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Iwona Mokwa-Tarnowska
Gdansk University of Technology
https://orcid.org/0000-0001-5776-0404

Viviana Tarnowska
Cranfield University
https://orcid.org/0000-0002-7861-7639

Through University Students' Headsets: To Immerse or Not to Immerse in New Learning Experiences

Abstract

Integrating technology-enhanced resources and activities into university curricula necessitates a restructuring of teaching programmes. To achieve a synergistic effect, conventional methods should be replaced with active learning approaches that provide students with innovative, engaging, and collaborative ways of building knowledge suited to contemporary society. Virtual reality (VR) is among the technological innovations expected to transform education into interactive and immersive learning environments. This paper investigates whether integrating VR into university courses can, in students' opinions, increase their interest in a deeper understanding of complex phenomena, and whether it may translate into greater engagement and improved achievement of learning outcomes. The challenges of implementing such instructional design are examined through an analysis of survey responses from bachelor's and master's students at Gdańsk University of Technology (Gdańsk Tech), collected in June and July 2025.

K e y w o r d s: virtual reality, VR, education, effectiveness, VR applications, educational outcomes

Introduction

Incorporating technology-enhanced resources and activities into a university curriculum involves restructuring the teaching programme to achieve a synergistic effect. Recent advances have enabled educators to move from instructivist approaches towards constructivist ones, fostering interactive, immersive, collaborative, and student-centred learning in contexts that were previously unavailable – now created through the affordances of the functionalities offered by digital environments. Technology alone will not change teachers' and students' perceptions of potential educational benefits. Its effective use to enhance learning opportunities requires understanding its added value and embracing novelty, which often involves attitude change and open-mindedness.

The paper aims to investigate whether redeveloping university curricula to include immersive experiences can increase students' interest in classes enhanced in this way, based on their perceptions of such changes. It further explores if their attitude can translate into greater engagement and improved achievement of intended learning outcomes. The challenges of such instructional design are examined through the analysis of responses from bachelor's and master's students of science and engineering at Gdańsk University of Technology (Gdańsk Tech), collected via a survey conducted in June and July 2025. The discussion is supported by both qualitative and quantitative research findings. The following research questions were addressed:

- To what extent are technically-minded students willing to embrace VR in their university courses? (RQ1)
- To what extent do technically-minded students believe that VR can help them retain knowledge and better understand complex issues? (RQ2)
- To what extent do technically-minded students believe that VR-enhanced classes can increase their engagement and motivation to learn? (RQ3)
- How do technically-minded students perceive the likelihood that VR will become a widely used teaching tool in university-level education over the next five years? (RQ4)
- To what extent does VR experience impact students' attitude to the adoption of VR-enhanced classes? (RQ5)

Virtual Reality in University Education

In the literature, various definitions of virtual reality (VR) can be found, with some emphasising either technical aspects or interactive experiences. To combine both perspectives, VR can be understood as the use of computer modelling and simulation to create computer-generated environments that immerse the user by replicating certain aspects of the real world through multi-sensory and dynamic experiences, which enable lifelike encounters. VR applications typically employ devices such as headsets, goggles, gloves, or body suits that transmit and receive information, allowing users to view three-dimensional simulated environments and manipulate virtual objects through force-feedback technologies.

Lampropoulos et al. (2022) claim that the release of consumer devices such as Oculus Rift, HTC Vive, and PlayStation VR in 2016, along with the growth of gaming applications, boosted public interest in VR technology. They support their findings with an analysis of tweets in which they found a number of positive emotions such as anticipation, trust, and joy in relation to VR; however, they also saw many neutral remarks, suggesting that the potential benefits of these technologies were not yet widely recognised by the public at that time. Notwithstanding similar positive expectations shared by the university community, VR technology has not yet become a widely used educational environment (AlGerafi et al., 2023, p.7) – the reasons being different.

VR applications can be used in a variety of ways to support learning of different subjects. They can simplify the understanding of abstract concepts and intricate solutions in a physical environment, thus allowing students to engage in experiences that would be otherwise challenging or difficult to achieve in a traditional classroom (Tekindur & Kara, 2025, p. 221; Lebiedź, 2024; Anjos et al., 2024; Merchant et al., 2014). According to Tekindur and Kara (2025, p. 221), and following the research by Avcı and Taşdemir (2019), employing three-dimensional models of molecular structures or using virtual simulations to replicate chemical reactions has been shown to enhance students' understanding of complex concepts in chemistry. Similarly, such technologies have been found to have supported experiential learning of core principles in the physics courses they investigated, such as Newton's laws of motion.

In line with Lampropoulos et al. (2025), Anjos et al. (2024), Bodzin et al. (2021) and Lampropoulos et al. (2022) another important reason for adopting VR in science education is its ability to make learning more engaging and flexible. By interacting with visual environments, students are believed to retain knowledge more effectively, deepen their understanding of scientific processes, and develop cognitive and practical skills (Almulqu et al., 2025; Sung et al., 2024; AlGerafi et al., 2023, p. 16). Therefore, VR seems to have a potential to transform, e.g., medical education by providing immersive learning experiences that support anatomy visualisation, surgical training, diagnostic simulations and collaboration, resulting in students developing a range of professional skills faster and earlier. A study at the University of Dundee, where students of varying experience levels explored 3D anatomical models in VR, showed promising results, with relatively high acceptance levels of such environments and performance results (AlGerafi et al., 2023,

p. 17; Erolin et al., 2019). Similarly, Kowalski et al., (2024) found that immersive experiences not only provide engaging learning environments for students of architecture, but also deepen their understanding of spatial concepts.

In addition, Mazhar and Al Rifaee (2023) report that their students showed high levels of satisfaction with classes implementing virtual reality technology, finding them to be a more enjoyable and immersive learning experience than traditional settings.

It is expected that in engineering education, VR can enhance student engagement, motivation, and performance while fostering key soft skills such as creativity, problem-solving, decision-making, and communication, looked for by employers (Mokwa-Tarnowska & Tarnowska, 2019, pp. 218-219), preparing them for future career demands. Moreover, compared to physical laboratories, it provides operational benefits, including lower construction costs, scalability, easier maintenance, reduced running costs and flexibility for adaptation and replication.

Bibliometric studies show that VR technology, to varying degrees of frequency, accessibility and complexity, has been featured in teaching science and education research since 2002. The results reveal a yearly increase in interest among educators, with most applications employing the constructivist paradigm (Tekindur & Kara, 2025, p. 229; Lampropoulos & Kinshuk, 2024).

However, research has also indicated several limitations to the wider adoption of VR in academic education, a key one being the high cost of the technology. Additionally, the requirement for specialized hardware and software can make its implementation challenging and maintenance demanding (Mazhar & Al Rifaee, 2023). Furthermore, the advanced IT skills needed to develop VR applications can restrict their use to universities of technology, whose staff are qualified to manage the technical demands and may be willing to incorporate them for pedagogical gain. Lastly, VR simulations can consume up to ten times more energy, thus raising environmental concerns (Mohammadi et al., 2025, p. 6).

From the student perspective, incorporating VR into instructional design presents challenges, including communication difficulties – as students usually use the environment alone; problems with object manipulation – since they must learn how to use the interface, which is not necessarily intuitive and can be time-consuming; and technical issues such as bugs and crashes – for which they will need support to avoid disruptions in their learning experience (AlGerafi et al., 2023, p. 23). Furthermore, it can have side effects as a result of prolonged use; yet few studies have examined possible health risks associated with VR (AlGerafi et al., 2023, p. 18).

Research Methodology

Data for this study were gathered through an online questionnaire accessible only to students of Gdańsk Tech via its website. The questionnaire comprised three questions using a nominal scale about the respondent's specialisation, level of study and experience with VR technology, with categorical variables not possessing inherent order, and fourteen questions using a five-point Likert-style scale, where respondents were instructed to rate their responses, facilitating a nuanced understanding of their opinions. One question with a request to provide comments was intended to collect deeper insights into the rationale behind their quantitative ratings, thus enriching the data collection process qualitatively. The nominal-scale questions were supposed to support the analysis of responses in relation to differences in VR experience, the degree of advancement in university education and the field of specialisation. To address the paper's objectives in relation to the research questions, the analysis focuses on the first part of the survey, comprising the initial eight questions.

To maintain the integrity of the study, all participants received the same set of questions and were tested under identical conditions. This approach ensures that the findings remain unaffected by variations in question content or testing circumstances. Participation in the questionnaire was restricted to 1^{st} and 2^{nd} degree students, who were notified about it via the university's managed learning environment. This selection criterion was applied to maintain methodological consistency.

Importantly, the questionnaire was intentionally designed not to request sociodemographic information from participants. This measure was taken to ensure the privacy and anonymity of the study's participants in line with ethical standards for data collection.

Quantitative data are presented as percentages. Statistical analyses were conducted using the Chi-Square Test of Independence to examine the association between participants' VR experience and their perception of the likeliness of using VR in future academic settings. Due to the presence of small expected cell counts in several contingency tables, a Monte Carlo simulation with 10,000 replicates was employed to provide a more robust estimation of *p-values.* Additionally, Fisher's Exact Test was applied as it is more appropriate for sparse data. Some of the results were considered statistically significant at $p<.05$ and others not with $p>.05$. All of them provided valuable insights into the potential value of VR-enhanced curricula. The statistical analyses were performed with RStudio.

Survey Results and Discussion

Altogether 169 students completed the questionnaire – 129 on a bachelor's course and 40 on a master's one. Their responses are divided by specialisation to capture diverse academic perspectives – Architecture, Biomedical Engineering, Chemistry, Civil Engineering, Computer Science, Electrical Engineering, Environmental Science / Engineering, Geodesy, Management and Economics, Material Science, Mechanical Engineering, Mathematics, Offshore Engineering / Ship Industry, Physics, Robotics, Telecommunication and Transport.

The data presented in Figures 1–19 were collected and analysed by the authors without support from external parties. Statistical analyses were conducted using RStudio. As there was only one MSc respondent with some coding experience, they were excluded from the experience–attitude analysis, as their data were treated as an outlier, significantly differing from other observations in the dataset. However, this respondent was included in the data shown in Figures 1–18, and their opinions were also taken into account. For clarity in the visualisations, specialisations represented by only one or two respondents in the case of BSc students were grouped under the label *Other*; these included Geodesy or Management and Economics or Material Science. Within the much smaller MSc group, the students themselves selected this category.

The data presented in Figures 1–20 were collected and analysed solely by the authors, without support from any external parties.

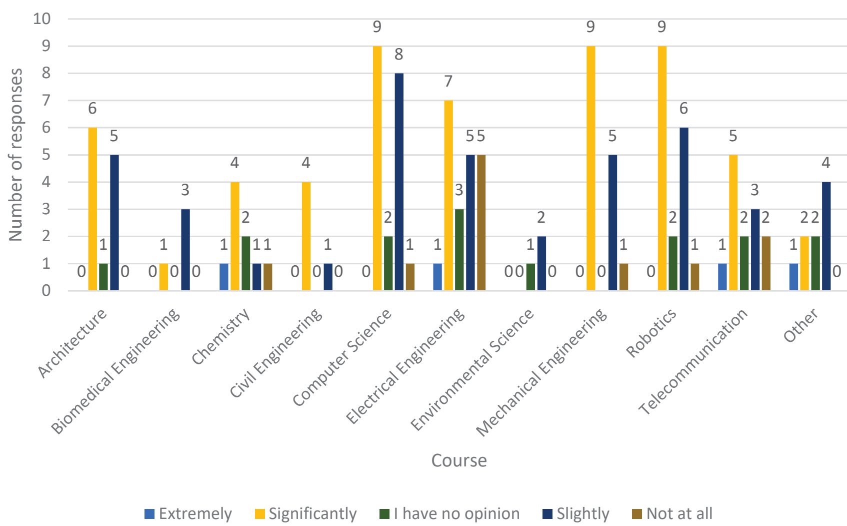

Figure 1. Bachelor's Students – VR and Understanding of Complex Academic Content

N o t e: Data collected and analysed by the authors.

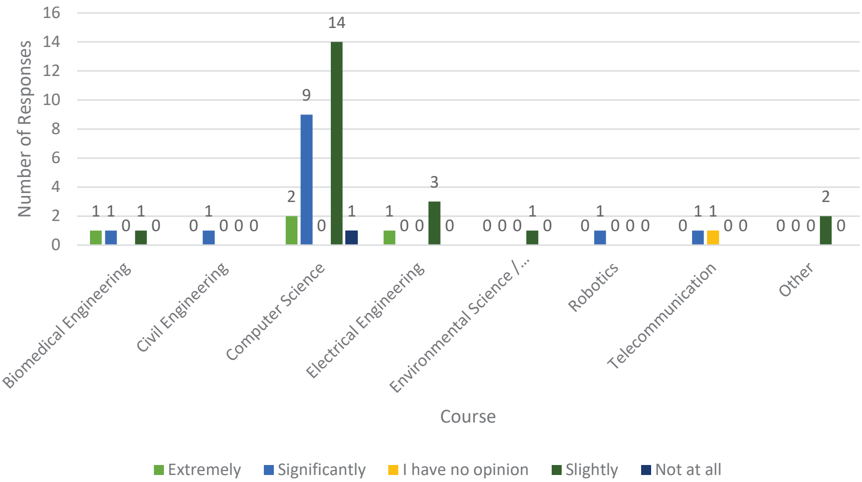

Figure 2. Master's Students – VR and Understanding of Complex Academic Content

N o t e: Data collected and analysed by the authors.

Figures 1 and 2 show how students perceive the potential of VR to enhance their understanding of complex academic content (RQ2). It appears that almost half of the respondents overall (45%), including both BSc and MSc students, believe that VR can help to a significant extent, with some variation across disciplines (e.g., BSc: 50% of Architecture, 56% of Chemistry, 80% of Civil Engineering, 45% of IT, 38% of Electrical Engineering, 60% of Mechanical Engineering, 50% of Robotics and 60% of Telecommunication; MSc: 42% of IT). Some students have no opinion (BSc: 11.6%, MSc: 2.5%), which means that almost the same proportion of bachelor's students (43.6%) and an even higher proportion of master's students (52.5%) think that the incorporation of VR will not contribute to them being able to gain a better understanding of complex issues related to their specialisation.

When it comes to retaining knowledge developed due to using VR-enhanced materials in class, addressed in RQ2, (Figs. 3 and 4), 55% of bachelor's students and 57.5% of master's students are of the opinion that using VR will be beneficial (e.g., BSc: 75% of Architecture, 67% of Chemistry, 60% of Civil Engineering, 45% of IT, 52% of Electrical Engineering, 67% of Mechanical Engineering, 50% of Robotics and 46% of Telecommunication; MSc: 61.5% of IT). Because slightly higher proportions of bachelor's and master's students do not have an opinion compared with the previous question – 18.6% and 7.5% respectively – a decrease in negative attitudes towards VR can be noticed (26.4% and 35%) if knowledge retention is taken into consideration.

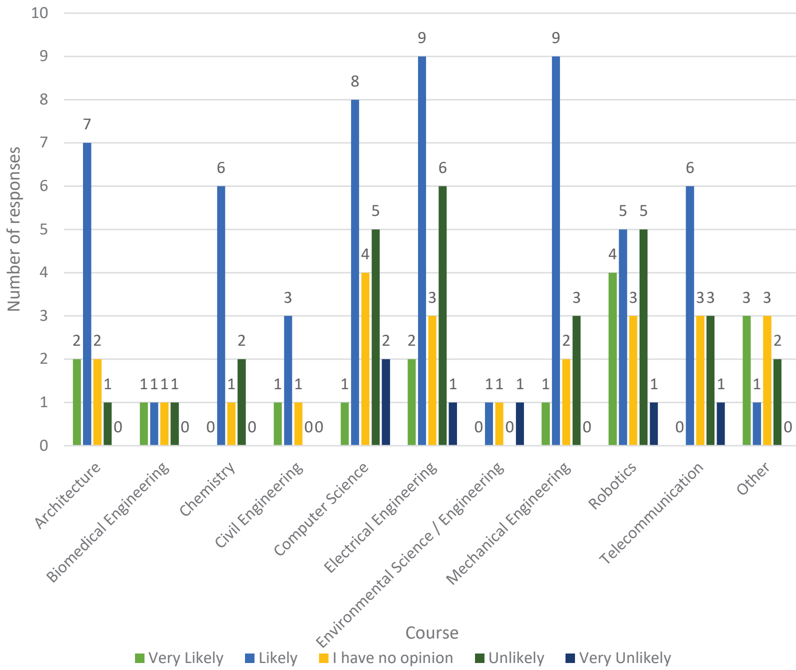

Figure 3. Bachelor's Students – VR and Knowledge Retention

N o t e: Data collected and analysed by the authors.

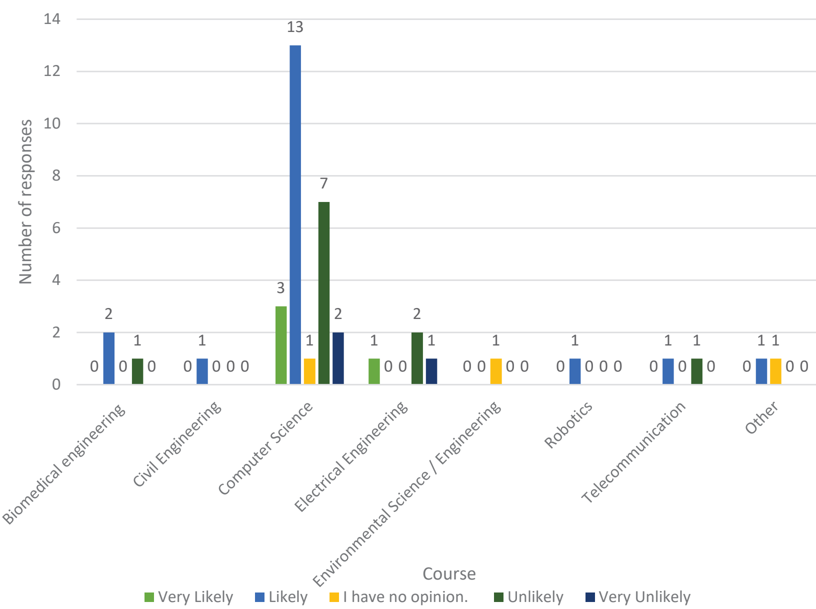

Figure 4. Master's Students – VR and Knowledge Retention

N o t e: Data collected and analysed by the authors.

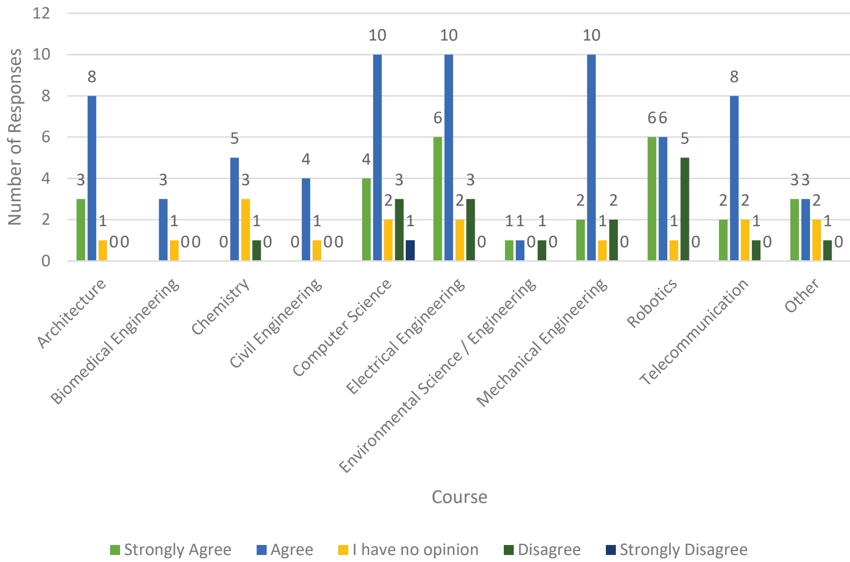

Figure 5. Bachelor's Students – Engaging Nature of VR

N o t e: Data collected and analysed by the authors.

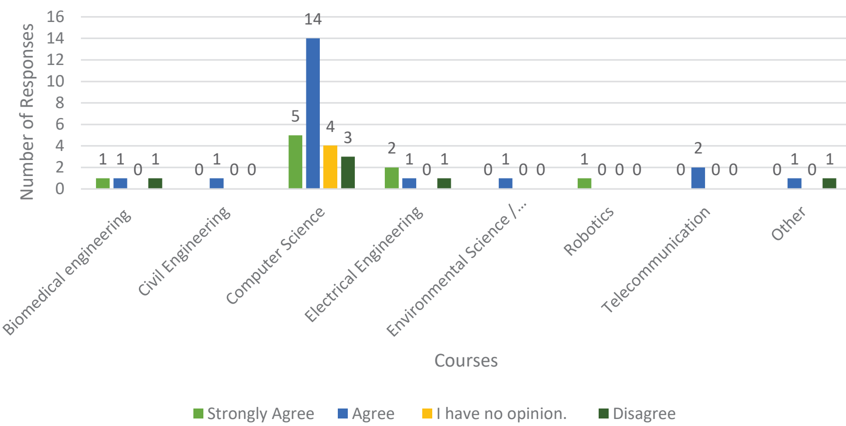

Figure 6. Master's Students – Engaging Nature of VR

N o t e: Data collected and analysed by the authors.

Figures 5 and 6 show students' high beliefs in the engaging nature of VR-based learning (RQ3). Unlike, the previous responses, which indicate a relatively low positive response towards VR, the answers about engagement, which are 74% and 75%, reflect more positive anticipation, with some variation across the sample (e.g., BSc: 92% of Architecture, 75% of Biomedical Engineering, 55.5% of Chemistry, 80% of Civil Engineering, 45% of IT, 76% of Electrical Engineering, 66.7% of

Environmental Engineering/Science, 80% of Mechanical Engineering, 66.7% of Robotics and 46% of Telecommunication; MSc: 73% of IT).

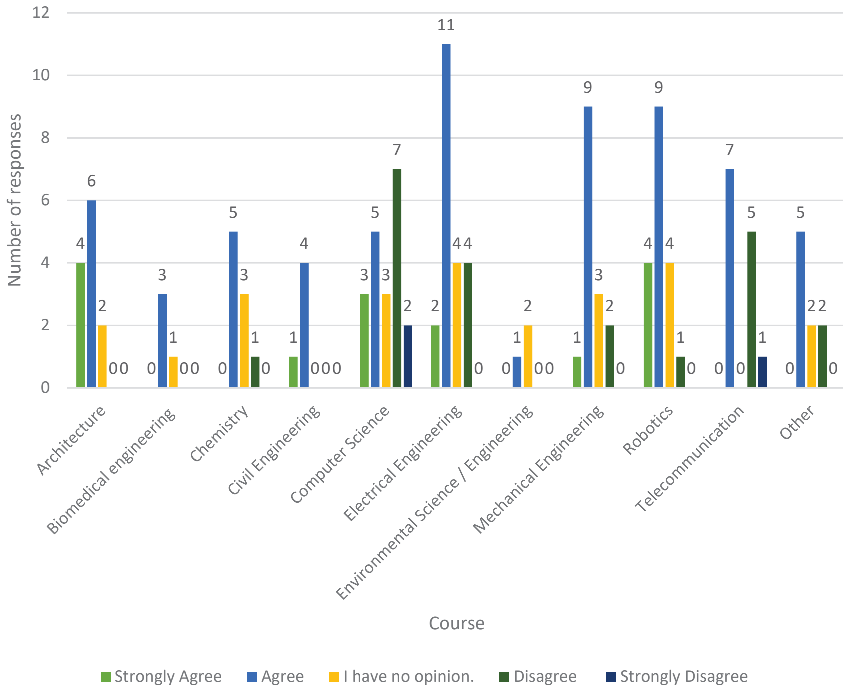

Figure 7. Bachelor's Students – VR and More Realistic and Immersive Experiences

N o t e: Data collected and analysed by the authors.

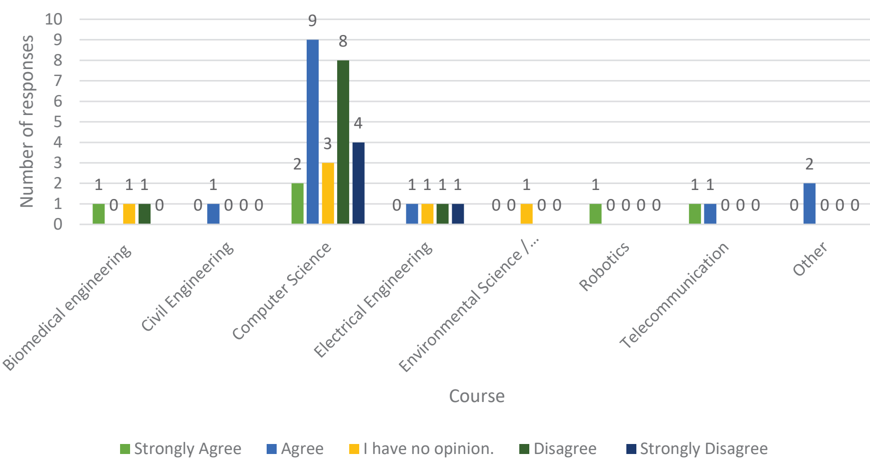

Figure 8. Master's Students – VR and More Realistic and Immersive Experiences

N o t e: Data collected and analysed by the authors.

As can be seen in Figures 7 and 8, overall bachelor's students expect VR-enhanced education to provide more realistic and immersive experiences than traditional classes – 62% and 47.5% respectively (RQ1). This can be explained by their earlier stage of professional development, which triggers high hopes, or their lower IT knowledge, which limits their understanding of VR possibilities (e.g., BSc: 83% of Architecture, 75% of Biomedical Engineering, 55.5% of Chemistry, 80% of Civil Engineering, 40% of IT, 62% of Electrical Engineering, 33.3% of Environmental Engineering/Science, 66.7% of Mechanical Engineering, 72% of Robotics and 54% of Telecommunication; MSc: 42% of IT). A relatively high number of BSc students (18.6%) and MSc students (12.5%) have no opinion. Twice as many master's students (40% and 19.4% respectively) do not perceive VR experiences as realistic or immersive.

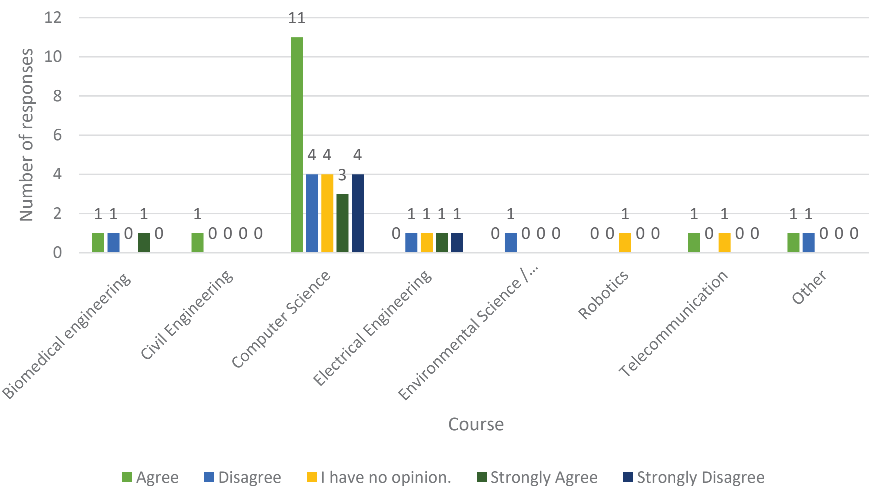

Figure 9. Bachelor's Students – VR and Motivation to Learn

N o t e: Data collected and analysed by the authors.

Generally speaking, as illustrated by the data in Figures 9 and 10, only about half of the respondents think that VR in academic settings can increase their motivation to learn (RQ3) – 51% of bachelor's students and 50% of master's students, showing minimal differences across specialisations (e.g., BSc: 50% of Architecture, 50% of Biomedical Engineering, 55.5% of Chemistry, 80% of Civil Engineering, 50% of IT, 43% of Electrical Engineering, 66.7% of Environmental Engineering/Science, 40% of Mechanical Engineering, 55.5% of Robotics and 54% of Telecommunication; MSc: 53.8% of IT). Almost a quarter of BSc students (24.2%) and nearly a third of MSc students (32.5%) are of the opinion that VR will not positively affect their motivation to learn.

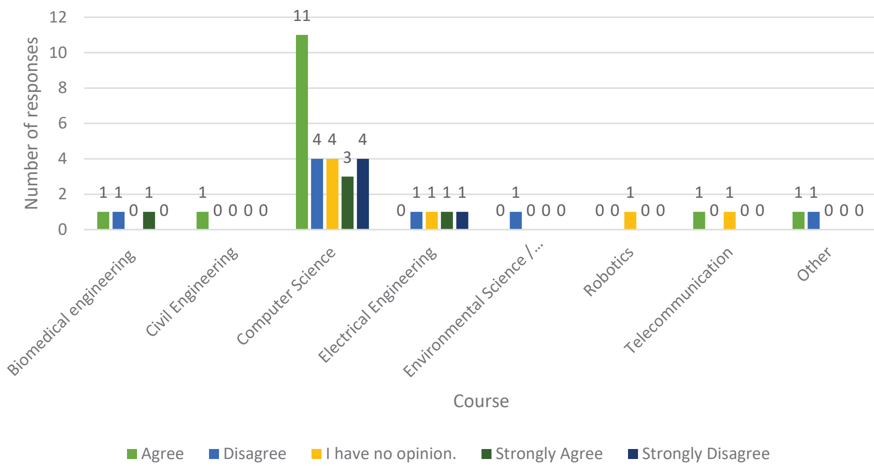

Figure 10. Master's Students – VR and Motivation to Learn

N o t e: Data collected and analysed by the authors.

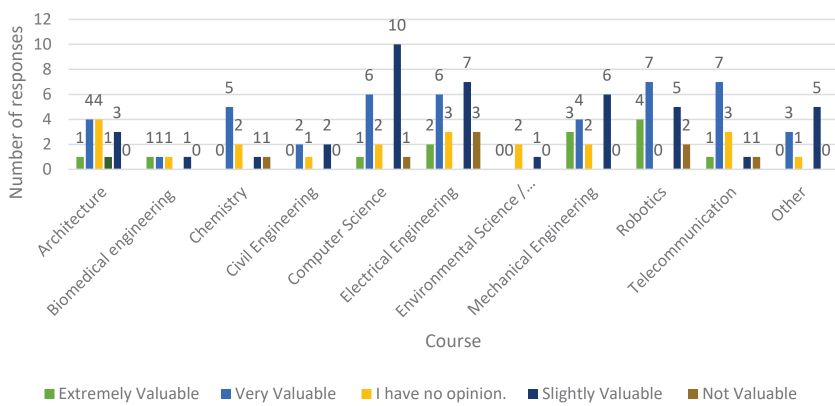

Figure 11. Bachelor's Students – VR and Real-World or Industry-Specific Tasks

N o t e: Data collected and analysed by the authors.

Fewer than half of the respondents – 45% of BSc students and 37.5% of MSc students – believe that VR can deliver experiences preparing them very well or even extremely well for real-world or industry-specific tasks (RQ1) (e.g., BSc: 42% of Architecture, 50% of Biomedical Engineering, 55.5% of Chemistry, 40% of Civil Engineering, 35% of IT, 38% of Electrical Engineering, 46.7% of Mechanical Engineering, 61% of Robotics and 61% of Telecommunication; MSc: 38.5% of IT), with 32.5% of bachelor's students and 45% of master's students seeing some advantages in this area (see Figures 11 and 12). This shows the most positive attitude altogether compared with the way the respondents perceive an increase in knowledge retention, understanding university subjects, engagement and motivation, only as few as 6.2% and 5% respectively negate the educational usefulness of VR in preparation for workplace-relevant tasks.

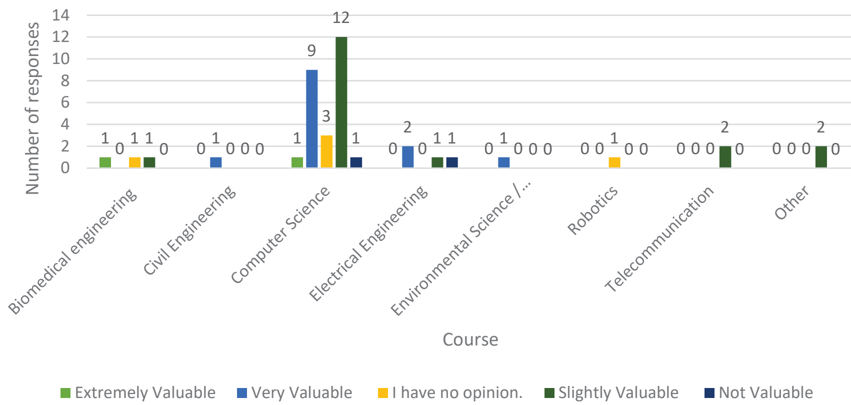

Figure 12. Master's Students – VR and Real-World or Industry-Specific Tasks

N o t e: Data collected and analysed by the authors.

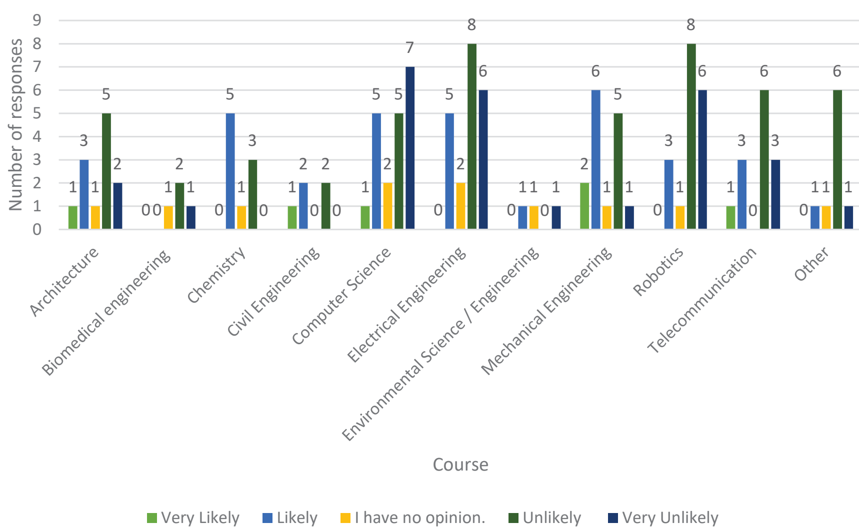

Figure 13. Bachelor's Students – VR as a More Widely Used Teaching Tool

N o t e: Data collected and analysed by the authors.

As Figures 13 and 14 indicate, almost the same number of respondents in both groups – 31% of BSc students and 32.5% of master's students – believe that VR will be incorporated into university curricula within the next five years – the issue addressed in RQ4, (e.g., BSc: 33.3% of Architecture, 55.5% of Chemistry, 60% of Civil Engineering, 30% of IT, 23.8% of Electrical Engineering, 33.3% of Environmental Engineering/Science, 53.3% of Mechanical Engineering, 16.7%

of Robotics and 30.7% of Telecommunication; MSc: 23% of IT), which does not reflect strong enthusiasm for this type of technological innovation in education. More than 60% (60.5% and 65% respectively) do not expect VR to have any impact on university teaching in the near future. The reasons the respondents chose are shown in Figures 15 and 16.

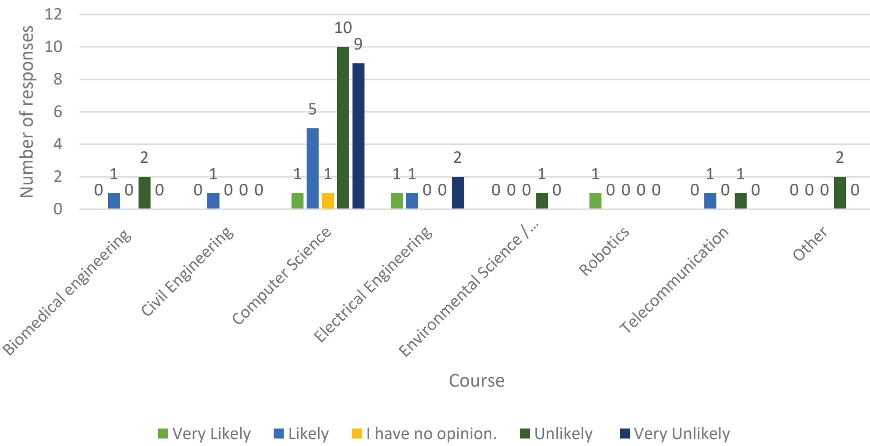

Figure 14. Master's Students – VR as a More Widely Used Teaching Tool

N o t e: Data collected and analysed by the authors.

As shown in Figures 15 and 16, BSc respondents identify motivation, engagement, personalisation, immersive experiences, and technological novelty as the main reasons why educators might be willing to enhance their classes with VR, with a total of 141 responses. Specifically, 32 BSc and 10 MSc students cited VR's potential to enhance engagement and motivation; 31 BSc and 10 MSc students mentioned technological advancements; 24 BSc and 6 MSc students highlighted support for personalised and immersive learning experiences (RQ1 and RQ4). Decreasing cost was also frequently noted (BSc 17, MSc 7).

Conversely, the most commonly selected reasons for why VR may not be incorporated into teaching reflect students' scepticism about its near-future adoption: high cost (BSc 65, MSc 19), educators' reluctance to implement major changes in teaching methods (BSc 51, MSc 14), and a preference for traditional approaches (BSc 44, MSc 14). Other factors mentioned include insufficient training and support for educators, and a perceived lack of added value. Negative reasons were chosen twice as often, totalling 287 responses. This may help explain why only about one third of the students predict the introduction of VR-enhanced education within the next five years.

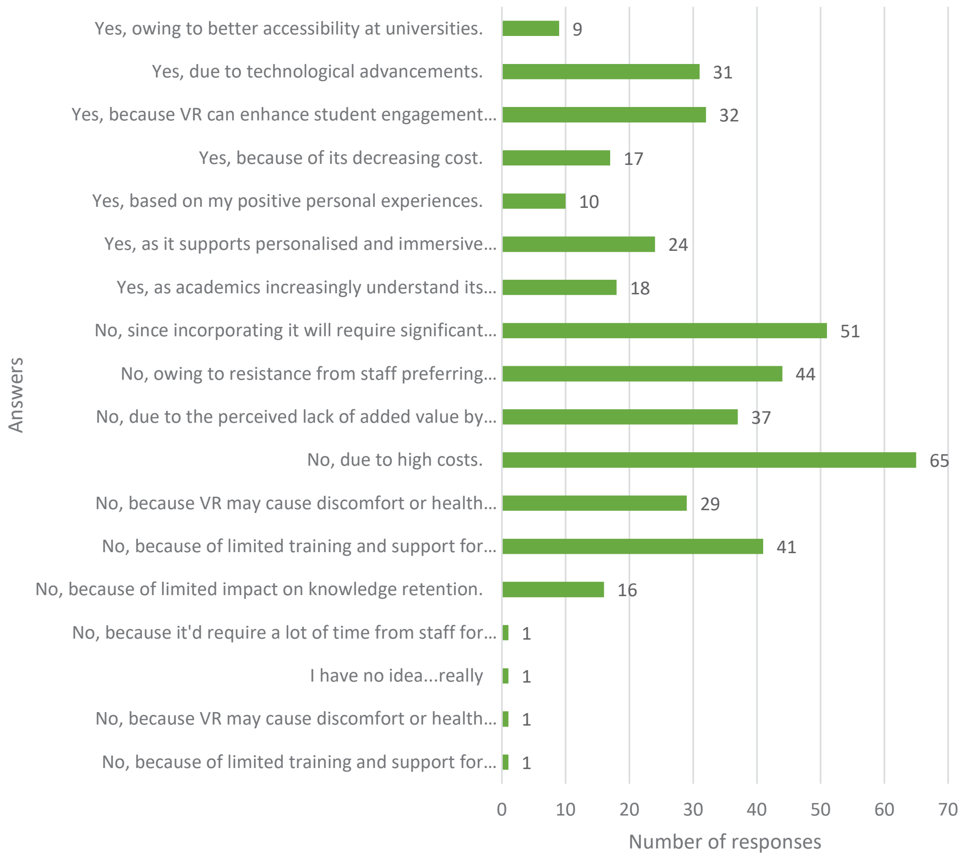

Figure 15. Bachelor's Students – Likelihood of VR Being Used in University-Level Education

N o t e: Data collected and analysed by the authors.

The respondents seem to be quite appreciative of the possible incorporation of VR into university education (RQ4) (see Figures 17 and 18). Almost three thirds (73% of bachelor's Students and 72.5% of master's students) express their support for such an initiative (e.g., BSc: 91.7% of Architecture, 50% of Biomedical Engineering, 55.5% of Chemistry, 100% of Civil Engineering, 75% of IT, 81% of Electrical Engineering, 33.3% of Environmental Engineering/Science, 86.7% of Mechanical Engineering, 66.7% of Robotics and 69% of Telecommunication; MSc: 73% of IT). Only 7% of BSc students and 10% of master's students appear to be reluctant to see teaching methods enhanced with VR integrated into their courses.

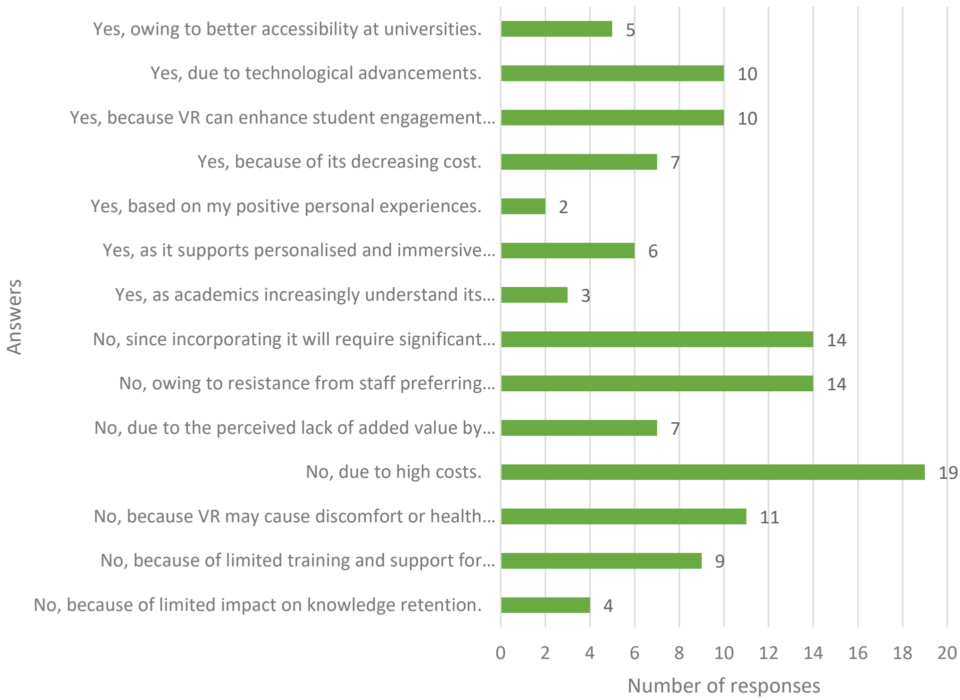

Figure 16. Master's Students – Likelihood of VR Being Used in University-Level Education

N o t e: Data collected and analysed by the authors.

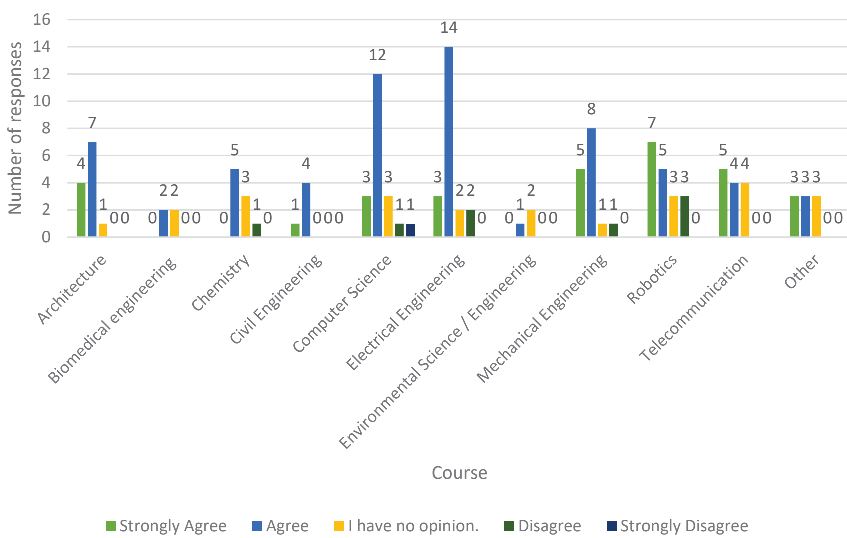

Figure 17. Bachelor's Students – VR-Based Education in the Future

N o t e: Data collected and analysed by the authors.

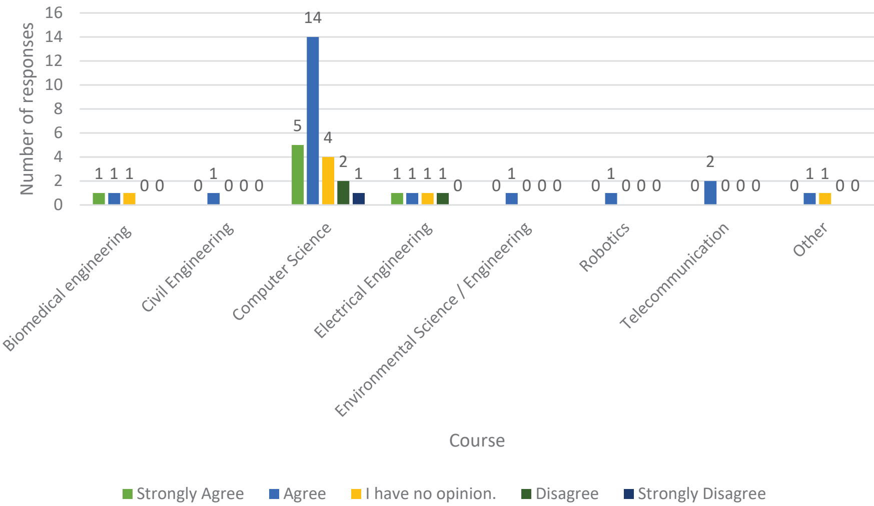

Figure 18. Master's Students – VR-Based Education in the Future

N o t e: Data collected and analysed by the authors.

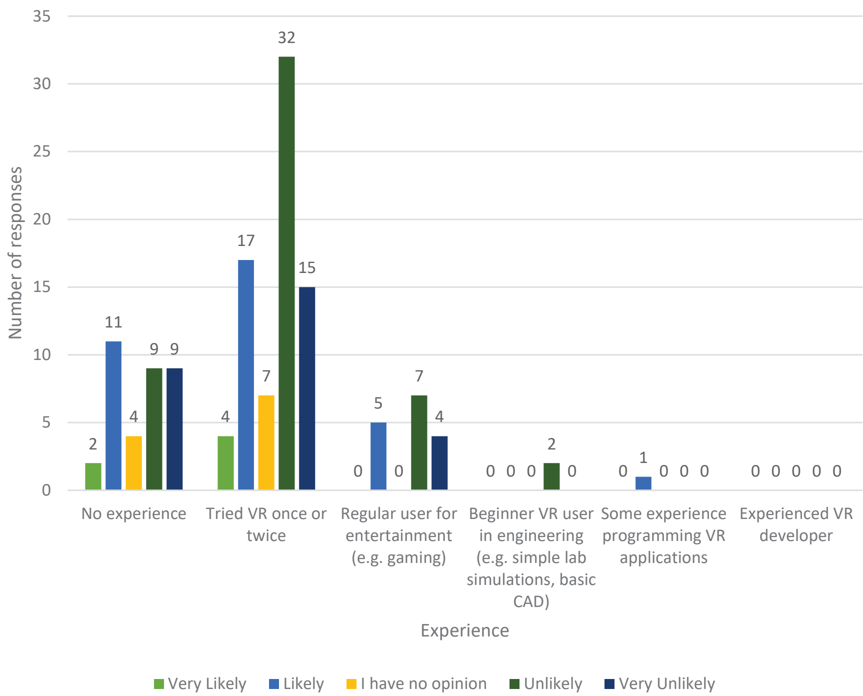

Figure 19. BSc Students' VR Experience and their Attitude Towards VR-Enhanced Classes

N o t e: Data collected and analysed by the authors.

Although the respondents do not expect VR-based classes to be introduced into university education in the near future, they express a desire to see a shift towards this pedagogical innovation. Even if they do not perceive its added value as particularly significant or beneficial, they maintain a positive attitude towards potential VR-based activities or resources that could supplement the learning opportunities with which they are already familiar. If so, educators should adopt an active learning approach to redesign their educational materials, and integrate VR-based activities in a way that enhances student engagement, promotes learning by doing, and supports the development of various skills relevant to their field of study and job market requirements.

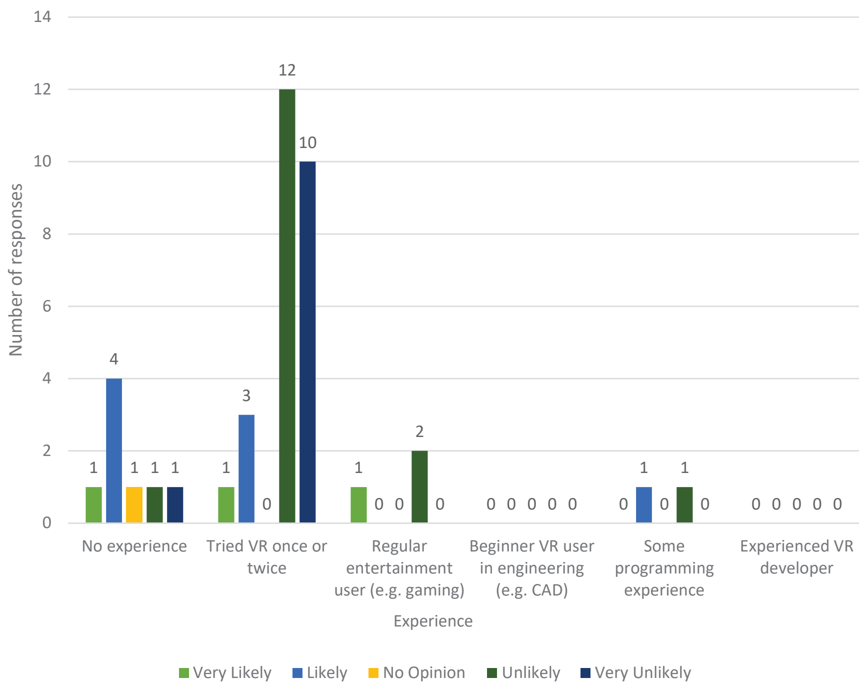

Figure 20. MSc Students' VR Experience and their Attitude Towards VR-Enhanced Classes

N o t e: Data collected and analysed by the authors.

As can be seen in Figure 19, a substantial number of BSc students with some degree of VR experience think that it will not be used to enhance university courses (RQ5) – they tend to associate it more with entertainment than to attribute educational value to it. The analysis of their responses shows that there is no statistically significant association between bachelor's students' VR experience and their attitude towards adopting VR-enhanced classes (χ^2= 9.03; *p-value* = *0.7*) – prior VR experience does not strongly predict whether they are likely or unlikely to be advocates of VR settings. However, several cells in the contingency table contained frequencies below five. To address this, in addition to the standard Chi-Square Test of Independence, a Monte Carlo simulation with 10,000 replicates was conducted to estimate *p-values* ($\chi^2 = 11.87$, simulated $p = 0.709$), confirming the initial result. Furthermore, Fisher's Exact Test was performed, as it is more reliable with sparse data, and also supported this finding ($p = 0.764$).

For the much smaller master's dataset ($n = 39$) (Fig. 20), the standard Chi-Square Test was applied ($\chi^2=18.56$; $p = 0.1$). Similar to the bachelor's sample, some contingency table cells had expected frequencies below five; therefore, a Monte Carlo simulation was again used to compute *p-values* ($\chi^2 = 18.56$, simulated $p = 0.146$). To further validate these findings, Fisher's Exact Test was also performed, which yielded a statistically significant result ($p = 0.027$). This suggests a potential association between master's students' prior VR experience and their positive attitudes towards adopting VR in education. Besides, master's students' IT expertise is higher, as is their general competence with more advanced subject-related educational activities, so their views may differ at least to some extent from bachelor's students. However, testing the association between high IT skills in MSc students and their attitude towards VR-based inclusions requires further research.

The present findings echo, to some degree, those reported in earlier studies. For example, research by Keskitalo (2012) found that healthcare students held relatively high expectations regarding the use of VR, with 67% of the respondents reporting that they expected "quite a lot" or "a lot." The findings, based on the variable *individual* and *competence-based studying*, suggested that the students anticipated opportunities to build upon their prior knowledge and to set personal learning goals. They also expected to become familiar with and practise using the professional equipment represented in VR and relevant to their future work, although the relatively high standard deviation indicated variability in these expectations. Moreover, the students expected their learning experiences in VR and simulation-based learning environments (SBLEs) to enhance understanding through practical application. They also anticipated that the equipment would be easy to use and that they would develop a high level of proficiency by the end of the course.

On the other hand, Alsalameen et al. (2023) found that their participants' responses on the performance expectancy dimension were close to neutral, suggesting that they were not yet fully aware of the potential usefulness of virtual reality (VR) in their education and future professional practice. They contrasted with previous research suggesting that students considered VR to be useful but experienced difficulties adapting to it. The study further revealed positive and significant relationships between students' perceptions of effort expectancy, performance expectancy, social influence, price value, and habit, and their behavioural intention to use VR in education. Among these factors, performance expectancy showed the strongest association with students' behavioural intention to use VR, while price value exhibited the weakest relationship.

Also, Matome and Jantjies (2021) found that, overall, students' expectations regarding the effectiveness of VR in higher education were moderate rather than excessively high. When asked what they expected from a VR-supported digital learning system, only 15% of the respondents anticipated that VR would provide realistic learning experiences, such as visiting nature reserves. In contrast, 5% of the students believed that a VR-based learning experience might negatively affect their learning. Just over one-fifth of the respondents expected VR to enhance their educational capabilities, both within formal institutions and through individual use. In terms of perceived advantages of integrating VR into higher education, 22% of the students reported that they could not identify any clear benefits. However, 20% viewed VR as an opportunity to gain practical experience rather than relying solely on theoretical learning, which aligns with what Keskitalo (2012) reported, and 19% anticipated that it could improve their learning and knowledge retention. Furthermore, 10% believed that the greatest benefit would be the ability to access and interact with course content remotely, while the remaining 16% highlighted increased interaction with learning materials as the key advantage of a VR-enhanced higher education system, which has not been reported by the present study.

Conclusion

Key findings reported in the literature highlight the most frequently applied teaching methods associated with VR-based education, with experiential learning, project- and problem-based approaches being the most common, while collaborative and game-based methods appear less frequently than anticipated (Zontou et al., 2024, p. 879). However, criticism has also been voiced – as it has been found that some problematic implementations may have resulted from merely replicating or recreating physical classrooms and relying on inadequate instructivist methods (Lege & Bonner, 2020, p. 172). This complies with the survey analysis, which indicates that the students of Gdańsk Tech see academics' unwillingness to adopt active learning methods as one of the major obstacles to the inclusion of VR into education.

The main health concern with VR is cybersickness, which can cause nausea, dizziness, headaches, sweating, eye strain, and disorientation (Ghazali et al., 2024, p. 10) – the literature presents it as a deterrent preventing students from embracing such an educational environment, with which some of the survey participants concurred in their comments. Hence, future research should address precautionary measures, such as limiting session duration and considering the type of VR technology, to help educators deliver the safest possible experiences.

Conventional teaching methods are gradually being replaced by new active learning approaches. This shift is driven by the recognition that educators need to provide students with innovative ways of building knowledge that are suited to a modern society. Virtual reality is among the technological innovations expected to help transform educational experiences into interactive and immersive learning environments. However, higher levels of immersion in VR may not necessarily enhance learning outcomes. Lege and Bonner (2020, p. 174), following previous research, argue that the complexity of immersive VR can generate extraneous cognitive load, which diverts students from essential learning and may reduce the effectiveness of the educational experience; it can also lead to a decrease in knowledge development due to the processing demands of working memory. This seems to be echoed in the respondents' attitudes, who, generally speaking, perceive VR more in terms of its entertainment or illustrative value than as an actively educational tool.

To effectively integrate VR-based activities into education, educators need to restructure their curricula according to constructivist principles (Mokwa-Tarnowska, Tarnowska & Roszak, 2023; Mokwa-Tarnowska, 2017), creating learning environments that are active and learner-centred (Reinfried, 2000). A constructivist classroom encourages a shift in control from teachers to students, supporting autonomy, exploration, and the development of higher-order thinking skills. By using authentic materials within VR settings, students can engage in meaningful learning experiences that promote skills ranging from comprehension and interpretation to the application of new concepts in context (Kołodziejczak, Mokwa-Tarnowska & Roszak, 2017). The inclusion of pictures, videos, and interactive visualisations in VR environments provides powerful visual stimuli, helping learners grasp complex material and construct new knowledge frameworks similar to those of expert users or native speakers.

Constructivism places emphasis on individualisation and learner autonomy, ensuring that learning is tailored to diverse student needs. Because no group of learners is entirely homogeneous, VR-based educational environments can support differentiation by allowing flexibility and learner choice, which in turn fosters motivation and engagement.

Another key constructivist concept is process-related awareness, which transforms traditional classrooms into spaces that promote reflection on learning itself. Within VR contexts, students can develop this awareness through contextualised self-assessment tools, such as multiple-choice, matching, gap-filling tasks and game-based activities, as well as through problem-solving, analytical reasoning, and production activities, involving a VR setting and traditional classroom-based activities. These immersive, process-oriented experiences can help students acquire skills essential for work-oriented and lifelong learning.

Contrary to a great deal of enthusiasm towards the adoption of VR-based materials expressed by educators in the literature in recent years, technically-minded students overall have doubts about its effectiveness in academic education, particularly among the larger sample of BSc students. They appear to be slightly sceptical and hesitant to acknowledge its presumed added value, possibly due to their IT expertise and their prior experience of traditional, instructivist settings in their university courses. They noted that the time required to understand how to use such applications and learn from them is often disproportionate to the gains in subject-related knowledge and skills development. Hence, educators should proceed with caution, balancing innovation with well-grounded pedagogical strategies to ensure that VR serves as a meaningful enhancement rather than a superficial addition.

References

AlGerafi, M. A., Zhou, Y., Oubibi, M., & Wijaya, T. T. (2023). Unlocking the potential: A comprehensive evaluation of augmented reality and virtual reality in education. *Electronics*, *12*(18), 3953. https://doi.org/10.3390/electronics12183953

Almulqu, A. A., Atmaja, S. A., & Hutabarat, R. A. (2025). Integration of Virtual Reality in STEM to Enhance Problem Solving Skills in Science Learning in the 21st Century: A Review. *Jurnal Penelitian Pendidikan IPA*, *11*(3), 11–18. https://doi.org/10.29303/jppipa.v11i3.10483

Anjos, F. E. V. D., Martins, A. D. O., Rodrigues, G. S., Sellitto, M. A., & Silva, D. O. D. (2024). Boosting engineering education with virtual reality: An experiment to enhance student knowledge retention. *Applied System Innovation*, 7(3), 50. https://doi.org/10.3390/asi7030050

Alsalameen, R., Almazaydeh, L., Alqudah, B., & Elleithy, K. (2023). Information Technology Students' Perceptions Toward Using Virtual Reality Technology for Educational Purposes. International Journal of Interactive Mobile Technologies, 17(7). https://doi.org/10.3991/ijim.v17i07.37211

Bodzin, A., Junior, R. A., Hammond, T., & Anastasio, D. (2021). Investigating engagement and flow with a placed-based immersive virtual reality game. *Journal of science education and technology*, 30(3), 347–360. https://doi.org/10.1007/s10956-020-09870-4

Erolin, C., Reid, L., & McDougall, S. (2019). Using virtual reality to complement and enhance anatomy education. *Journal of Visual Communication in Medicine*, *42*(3), 93–101. https://doi.org/10.1080/17453054.2019.1597626

Ghazali, A. K., Ab. Aziz, N. A., Ab. Aziz, K., & Tse Kian, N. (2024). The usage of virtual reality in engineering education. *Cogent Education*, *11*(1), 2319441. https://doi.org/10.1080/2331186X.2024.2319441

Keskitalo, T. (2012). Students' expectations of the learning process in virtual reality and simulation-based learning environments. *Australasian Journal of Educational Technology*, *28*(5). https://doi.org/10.14742/ajet.820

Kowalski, S., Lebiedź, J., Parinello, S., & Picchio, F. (2024). New skills for architects: 3D scanning for an immersive experience in architectural education. *Global Journal of Engineering Education*, *26*, 115–121. https://mostwiedzy.pl/en/publication/new-skills-for-architects-3d-scanning-for-an-immersive-experience-in-architectural-education,163020-1

Lampropoulos, G., Fernández-Arias, P., de Bosque, A., & Vergara, D. (2025). Virtual Reality in Engineering Education: A Scoping Review. *Education Sciences*, *15*(8), 1027. https://doi.org/10.3390/educsci15081027

Lampropoulos, G., Keramopoulos, E., Diamantaras, K., & Evangelidis, G. (2022). Augmented reality and virtual reality in education: Public perspectives, sentiments, attitudes, and discourses. *Education Sciences*, *12*(11), 798. https://doi.org/10.3390/educsci12110798

Lampropoulos, G., & Kinshuk (2024). Virtual reality and gamification in education: A systematic review. *Education Technology Research and Development*, 72(3), 1691–1785. https://doi.org/10.1007/s11423-024-10351-3

Lebiedź, J. (2024). The Drawing Paradigm between Representation and Interaction with Virtual Image. *TRIBELON Journal of Drawing and Representation of Architecture, Landscape and Environment*, *1*(2), 86–95. https://doi.org/10.36253/tribelon-2946

Lege, R., & Bonner, E. (2020). Virtual reality in education: The promise, progress, and challenge. *The jalt call Journal*, *16*(3), 167–180. https://doi.org/10.29140/jaltcall.v16n3.388

Matome, T. J., & Jantjies, M. (2021). Student perceptions of virtual reality in higher education. In *Balancing the tension between digital technologies and learning sciences* (pp. 167–181). Cham: Springer International Publishing. https://eric.ed.gov/?id=ED608662

Mazhar, A. A., & Al Rifaee, M. M. (2023, August). A Systematic Review of the use of Virtual Reality in Education. In *2023 International Conference on information technology (ICIT),* pp. 422–427. IEEE. https://doi.org/10.1109/ICIT58056.2023.10225794

Merchant, Z., Goetz, E. T., Cifuentes, L., Keeney-Kennicutt, W., & Davis, T. J. (2014). Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis. *Computers & Education*, 70, 29–40. https://doi.org/10.1016/j.compedu.2013.07.033

Mohammadi, Z., Mojtahedzadeh, R., Najimi, A., Alizadeh, M., & Mohammadi, A. (2025). Identifying key drivers affecting the future of virtual reality in medical education. *Journal of Education and Health Promotion*, *14*(1), 97. https://doi.org/10.4103/jehp.jehp_1874_23

Mokwa-Tarnowska, I., Tarnowska, V., & Roszak, M. (2023). The Appeal of Gamification for Master's Students of Science and Technology. *International Journal of Research in E-learning*, *9*(1), 1–18. https://doi.org/10.31261/IJREL.2023.9.1.03

Mokwa-Tarnowska, I., & Tarnowska, V. (2019). Web-enhanced secondary and academic education structured around expectations and learning preferences of Generation Z. *E-learning*, *11*, 217–232. https://doi.org/10.34916/el.2019.11.14

Mokwa-Tarnowska, I. (2017). *E-learning i blended learning w nauczaniu akademickim: zagadnienia metodyczne [E-Learning and blended learning in academic education: teaching aspects]*. Gdańsk: Wydawnictwo Politechniki Gdańskiej. ISBN/ISSN 978-83-7348-613-3.

Reinfried, M. (2000). Can radical constructivism achieve a viable basis for foreign language teaching?- A refutation of the 'Wolff-Wendt' theorem. EESE 8/2000. Retrieved from http://webdoc.gwdg.de/edoc/ia/eese/artic20/marcus/8_2000.html

Sung, H., Kim, M., Park, J., Shin, N., & Han, Y. (2024). Effectiveness of virtual reality in healthcare education: Systematic review and meta-analysis. *Sustainability*, *16*(19), 8520. https://doi.org/10.3390/su16198520

Tekindur, A. & Kara, S. (2025). Virtual reality technology in science education: Exploring trends and future perspectives. Journal of Education in Science, Environment and Health (JESEH), 11(3), 220–234. https://doi.org/10.55549/jeseh.802

Zontou, E., Kaminaris, S., & Rangoussi, M. (2024). On the role of virtual reality in engineering education: a systematic literature review of experimental research (2011–2022). *European Journal of Engineering Education*, *49*(5), 856–888. https://doi.org/10.1080/03043797.2024.2369188

Iwona Mokwa-Tarnowska, Viviana Tarnowska

Z perspektywy studentów: Zanurzyć się czy nie zanurzyć w nowe doświadczenia edukacyjne?

S t r e s z c z e n i e

Włączanie zasobów i aktywności wspomaganych technologią do programów nauczania na uczelniach wyższych wymaga restrukturyzacji programów dydaktycznych. Aby osiągnąć efekt synergii, tradycyjne metody powinny zostać zastąpione podejściami bazującymi na aktywnym uczeniu się, oferującymi studentom innowacyjne, angażujące i oparte na współpracy sposoby zdobywania wiedzy, dostosowane do wymogów współczesnego społeczeństwa. Wirtualna rzeczywistość (VR) należy do tych nowości technologicznych, które mają potencjał przekształcania edukacji w interaktywne i immersyjne środowisko nauki. Artykuł bada, czy wprowadzenie zasobów i aktywności opartych na VR do dydaktyki uniwersyteckiej może, według studentów, zwiększyć ich zainteresowanie dogłębnym zrozumieniem złożonych zjawisk oraz czy może przełożyć się na większe zaangażowanie i lepsze osiąganie efektów kształcenia. Wyzwania związane z wdrażaniem materiałów edukacyjnych wykorzystujących VR analizowane są na podstawie ankiety, w której wzięli udział studenci studiów inżynierskich i magisterskich Politechniki Gdańskiej, przeprowadzonej w czerwcu i lipcu 2025 roku.

S ł o w a k l u c z o w e: wirtualna rzeczywistość, VR, edukacja, skuteczność, zastosowania VR, efekty kształcenia

Iwona Mokwa-Tarnowska, Viviana Tarnowska

A través de los visores de los estudiantes universitarios: sumergirse o no sumergirse en nuevas experiencias de aprendizaje

R e s u m e n

La integración de recursos y actividades apoyados en la tecnología en los planes de estudio universitarios requiere una reestructuración de los programas de enseñanza. Para lograr un efecto sinérgico, los métodos convencionales deben ser sustituidos por enfoques de aprendizaje activo que ofrezcan a los estudiantes formas innovadoras, motivadoras y colaborativas de construir conocimiento, adaptadas a la sociedad contemporánea. La realidad virtual (VR) se encuentra entre las innovaciones tecnológicas llamadas a transformar la educación en entornos de aprendizaje interactivos e inmersivos. Este artículo analiza si la integración de la VR en los cursos universitarios puede, en opinión de los estudiantes, aumentar su interés por una comprensión más profunda de fenómenos complejos y si esto podría traducirse en un mayor compromiso y en una mejora en el logro de los resultados de aprendizaje. Los desafíos de implementar este tipo de diseño instruccional se examinan a partir de un análisis de las respuestas de estudiantes de grado y máster de la Universidad Tecnológica de Gdansk (Gdańsk Tech), recogidas en junio y julio de 2025.

P a l a b r a s c l a v e: realidad virtual, VR, educación, eficacia, aplicaciones de VR, resultados de aprendizaje

Ивона Мoква-Тарновская, Вивиана Тарновская

С точки зрения учащихся: погружаться или не погружаться в новый учебный опыт

Аннотация

Интеграция ресурсов и видов деятельности, усиленных технологиями, в учебные программы университетов требует их реструктуризации. Для достижения синергического эффекта традиционные методы должны быть заменены подходами активного обучения, предлагающими студентам инновационные, увлекательные и коллаборативные способы построения знаний, адаптированные к потребностям современного общества. Виртуальная реальность (VR) относится к тем технологическим инновациям, от которых ожидается трансформация образования в направлении интерактивных и погружных сред обучения. В статье исследуется, может ли интеграция VR в учебные курсы университетов, по мнению студентов, повысить их интерес к более глубокому пониманию сложных явлений и может ли это привести к большему вовлечению и улучшению достижения результатов обучения. Вызовы внедрения такого инструкционного дизайна проанализированы на основе результатов опроса студентов бакалавриата и магистратуры Гданьского политехнического университета (Gdańsk Tech), проведенного в июне-июле 2025 года.

Ключевые слова: виртуальная реальность, VR, образование, эффективность, применение VR, результаты обучения