promotes active learning and engagement, increasing knowledge retention and skill development. Additionally, VR can be easily adapted to cater to different industries and job roles, making it a versatile and scalable solution for OHS training. Lastly, by reducing the need for physical training equipment and space, VR training can lead to cost savings for organizations while ensuring effective OHS preparedness.

3.5. Other Fields

Virtual reality can also be used in other than the mentioned fields of university activity. Beyond educational purposes, universities can offer VR experiences for entertainment and relaxation, enhancing campus life and student engagement. Making virtual reality available to students, for example, in student zones or in relaxation zones, would certainly be a great benefit to the well-being and comfort of students and the university image. The application of virtual reality continues to expand, offering universities innovative ways to enhance education, research, and various aspects of campus life. Moreover, VR can create interactive fitness and training experiences. On the one hand, the use of VR sports application can allow students and employees to move after sitting for several hours in class, which is good for their health, both body and mind. On the other hand, virtual reality can also be used in physical education classes. It should be mentioned that according to research of Stecuła's (Stecuła, 2022a), the sport application called Walkabout Mini Golf VR got the highest score (ex aequo with a shooter Half Life: Alyx) of all VR applications available on the Steam platform (data from 2022). It got an "overwhelmingly positive" status, receiving 98% positive reviews from users all over the world. Figure 4 shows a screenshot of this application.



Figure 4. A screenshot of the Walkabout Mini Golf VR application.

Source: (Valve Corporation, 2023).

Furthermore, there is a huge potential to use VR in the social area of the university. Virtual reality can revolutionize the social area of the university, offering students unique and immersive experiences that enhance social connections and engagement. If developed, VR can facilitate virtual meetups, clubs, and interest groups, allowing students, but also workers, to socialize and collaborate (Zhaparova et al., 2023). Additionally, according to Schutte and Stilinović (Schutte, Stilinović, 2017), VR can facilitate experiences that promote empathy and perspective-taking, allowing people to better understand diverse perspectives and social issues. What is more, virtual reality can be used for therapy (Boeldt et al., 2019; Caponnetto et al., 2021), stress reduction (Kamińska et al., 2020; Lyu, 2021), and cognitive rehabilitation (Rizzo, Buckwalter, Neumann, 1997).

The usage of virtual reality depends on the needs, will, and limitations of imagination. Technology offers many possibilities in various fields, from education and training to entertainment, healthcare, research, and beyond. It allows one to create and experience virtual worlds, scenarios, and simulations that were unimaginable years ago. As VR continues to evolve and become more accessible, its potential to change the way people work, study, and even live grows. Virtual reality can unlock new ways of learning, communicating, collaborating, and exploring, shaping a future where the limits of human experiences are expanded. The possibilities are great, and the limitation is people's willingness to explore this cutting-edge technology.

4. Perception of Virtual Reality: A Study from Researchers' Night 2022

This chapter and its subchapters describe the results of research that concern one of the above-mentioned fields of application of virtual reality at the university. The author conducted research on the perception of virtual reality in the field of university marketing.

4.1. Experimental Framework and Research Trial

On October 8, 2022, Researchers' Night took place at the Silesian University of Technology (SUT), at all of the faculties. Researchers' Night is an initiative organized by the SUT as part of the nationwide event. It is a special night dedicated to the presentation of the popular science of various fields of science and the achievements of scientists and researchers from the university. During this event, laboratories are opened, workshops, lectures and presentations are conducted, aimed at bringing the public closer to various scientific issues and inspiring interest in science and technology. This event is also an opportunity to meet scientists, ask questions, and participate in interactive experiences, helping to promote scientific and educational awareness.

The author prepared a virtual reality laboratory that was exposed to be visited by the participants of the Researchers Night. Anyone willing could personally try virtual reality and experience an unforgettable immersion. The opportunity to try virtual reality took place between 5 pm and 8 pm. During this time, participants could play various VR games and applications. Then, all people who left the virtual reality laboratory were asked to fill out the questionnaire voluntarily. Therefore, the research sample included people who used virtual reality in the given laboratory during the event and decided to complete the survey immediately after leaving the laboratory.

Due to the fact that the event lasted three hours, the number of people who were able to try VR and participate in the study was limited. Because within three hours it is not possible for a very large group of people to experience virtual reality, the research trial was limited. Finally, the research sample included 35 people who decided to complete the questionnaire. 54% of them were under 18 years old, 29% were between 19 and 35 years old, and 17% were 36-60 years old. No one was older than 60 years. The data are presented in Figure 5.

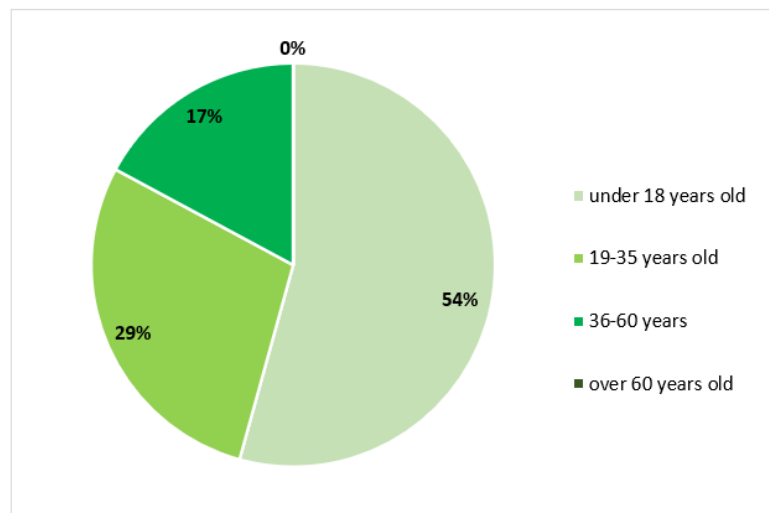


Figure 5. Age of the participant (results rounded to full values).

4.2. Survey Results

Participants were asked if virtual reality workshops influenced the perception of the university they visited. The results showed that 69% of the participants selected the answer 'yes, very positively', while 20% indicated 'yes, quite positive'. This implies that nearly 90% of the respondents acknowledged a favorable effect of VR usage on the university image. No individuals endorsed a negative impact response ('yes, quite negatively' or 'yes, very negatively'). The remaining 11% stated that VR had no influence on their university perception. The results were rounded to full values. The data are presented in Figure 6.

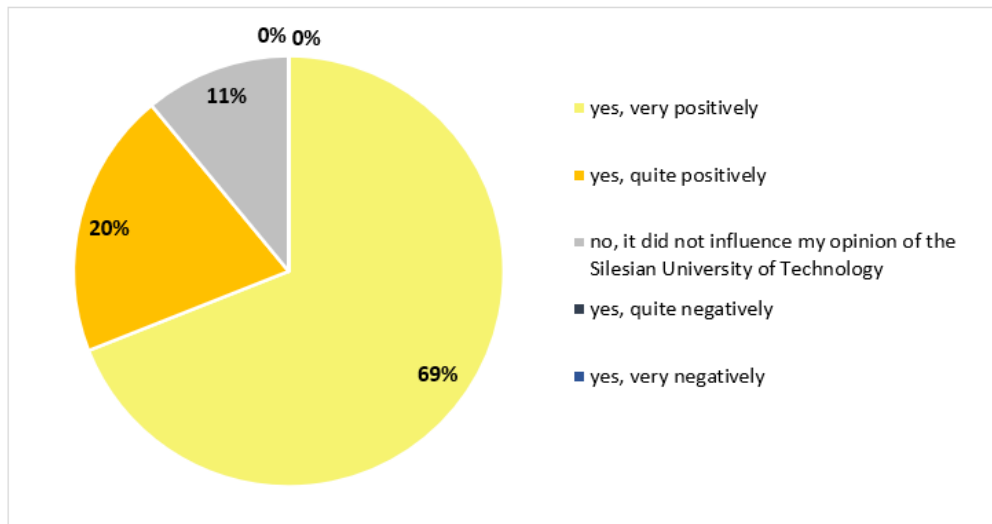


Figure 6. Answers to the question ‘Has the virtual reality workshop influenced your perception of our university?’ (results rounded to full values).

In the next question, participants had to specify, on a scale of 1 to 5, whether the virtual reality show or workshop made the university more attractive to visitors. 1 stood for ‘not at all’, and 5 – ‘yes, very much’. More than three-quarters of the participants (77%) awarded the highest score of 5 points. Meanwhile, 11% assigned 4 points, and the intermediate value of 3 points was selected by a mere 6%. A smaller percentage, specifically 3% of respondents, allocated 2 and 1 point, respectively. In the case of the answer to this question, the median was 5, and the arithmetic mean was 4.57. The data are presented in Figure 7.

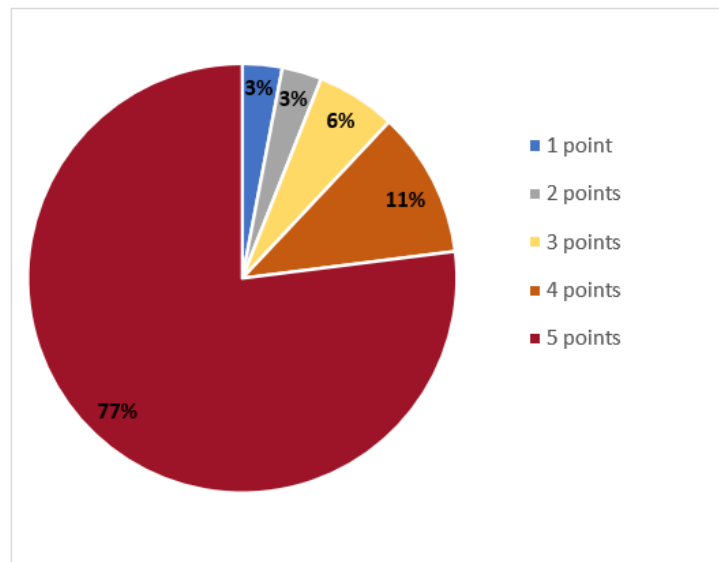


Figure 7. Answers to the question ‘Did the virtual reality workshop make the university seem more attractive (1-not at all, 5-yes, very much)?’ (results rounded to full values).

In the next question, participants were asked to express their preference for classes using virtual reality. They were asked to rate the level of attractiveness of these classes on a scale ranging from 1 to 5, where 1 signified ‘no, not at all’ and 5 – ‘yes, very much’. A significant majority of participants, comprising 86%, rated this concept with a 5-point evaluation,

while 9% rated it 4 points. This indicates that nearly all participants expressed a highly positive view regarding virtual reality and its application in university class settings. Among the survey respondents, 3% assigned 3 and 2 points, respectively, and no participants gave a 1 point. The data obtained, the median was 5, and the average value was 4.77. The data are presented in Figure 8. The average rating for this question is higher compared to the previous one, indicating that while participants had highly positive evaluations in both cases, classes enriched with virtual reality garnered even higher scores than the university's attractiveness perception through virtual reality.

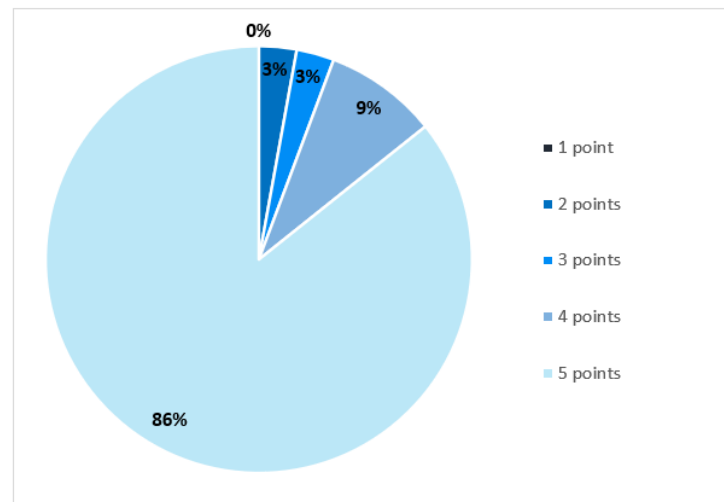


Figure 8. Answers to the question ‘Would classes using virtual reality seem more attractive to you (1 - no, not at all 5 - yes, very much)?’ (results rounded to full values).

5. Conclusions

The paper discusses the multiple applications of virtual reality within the university environment. In the first part of the research, it focuses on exploring the roles of VR in the university, dividing the possible use of it into the following fields: education, training for academics, university marketing, occupational and safety training, and others. Education can benefit greatly from virtual reality's immersive and interactive experiences, transforming traditional teaching methods into innovative ones. From developing subject content to identifying learning outcomes for classes using VR, careful planning and alignment with educational objectives are key. Integration of VR into classrooms enables active learning, critical thinking, and practical skill enhancement. Moreover, virtual reality expands the possibilities of training academics in diverse areas, including pedagogy, communication, research skills, and the mastery of online tools. These trainings equip academics with the necessary skills for effective teaching and contribute to their professional growth. Virtual reality can also serve as a tool for university marketing. Through 360-degree videos and

VR experiences, potential students gain insight into campus life, facilities, and student activities. Through this, universities can engage potential applicants and shape their decisions. The use of VR during open days enhances the university's image and modernizes its informational efforts. Additionally, VR finds its place in occupational and safety training, offering a controlled environment for people to simulate hazardous tasks, improve situational awareness, and promote active learning.

The second part of the research focused on examining the perception of virtual reality in a selected area. Survey research was carried out during Researchers' Night 2022 while the workshop on virtual reality took place. People who tried VR were encouraged to participate in the survey. The results of the survey provide valuable insight into the impact of VR on university perception by participants, their assessment of its attractiveness, and their preferences for VR classes. The findings show the positive influence of VR usage on the university image, as nearly 90% of the respondents recognize the favorable impact of VR on the university image. The subsequent questions based on the answers on the scale from 1 to 5. The first of them referred to the attractiveness of university in the context of using VR by it. 77% of the participants awarded the highest rating of 5 points, 11% – of 4 points, 6% – of 3 points, and 3% – both, of 2 and 1 points. The mean score stood at 4.57, suggesting a general tendency towards a positive impact on the university's attractiveness due to VR initiatives. The last question prompted participants to express their preference for virtual reality-based classes. 86% assigned the highest rating of 5 points, while 9% gave 4 points. This trend highlights the overwhelmingly positive attitude of participants towards incorporating virtual reality into university class settings. It should be noted that no one selected the lowest score of 1 point. The calculated average value was 4.77. The average rating for this question surpassed that of the previous question, suggesting that participants evaluate VR classes even higher compared to the impact on the university's overall attractiveness through VR.

In sum, the survey outcomes indicate the highly positive participants impressions toward virtual reality's integration within the university context. These findings emphasize the potential of VR to not only enhance the university's image and attractiveness, but also significantly increase the effectiveness of education. As technology continues to evolve, these results encourage further exploration and integration of virtual reality to enrich various areas of university life. The transformative potential in education, research, and daily life remains great. By using virtual reality's capabilities, universities can shape a future where learning, collaboration, and innovation have no limits.

Future research directions should focus on the ways virtual reality is used for educational purposes within the university environment. This includes conducting more extensive studies on the development of educational applications, the effectiveness of VR-based teaching methods, exploring the impact on different learning styles and subjects, and investigating the potential of VR to be used in various university courses. Much practice should be put into supporting regular classes with VR. Furthermore, research can focus on the development of

standardized guidelines and best practices to integrate virtual reality into university curricula. This would help to ensure consistency and quality in the use of VR in different academic disciplines and institutions. It should also be noted that as technology advances, educational methods must also evolve to remain effective and engaging. Virtual reality offers a promising way for this transformation, providing a dynamic and immersive educational experience that aligns with the changing needs and expectations of students and educators.

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References

1. Angelov, V. *et al.* (2020). *Modern virtual reality headsets*. 2020 International congress on human-computer interaction, optimization and robotic applications (HORA). IEEE, pp. 1-5.
2. Baghaei, N. *et al.* (2021). Virtual reality for supporting the treatment of depression and anxiety: Scoping review. *JMIR mental health*, 8(9), p. e29681.
3. Bashabsheh, A.K., Alzoubi, H.H., Ali, M.Z. (2019). The application of virtual reality technology in architectural pedagogy for building constructions. *Alexandria Engineering Journal*, 58(2), pp. 713-723.
4. Beck, J., Rainoldi, M., Egger, R. (2019). Virtual reality in tourism: a state-of-the-art review. *Tourism Review*, 74(3), pp. 586-612.
5. Boeldt, D. *et al.* (2019). Using virtual reality exposure therapy to enhance treatment of anxiety disorders: Identifying areas of clinical adoption and potential obstacles. *Frontiers in psychiatry*, 10, p. 773.
6. Caponnetto, P. *et al.* (2021). The simulation game—virtual reality therapy for the treatment of social anxiety disorder: A systematic review. *International journal of environmental research and public health*, 18(24), p. 13209.
7. Chen, C. (2022). Immersive virtual reality to train preservice teachers in managing students' challenging behaviours: A pilot study. *British Journal of Educational Technology*, 53(4), pp. 998-1024.

8. Desai, S.P., Lele, V. (2017). Correlating Internet, social networks and workplace—a case of generation Z students. *Journal of commerce and management thought*, 8(4), pp. 802-815.
9. Dinis, F.M. *et al.* (2020). Improving project communication in the architecture, engineering and construction industry: Coupling virtual reality and laser scanning. *Journal of Building Engineering*, 30, p. 101287.
10. EpicVR (2022). *Szkolenia BHP w VR*. Available at: https://www.youtube.com/watch?v=HSJkgomRoVo&ab_channel=EpicVR-VRARExpert, 25 May 2023.
11. Fabris, C.P. *et al.* (2019). Virtual reality in higher education. *International Journal of Innovation in Science and Mathematics Education*, 27(8).
12. Fracaro, S.G. *et al.* (2021). Towards design guidelines for virtual reality training for the chemical industry. *Education for Chemical Engineers*, 36, pp. 12-23.
13. Fussell, S.G. (2020). *Determinants of Aviation Students' Intentions to Use Virtual Reality for Flight Training*. Embry-Riddle Aeronautical University.
14. HTC (2023a). *HTC*. Available at: <https://www.vive.com>, 4 August 2023.
15. HTC (2023b). *XR Elite*. Available at: <https://www.vive.com/us/product/vive-xr-elite/overview/>, 4 August 2023.
16. Hussein, M., Nätterdal, C. (2015). *The benefits of virtual reality in education - A comparison Study*.
17. Izard, S.G., Juanes Méndez, J.A., Palomera, P.R. (2017). Virtual reality educational tool for human anatomy. *Journal of medical systems*, 41, pp. 1-6.
18. Kamińska, D. *et al.* (2020). Stress reduction using bilateral stimulation in virtual reality. *IEEE Access*, 8, pp. 200351-200366.
19. Khan, A. *et al.* (2017). Communication Skills of a Teacher and Its Role in the Development of the Students' Academic Success. *Journal of Education and Practice*, 8(1), pp. 18-21.
20. di Lanzo, J.A. *et al.* (2020) 'A review of the uses of virtual reality in engineering education. *Computer Applications in Engineering Education*, 28(3), pp. 748-763.
21. Lawson, G., Salanitri, D., Waterfield, B. (2016). Future directions for the development of virtual reality within an automotive manufacturer. *Applied ergonomics*, 53, pp. 323-330.
22. Li, L. *et al.* (2017). Application of virtual reality technology in clinical medicine', *American journal of translational research*, 9(9), p. 3867.
23. Lyu, A. (2021). *Applications and Future Perspectives of Virtual Reality in the Treatments of Post Traumatic Stress Disorder*. 3rd International Conference on Intelligent Medicine and Image Processing, pp. 151-155.
24. Ozdemir, M.A. (2021). Virtual reality (VR) and augmented reality (AR) technologies for accessibility and marketing in the tourism industry. In: *ICT tools and applications for accessible tourism*. IGI Global, pp. 277-301.
25. Pallavicini, F. *et al.* (2016). Virtual reality applications for stress management training in the military. *Aerospace medicine and human performance*, 87(12), pp. 1021-1030.

26. Parsons, T.D. *et al.* (2017). Virtual reality in pediatric psychology. *Pediatrics*, 140 (Supplement_2), pp. S86-S91.
27. Rizzo, A.A., Buckwalter, J.G., Neumann, U. (1997). Virtual reality and cognitive rehabilitation: a brief review of the future. *The Journal of head trauma rehabilitation*, 12(6), pp. 1-15.
28. Roldán, J.J. *et al.* (2019). A training system for Industry 4.0 operators in complex assemblies based on virtual reality and process mining. *Robotics and computer-integrated manufacturing*, 59, pp. 305-316.
29. Schutte, N.S., Stilinović, E.J. (2017). Facilitating empathy through virtual reality. *Motivation and emotion*, 41, pp. 708-712.
30. Shen, J. *et al.* (2020). Using virtual reality to promote the university brand: When do telepresence and system immersion matter? *Journal of Marketing Communications*, 26(4), pp. 362-393.
31. Smits, M., Staal, J.B., Van Goor, H. (2020). Could Virtual Reality play a role in the rehabilitation after COVID-19 infection? *BMJ open sport & exercise medicine*, 6(1), p. e000943.
32. Stecula, K. (2019). *Application of Virtual Reality for Education at Technical University*. Proceedings of ICERI 2019 Conference, 11th-13th November 2019, pp. 7437-7444.
33. Stecula, K. (2022a). Virtual Reality Applications Market Analysis—On the Example of Steam Digital Platform. In: *Informatics*. Multidisciplinary Digital Publishing Institute, p. 100.
34. Stecula, K. (2022b). Wirtualna rzeczywistość na uczelni – potencjał, korzyści i zagrożenia. In: *Wirtualna rzeczywistość w perspektywie prawnej, bezpieczeństwa cyfrowego i technologii informacyjnych*. Radom: Akademia Handlowa Nauk Stosowanych w Radomiu, pp. 130-143.
35. Valve Corporation (2022) *Steampowered*. Available at: <https://steampowered.com>, 6 July 2022.
36. Valve Corporation (2023) *Steampowered*. Available at: <https://steampowered.com>, 8 August 2023.
37. Vergara, D. *et al.* (2022). Educational trends post COVID-19 in engineering: Virtual laboratories. *Materials Today: Proceedings*, 49, pp. 155-160.
38. VRcompare (2023). *VR compare*. Available at: <https://vr-compare.com/>, 4 August 2023.
39. Zhang, M. *et al.* (2018). Recent developments in game-based virtual reality educational laboratories using the microsoft kinect. *International Journal of Emerging Technologies in Learning (iJET)*, 13(1), pp. 138-159.
40. Zhaparova, B. *et al.* (2023). Influence of virtual reality on the process of personality socialization: A distance model of socialization. *International Journal of Innovative Research and Scientific Studies*, 6(2), pp. 235-241.