**Edelweiss Applied Science and Technology**
*ISSN: 2576-8484*
*Vol. 8, No. 5, 1445-1453*
*2024*
*Publisher: Learning Gate*
*DOI: 10.55214/25768484.v8i5.1847*


# Educational utilization of virtual and mixed reality

SangHun Nam[1]*
[1]Department of Culture and Technology, Changwon National University, Korea, sanghunnam@changwon.ac.kr (S.N.)

**Abstract:** This study investigated the application and acceptance of virtual reality (VR) and mixed reality (MR) technologies in university education. Here, university freshmen were introduced to these technologies and surveyed to assess their perceptions of VR and MR systems when applied in educational settings. The results demonstrate that the participants generally responded positively to both technologies, with VR being rated higher in terms of enjoyment and perceived usefulness. The findings suggest that students are more inclined to use VR in future educational settings. MR also received favorable evaluations; however, it received lower evaluations, particularly in terms of ease of use, which is likely due to the participants' relative inexperience with the technology. The findings of this study highlight the potential of VR and MR technologies as effective educational tools and emphasize the importance of leveraging their respective advantages.
***Keywords:*** *Educational technology, Immersive learning, Mixed reality, Student engagement, Virtual reality.*

## 1. Introduction

Emerging advanced technologies have considerable impacts on various sectors of industry and society. Advanced technologies lead to the development of new consumer culture and new media trends; thus, educational institutions provide training to cultivate talent that can utilize such advanced technologies in emerging industries. Advanced technologies are utilized in university education to enhance conventional teaching methods and establish new learning paradigms. For example, virtual reality (VR) and mixed reality (MR) technologies have potential to transform university education. Conventional teaching methods involve passive learning through lectures and textbooks; however, classes that utilize VR and MR encourage students to actively participate in learning through interaction with educational programs. Thus, immersive technologies, e.g., VR and MR, have a positive impact on student engagement and performance [1].

To motivate student interest and provide new learning experiences, immersive learning content that utilizes VR and MR technologies should be presented differently from conventional teaching methods. By offering virtual environments and scenarios tailored to the subject matter, students can understand educational content within an immersive learning environment [2, 3]. In addition, by utilizing immersive devices, students can engage multiple senses, e.g., sight, hearing, and touch, thereby gaining a richer learning experience [4]. Through interaction with educational content, students can enhance their understanding of various situations, and unlike traditional learning methods, which are limited to theoretical approaches, immersive learning facilitates the expansion or contraction of space, the manipulation of time (slowing or speeding up), and the simulation and visualization of virtual information without being constrained by laws of physics. Numerous studies related to immersive learning content have demonstrated that VR and MR technologies enhance learning outcomes by increasing learner engagement [5-8].

University education is increasingly shifting toward cultivating creative and interdisciplinary thinkers, utilizing various digital technologies in the process [9]. Specifically, VR and MR technologies


* Correspondence: sanghunnam@changwon.ac.kr

are widely adopted in higher education and are expected to become increasingly prevalent. These technologies are expected to transform higher education significantly by providing highly immersive and interactive personalized experiences. In addition, the integration of digital educational content with network technologies can extend the reach of university education beyond physical boundaries, thereby leading to a spatially expanded educational environment. In this study, we explored the application of VR and MR content in university education, and we investigated methods to produce and utilize such content. In addition, through surveys to assess student experiences with VR and MR content, this study examined their interest in and perceived usefulness of each technology to identify effective strategies to integrate these technologies into higher education.

## 2. Virtual Reality and Mixed Reality

VR and MR technologies offer novel sensory experiences that typically cannot be realized in everyday life by generating and delivering virtual digital information. Research is ongoing to enhance the realism and immersion of virtual content by incorporating various sensory modalities, including visual and auditory stimuli, and tactile, kinesthetic, olfactory, and gustatory sensations [10]. By tracking the users' body movements and controllers, real-time interactions with the virtual environment can be realized, which increases user immersion by reflecting changes based on user input. In addition, the use of visual and haptic feedback in VR enhances the sense of realism and immersion, making it a prominent area of study, particularly in medical simulations where haptic sensations of the hands are critically important [11, 12].

Similar technologies are employed to implement VR and MR content; however, the contextual characteristics of the content differ due to the distinct hardware and software requirements of each technology [13]. VR technology allows users to interact and engage within a virtual world using various devices, e.g., VR headsets and controllers [14]. The head-mounted displays (HMD) used in VR completely block out the real world to create an immersive user environment. By rendering different images to each eye in real time, considering binocular disparity, users can perceive depth and experience the illusion of being present in a physical space. Previously, HMDs and the personal computers required to operate them were high-end, expensive devices; however, with the recent introduction of standalone HMDs, the lower cost and ease of use have resulted in wider adoption of such devices. In contrast, MR utilizes a see-through approach that combines digital content with the real world to create a hybrid experience where physical and virtual elements coexist and interact in real time. By recognizing the real world spatially and analyzing user movements, virtual information is rendered in real time, which allows the users to feel as though the virtual objects are integrated with the real environment. MR is supported by various devices, e.g., Microsoft's HoloLens and Apple's Vision Pro, which are equipped with sensors that can measure depth information [15].

VR and MR technologies are utilized across various educational fields, with significant applications in medicine, science, technology, history, and foreign language education, and their scope of use is expanding [16, 17]. In addition, the integration of VR and augmented reality (AR) in educational contexts is increasing, thereby leading to the development of diverse educational programs [18]. VR is characterized by its ability to create entirely new spaces, offering users completely novel experiences. Images and videos are typically used in conventional medical education. In contrast, VR-based instruction allows for the use of three-dimensional models and sophisticated surgical simulations, which enables the acquisition of specialized knowledge without time and budget constraints. Medical training that incorporates VR enhances knowledge acquisition and increases educational satisfaction compared to traditional methods [19]. Furthermore, the gamification of VR facilitates engaging and interactive learning, thereby fostering active learning. For example, the application of a virtual reality escape room in biology education, which incorporates escape room game mechanics, has been found to increase knowledge acquisition through active learning approaches in the short term; however, no significant differences were observed in the long term compared with conventional learning methods [20].

AR enhances virtual information by combining the physical world with the digital world using MR displays. When using content based on the real world, AR provides a high sense of realism and allows for the addition of various narratives across different fields. AR is widely used in tourism, education, and entertainment. In the cultural heritage field, AR enriches user experiences by extending cultural content in diverse forms and offering contextually relevant information ranging from past to present to tourists visiting historical sites [21]. In addition, in terms of machinery assembly training and maintenance, rather than modeling an entire complex machine for VR, it is more effective to augment the required information directly onto the real machine during training. It has been demonstrated that using AR programs in training can improve student understanding [22]. MR utilizes specialized display devices to project spatial holograms, which facilitates active user engagement through interactive experiences. For example, when applied in museums, MR systems enhance the visitor's experience by combining historical interaction visualizations with physical artifacts and exhibits, and visitors who have used MR-based tour systems in museums have responded positively [23] . In the case of Mathland, which is an MR application for mathematics education, the HoloLens device has been used to explore mathematical phenomena and facilitate interactive learning, which was found to be effective in terms of immersion, collaborative learning, and problem solving [24]. In anatomy education, an experiment was conducted to compare groups of participants using optical microscopes and HoloLens devices. Both groups achieved similar scores in knowledge assessment; however, the HoloLens group reported higher levels of understanding and rated their learning activities more positively, which suggests that MR provides a beneficial learning experience [25]. In addition, compared with conventional methods, the use of MR in design courses was found to improve geometric analysis skills and creativity considerably [26].

## 3. Preferences for Virtual Reality and Mixed Reality

VR and MR have distinct hardware characteristics and contextual content properties. VR offers highly immersive and concentrated experimental scenarios separate from reality; however, it may induce visual fatigue and sensory overload. In contrast, MR, though less immersive than VR, allows users to interact with their surrounding environment, thereby facilitating simultaneous understanding of virtual elements and the physical world in a realistic context. This makes MR particularly advantageous for educational content that connects learning with real-life applications. Both technologies are being utilized increasingly across various fields, including educational content; thus, their inclusion in university curricula is essential.

This study explored students' preferences for these technologies as part of the curriculum and educational content development. Prior to developing biases through major-specific courses, freshmen were surveyed to determine their preferences for VR and MR technologies, and their preferred application of these technologies in the academic context. As shown in Figure 1, students participated in hands-on experiences using both VR and MR technologies, which was followed by a survey to assess their preferences. The VR experience was conducted using Meta Quest VR headsets, and Microsoft HoloLens 2 devices were utilized in the MR experience. The VR experience involved interaction via controllers, and the MR experience involved interactions using finger gestures.

Before participating in the experiment, 16 students (72.7%) had prior experience with VR, and only two students (9.1%) had experience with MR. The high percentage of VR-experienced students suggests that VR equipment and content are frequently used in exhibitions or experience centers. In contrast, the limited experience with MR devices, e.g., the Microsoft HoloLens or Apple Vision Pro, is likely due to the high hardware costs and lack of available content.

**Figure 1.**
Virtual reality and mixed reality experiences.

A modified version of a questionnaire comprising 20 questions was administered to measure how students accept VR and MR technologies [27]. This questionnaire was designed to assess five factors, i.e., personal innovativeness (four items), perceived enjoyment (six items), perceived ease of use (four items), perceived usefulness (two items), and intention to use (four items). Here, a five-point Likert scale was employed for the user survey, ranging from "(1) Strongly Disagree" to "(5) Strongly Agree." The personal innovativeness factor was assessed as a common item, and the other four factors were evaluated separately after experiencing the VR and MR content to facilitate an effective comparison.

Table 1 shows the results for the personal innovativeness items (questions 1–4), which assess the participants' interest in new technologies. As can be seen, based on the responses to question 1, most participants expressed excitement about trying new technologies. However, as indicated by the responses to question 2, they tend to approach new technologies with caution. In addition, the responses to questions 3 and 4 suggest that the participants have an overall positive attitude toward new technologies.

**Table 1.**
Personal innovativeness.

| Question | Statement |
|---|---|
| 1 | Look forward to experimenting with new technologies |
| 2 | The first person to try new technologies |
| 3 | Not hesitant to try new technologies |
| 4 | Like to experiment with new technologies |

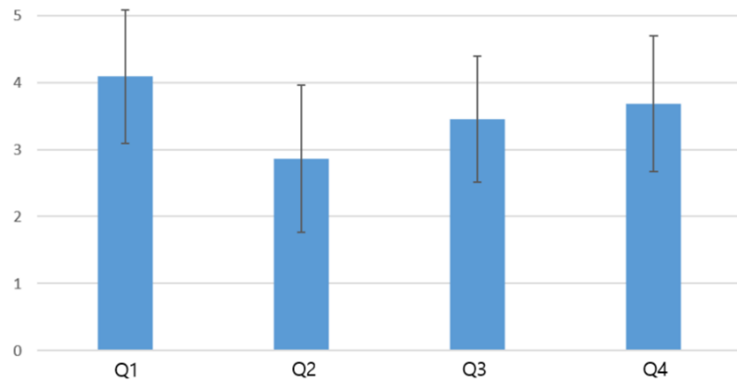


**Figure 2.**
Results for personal innovativeness.

Table 2 shows the questions related to perceived enjoyment, which were used to measure the participants' enjoyment while experiencing the VR and MR systems. Here, VR obtained an average score of 4.37, and MR obtained an average score of 4.22. As shown, VR was rated slightly higher; however, the difference was not statistically significant. Both VR and MR received the highest scores for question 10 and the lowest score for question 6. These results demonstrate that both VR and MR technologies provided the participants with engaging and interesting experiences; however, the results also suggest that the participants may not yet be fully accustomed to wearing the hardware required for these systems. The consistently high scores obtained for the questions related to enjoyment, e.g., items 5, 7, and 10, confirm that VR and MR technologies can generate interest and enjoyment among students.

**Table 2.**
Perceived enjoyment.

| Question | Statement | VR (Mean) | MR (Mean) |
|---|---|---|---|
| 5 | System is fun to use | 4.59 | 4.5 |
| 6 | System is pleasant | 4.05 | 3.64 |
| 7 | Feel enjoyment | 4.5 | 4.41 |
| 8 | Unhappy the session over | 4.05 | 3.77 |
| 9 | Willing to repeat the same experience | 4.32 | 4.36 |
| 10 | Interesting experience | 4.73 | 4.68 |

*Edelweiss Applied Science and Technology*
*ISSN: 2576-8484*
*Vol. 8, No. 5: 1445-1453, 2024*
*DOI: 10.55214/25768484.v8i5.1847*

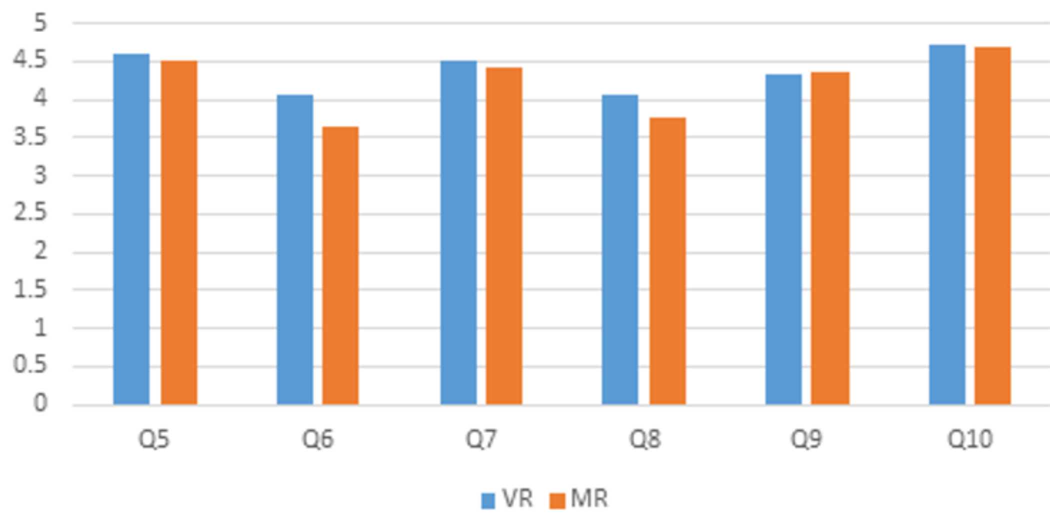


**Figure 3.**
Results for perceived enjoyment.

Table 3 shows the questions related to perceived ease of use, which were used to measure the participants' subjective perceptions of how easy or difficult it is to use the VR and MR technologies. The perceived ease of use category shows that the VR system obtained an average score of 3.49, and the MR system obtained an average score of 3.36. These results indicate that both the VR and MR systems received similar evaluations in terms of ease of use.

**Table 3.**
Perceived ease of use.

| Question | Statement | VR (Mean) | MR (Mean) |
|---|---|---|---|
| 11 | Learning to use (VR, MR) would be easy | 3.59 | 3.59 |
| 12 | I would find it easy to get (VR, MR) to do what I want it to do | 3.32 | 3.32 |
| 13 | It would be easy for me to become skillful at using (VR, MR) | 3.5 | 3.23 |
| 14 | Overall, I would find (VR, MR) easy to use | 3.55 | 3.32 |

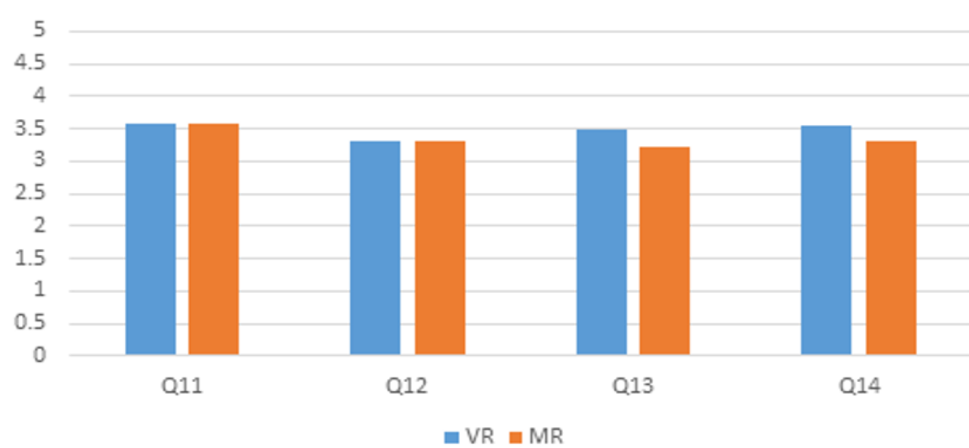


**Figure 4.**
Results for perceived ease of use.

*Edelweiss Applied Science and Technology*
*ISSN: 2576-8484*
*Vol. 8, No. 5: 1445-1453, 2024*
*DOI: 10.55214/25768484.v8i5.1847*

Table 4 shows the questions related to perceived usefulness, which were used to measure the participants' perceptions of how beneficial the VR and MR systems would be when applied to educational settings. Here, the VR system obtained an average score of 3.84, and the MR system obtained an average score of 3.61, which indicates that the VR system was rated more favorably than the MR system.

**Table 4.**
Perceived usefulness.

| Question | Statement | VR(Mean) | MR(Mean) |
|---|---|---|---|
| 15 | (VR, MR) technology would make it easier to do my study | 3.41 | 3.5 |
| 16 | I find (VR, MR) technology useful in teaching and learning | 4.27 | 3.73 |

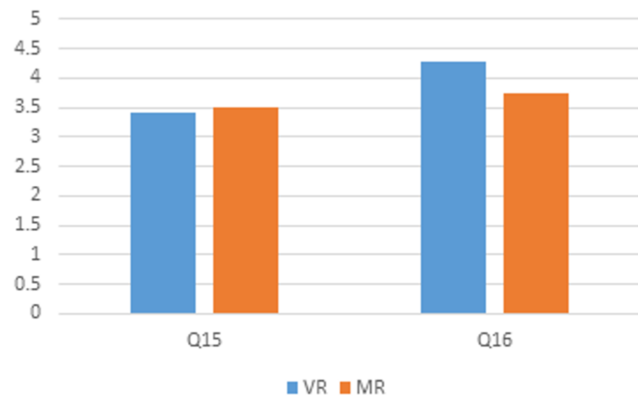


**Figure 5.**
Results for perceived usefulness.

Table 5 shows the questions related to the intention to use category, which were used to measure the participants' willingness to use VR and MR technologies in the future. Here, the VR system obtained an average score of 4.17, and the MR system obtained an average score of 3.82. These results reflect the largest difference between the two systems across the survey items, with VR system rated significantly higher than the MR system.

**Table 5.**
Intention to use.

| No. | Statement | VR (Mean) | MR (Mean) |
|---|---|---|---|
| 17 | I intend to use any system using (VR, MR) technology when it becomes available in my university. | 4.09 | 3.73 |
| 18 | I intend to use other applications using (VR, MR) in other subjects. | 4.23 | 3.68 |
| 19 | Given that I had access to the system, I predict that I would use it frequently. | 4.09 | 3.91 |
| 20 | Assuming I had access to the system, I intend to use it. | 4.27 | 4.00 |


*ISSN: 2576-8484*
*Vol. 8, No. 5: 1445-1453, 2024*
*DOI: 10.55214/25768484.v8i5.1847*

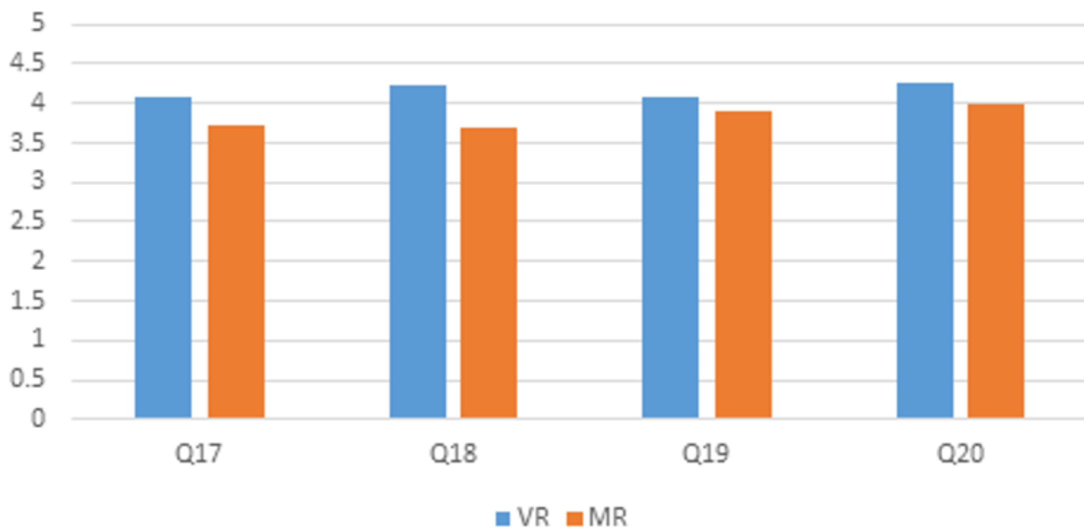


**Figure 6.**
Results for intention to use.

## 4. Conclusion

In this study, university freshmen were introduced to VR and MR technologies and surveyed to assess their perceptions of these technologies when applied in educational environments. The results indicate that the participants generally responded positively to both the VR and MR technologies. In particular, the VR system was rated higher in terms of enjoyment and perceived usefulness, which suggests that students are more inclined to use VR in future educational settings. The MR system also received favorable evaluations; however, it scored comparatively lower than the VR system. The participants reported experiencing greater enjoyment and usefulness in the immersive VR environment. The lower scores for the MR system, particularly in terms of the system's ease of use, are likely due to the participants' relative inexperience with the technology and unfamiliarity with the system's hardware and user interface. MR technology is still in its early adoption stage; thus, it is essential to provide students with more opportunities to experience MR, thereby helping them become more accustomed to the technology.

Both VR and MR have the potential to play effective roles as educational tools, and it is crucial to consider the strengths and weaknesses of each technology when developing educational content. Leveraging the high level of immersion and immediate usefulness offered by VR can enhance student engagement, and the integration of MR's real-world context can connect learning content to real-life applications effectively. It is expected that this approach can mitigate the limitations of both technologies, thereby providing students with a richer and more comprehensive learning experience. The findings of this study confirm that VR and MR technologies can have a positive impact on higher education, and future research will focus on investigating effective strategies to integrate these technologies to enhance students' learning experiences.



## References

[1] Tene, T., Marcatoma Tixi, J.A., Palacios Robalino, M.D.L., Mendoza Salazar, M.J., Vacacela Gomez, C. and Bellucci, S. (2024). "Integrating immersive technologies with STEM education: A systematic review". Frontiers Education, 9: 1410163.

[2] Suh, A. and Prophet, J. (2018). "The state of immersive technology research: A literature analysis". Computers in Human Behavior, 86: 77-90.
[3] Bermejo, B., Juiz, C., Cortes, D., Oskam, J., Moilanen, T., Loijas, J., Govender, P., Hussey, J., Schmidt, A.L., Burbach, R., King, D., O'Connor, C. and Dunlea, D. (2023). "AR/VR teaching-learning experiences in higher education institutions (HEI): A systematic literature review". Informatics, 10 (2): 45.
[4] Sanfilippo, F., Blazauskas, T., Salvietti, G., Ramos, I., Vert, S., Radianti, J., Majchrzak, T.A. and Oliveira, D. (2022). "A perspective review on integrating VR/AR with haptics into stem education for multi-sensory learning". Robotics, 11 (2): 41.
[5] Huang, H.M., Rauch, U. and Liaw, S.S. (2010). "Investigating learners' attitudes toward virtual reality learning environments: Based on a constructivist approach". Computers and Education, 55 (3): 1171-1182.
[6] Hsiao, P.W. and Su, C.H. (2021). "A study on the impact of STEAM education for sustainable development courses and its effects on student motivation and learning". Sustainability, 13 (7): 3772.
[7] Wu, C.H., Tang, Y.M., Tsang, Y.P. and Chau, K.Y. (2021). "Immersive learning design for technology education: A soft systems methodology". Frontiers in Psychology, 12: 745295.
[8] Wu, B., Yu, X. and Gu, X. (2020). "Effectiveness of immersive virtual reality using head-mounted displays on learning performance: A meta-analysis". British Journal of Educational Technology, 51 (6): 1991-2005.
[9] Bygstad, B., Øvrelid, E., Ludvigsen, S. and Dæhlen, M. (2022). "From dual digitalization to digital learning space: Exploring the digital transformation of higher education". Computers and Education, 182: 104463.
[10] Kerruish, E. (2019). "Arranging sensations: Smell and taste in augmented and virtual reality". The Senses and Society, 14 (1): 31-45.
[11] Gibbs, J.K., Gillies, M. and Pan, X. (2022). "A comparison of the effects of haptic and visual feedback on presence in virtual reality". International Journal of Human-Computer Studies, 157: 102717.
[12] Yovanoff, M., Pepley, D., Mirkin, K., Moore, J., Han, D. and Miller, S. (2016). "Improving medical education: Simulating changes in patient anatomy using dynamic haptic feedback". In: Proceedings of the Human Factors and Ergonomics Society Annual Meeting (Vol. 60, No. 1, pp. 603-607). Los Angeles, CA: Sage Publications.
[13] Muñoz-Saavedra, L., Miró-Amarante, L. and Domínguez-Morales, M. (2020). "Augmented and virtual reality evolution and future tendency". Applied sciences, 10 (1): 322.
[14] Burdea, G.C. and Coiffet, P. (2024). Virtual Reality Technology. New Jersey: John Wiley and Sons.
[15] Soares, I., B Sousa, R., Petry, M. and Moreira, A.P. (2021). "Accuracy and repeatability tests on HoloLens 2 and HTC Vive". Multimodal Technologies and Interaction, 5 (8): 47.
[16] Boyles, B. (2017). Virtual Reality and Augmented Reality in Education. West Point, NY: Center For Teaching Excellence, United States Military Academy.
[17] Maas, M.J. and Hughes, J.M. (2020). "Virtual, augmented and mixed reality in K–12 education: A review of the literature". Technology, Pedagogy and Education, 29 (2): 231-249.
[18] Al-Ansi, A. M., Jaboob, M., Garad, A. and Al-Ansi, A. (2023). "Analyzing augmented reality (AR) and virtual reality (VR) recent development in education". Social Sciences and Humanities Open, 8 (1): 100532.
[19] Zhao, G., Fan, M., Yuan, Y., Zhao, F. and Huang, H. (2021). "The comparison of teaching efficiency between virtual reality and traditional education in medical education: A systematic review and meta-analysis". Annals of Translational Medicine, 9 (3): 252.
[20] Christopoulos, A., Mystakidis, S., Cachafeiro, E. and Laakso, M.J. (2023). "Escaping the cell: Virtual reality escape rooms in biology education". Behaviour and Information Technology, 42 (9): 1434-1451.
[21] Fanini, B., Pagano, A., Pietroni, E., Ferdani, D., Demetrescu, E. and Palombini, A. (2023). "Augmented reality for cultural heritage". In: Springer Handbook of Augmented Reality (pp. 391-411). Berlin: Springer International Publishing.
[22] Aziz, F.A., Alsaeed, A.S., Sulaiman, S., Ariffin, M.K. and Al-Hakim, M.F. (2020). "Mixed reality improves education and training in assembly processes". Journal of Engineering and Technological Sciences, 52 (4): 598-607.
[23] Hammady, R., Ma, M., Strathern, C. and Mohamad, M. (2020). "Design and development of a spatial mixed reality touring guide to the Egyptian museum". Multimedia Tools and Applications, 79 (5): 3465-3494.
[24] Khan, M., Trujano, F. and Maes, P. (2018). "Mathland: Constructionist mathematical learning in the real world using immersive mixed reality". In: Immersive Learning Research Network: 4th International Conference, iLRN 2018, Missoula, MT, USA, June 24-29, 2018, Proceedings 4 (pp. 133-147). Berlin: Springer International Publishing.
[25] Robinson, B.L., Mitchell, T.R. and Brenseke, B.M. (2020). "Evaluating the use of mixed reality to teach gross and microscopic respiratory anatomy". Medical Science Educator, 30 (4): 1745-1748.
[26] Tang, Y. M., Au, K. M., Lau, H. C., Ho, G. T. and Wu, C. H. (2020). "Evaluating the effectiveness of learning design with mixed reality (MR) in higher education". Virtual Reality, 24 (4): 797-807.
[27] Rasimah, C.M.Y., Ahmad, A. and Zaman, H.B. (2011). "Evaluation of user acceptance of mixed reality technology". Australasian Journal of Educational Technology, 27(8).