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Use of VR in Higher Education: A Systematic Review (2014-2023)

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Abstract

With the ongoing advancement of intelligent information technology, virtual reality (VR) higher education, during this new era of reform, the incorporation of VR technology has led to an evolution of teaching methods. VR technology has been integrated into education and teaching, for example through virtual laboratories, digital environments and simulation-based training, thus providing higher education institutions with diverse teaching approaches and developmental opportunities.This study systematically categorises the utilisation of VR technology in tertiary education through the analysis of two databases, Web of Science (WoS) and Scopus.The systematic review process was conducted by referring to PRISMA (Preferred Reporting Items forSystematic Review and Meta-Analyses) as a guide, and 29 articles were extracted from the 478 articles for the period 2014 to 2023, taking into account exclusion and inclusion criteria.Firstly, the review revealed significant benefits of using VR applications in higher education, which were categorised into three categories. Secondly, the review examined challenges related to the use of VR in higher education content and categorised them into five categories.Overall, this review consolidates research discoveries and pragmatic insights to offer a refined comprehension of the present condition of VR in advanced education. Moreover, it provides recommendations for future development, which holds significant value for the effective use of VR technology in higher education.

Keywords: VR, Virtual Reality, VR technology, Higher Education, Higher Learning

Introduction

VR virtual reality technology encompasses system simulation, sensing, big data network information technology, and graphics, delivering significant practical benefits. When applied to higher education, teaching design, experimental analysis and professional skills training, it plays a crucial supporting and promotional role. According to (Rajendran & Yunus, 2021), the Chinese examination-oriented culture has such serious backwash effects on its learners that they are often characterized as passive consumers rather than.This paper aims to comprehensively analyse and explore the practical application of VR virtual reality technology

in higher education. It will examine the advantages and characteristics of this technology and make practical attempts to further expand its application within higher education.

The following general questions guided the process of analysing the following literature

Question 1: Benefits of VR Applications in Higher Education?

Question 2: Challenges of using VR in higher education?

By dealing with these questions, this study hopes to support the evolution of teaching and learning strategies and methodologies, and provide insights and recommendations for the use of VR in higher education.

Characteristics and application status of VR virtual reality technology

VR technology is primarily founded on computer simulation, artificial intelligence, big data, sensing, and system simulation. Essentially, virtual reality (VR) technology utilizes people's sensory organs such as vision, hearing, and touch, by means of virtual image and sound processing, to create a highly simulated virtual environment that immerses people within it.(De Back& Louwerse,2020)Virtual reality technology possesses features of immersion, interactivity, and imagination. The present utilisation of VR technology in higher education is mainly centred around "human-computer interaction"(Albus & Seufert, 2021). In the case of COVID-19, large-scale of changes happened overnight to find ways to optimise distance education and virtual learning was emerging and evolving quickly Educators were forced to adapt to the rapid changes in the education system (Santhanasamy & Yunus, 2022)

Methods

The systematic review process was conducted by referring to PRISMA (Preferred Reporting Items forSystematic Review and Meta-Analyses) as a guide.As shown in Figure 1.

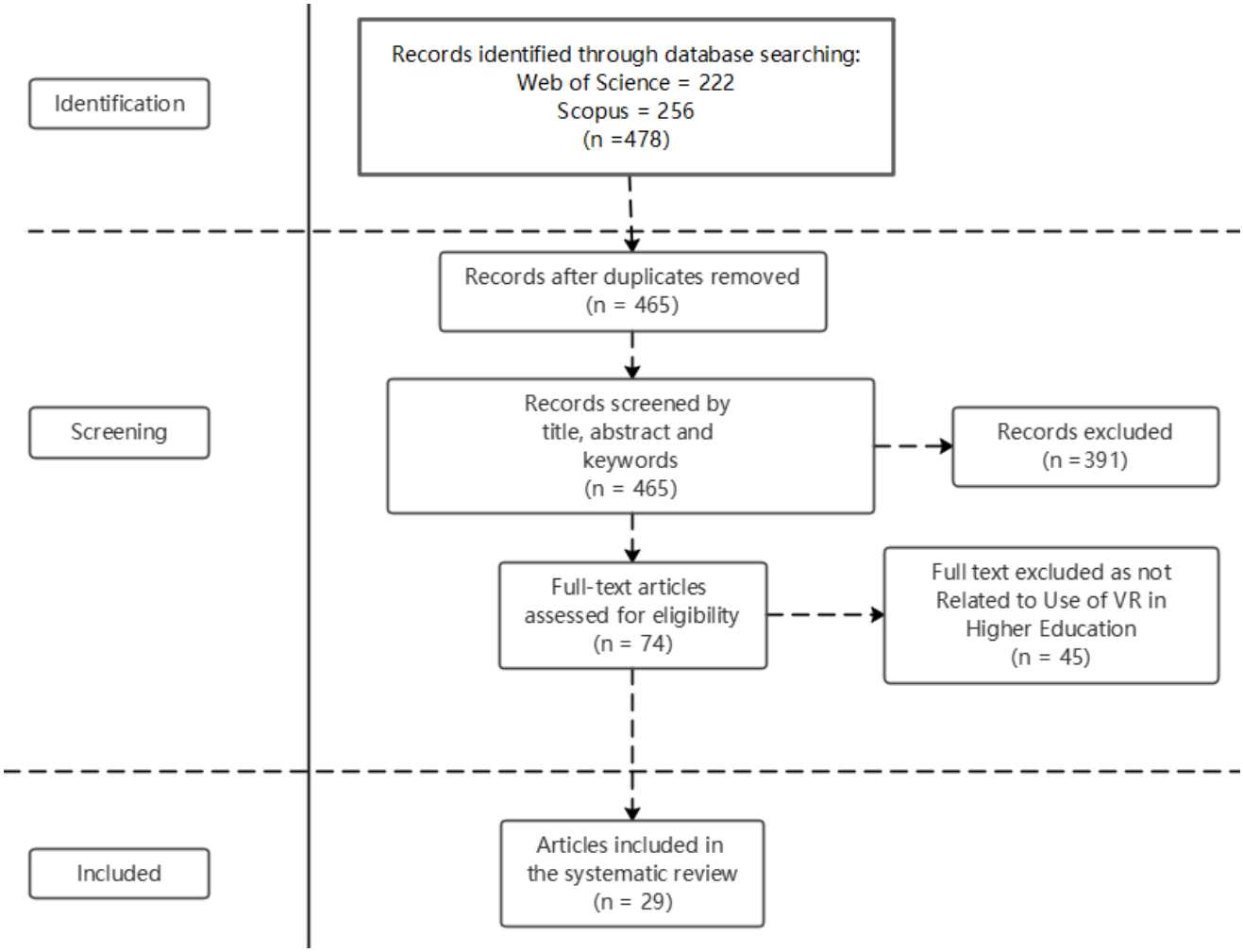

Figure 1. PRISMA systematic review adapted from

1. Identification

The first step is to select four suitable databases (Web of Science (WoS), Scopus) Table 1 below shows the search strings used for each database in this study.

Table 1
Search string

Database	**KeywordUsed**
Scopus	TITLE-ABS-KEY(("VR" OR "Virtual Reality*" OR "Immersive Technology" OR "VR technology ") AND ("Higher Education*" OR "tertiary education" OR "Higher Learning*" OR "post-secondary" OR " postsecondary" OR "University Education" OR "Academic Education" OR "Advanced Education" OR "College-Level Education")AND ("appliance*" OR "use*" OR "Technical Applications*") AND ("benefit*" OR "Advantage*"))
Web of Science	TS =("VR" OR "Virtual Reality*" OR "Immersive Technology" OR "VR technology " AND "Higher Education*" OR "tertiary education" OR "Higher Learning*" OR "post-secondary" OR " postsecondary" OR "University Education" OR "Academic Education" OR "Advanced

	Education" OR "College-Level Education" AND "appliance*" OR "use*" OR "Technical Applications*" AND "benefit*" OR "Advantage*")

*: Search String

2. Screening

The first step was to remove duplicate articles (13 in total) and 465 articles were eligible for further screening. The 465 articles were screened based on title, abstract and keywords with the aim of making them relevant to virtual reality and higher education.

The search results of the selected databases showed that before 2014, relevant articles were very sparse and not clearly oriented,there are not many systematic reviews before 2014. Therefore, 2014 to 2023 was used as one of the inclusion criteria.

Table 2
Screening condition

Criterion	Eligibility	Exclusion
Timeline	Between 2014 to 2023 (10 years)	<2014
Literature type	Articles from journals	Systematic reviews, books, chapters in a book, conference proceedings
Language	English	Non-English
Scope	Related to Use of VR in Higher Education	Not related to Use of VR in Higher Education

After careful screening based on inclusion and exclusion criteria, 29 articles were potentially included in this systematic review. Although conference proceedings and book chapters were reviewed, they were excluded because they were not comprehensive enough.

3. Included

The articles reviewed in this systematic review are centred around "Virtual Reality Technology in Higher Education". as shown in Table 3, 16 articles were selected from Scopus and 13 articles from WoS.

The studies aim to explore the use of VR technology in higher education. The research has been primarily conducted in higher education institutions, including colleges and universities [1-29], with a focus on utilising VR for classroom instruction [1,3,5-8,11,12,17-29] and simulation experimentation [2,4,9,10,13-16,21-25].

Table 3
Summary

Study	Database	Aim	Samples	Findings
de Back, T. T., Tinga, A. M., Nguyen, P., & Louwerse, M. M. (2020).	Scopus	The current study evaluated whether academic learning using a cutting-edge CAVE resulted in greater learning gains than traditional textbooks.	Learners at school	The results showed that collaborative learning in the CAVE resulted in much better learning gains with large effect sizes.Furthermore, the study shows how immersive learning might give unique scaffolding to improve performance in individuals who need it the most.
Al-Khiami, M. I., & Jaeger, M. (2023).	Scopus	The purpose of this research is to look into the applicability of a specific safety training module linked to "Working at Heights" for workers	VR module users	The data show that workers exposed to the VR technique have a statistically insignificantly higher learning effectiveness.
Issleib, M., Kromer, A., Pinnschmidt, H. O., Süss-Havemann, C., & Kubitz, J. C. (2021).	Scopus	Virtual reality is a cutting-edge tool for medical education with a high level of empirical realism. As a result, this study compares traditional CPR training to Virtual Reality (VR) instruction	104 first-year undergraduate students	In terms of imparting technical skills, a "classic" BLS-course with a seminar and training appears to be preferable to VR. However, the overall learning gain with VR was greater. VR integration should be considered in future BLS course forms.
Soto, J. H. B., Ocampo, D. C. T., del Carmen Beltrán Colón, L., & Oropesa, A. v. (2020).	Scopus	The main aim of the project is to analyse the impact of using the virtual reality platform ImmerseMe as an empowering and innovative tool for learning English in private institutions	Private university 1st-3rd year students	The study's conclusions demonstrated that an immersive virtual reality platform such as this one is perfect for improving the various aspects of EFL from an immersive focus while taking into account various contexts

Caño de las Heras, S., Gargalo, C. L., Caccavale, F., Kensington-Miller, B., Gernaey, K. v, Baroutian, S., & Krühne, U. (2022).	Scopus	Semi-structured interviews, surveys, casual talks between the students and the developer, and other methods have been used in two different colleges to gather both qualitative and quantitative data.	Students in higher education	It was discovered that the viewpoints of the students offered insightful criticism regarding the functionality, usability, and content of the platform. Opinions were gathered and carefully evaluated, such as suggestions to modify the platform name or include coding exercises linked to bioprocesses.
Paszkiewicz, A., Salach, M., Dymora, P., Bolanowski, M., Budzik, G., & Kubiak, P. (2021).	Scopus	This essay offers a completely novel strategy for integrating virtual reality (VR) into the classroom. It is predicated on the extensive methodology that has been suggested, which covers the planning, development, execution, and assessment of specific courses that are used in virtual reality. The new methodology's comprehensiveness and universality are crucial features.	Participants trained in the virtual environment	It can be used in numerous fields, including higher education, shipbuilding, aviation, automobile, and energy. The study also lists the notable benefits and drawbacks of VR-based learning, which could affect the field and type of applications for it. Furthermore, a virtual reality training station model has been created based on the suggested methodology.
Li, G. (2022).	Scopus	This study examines the current state of higher education through a questionnaire survey, and it analyses the benefits, issues that still need to be resolved, and potential uses of virtual reality and	student of a university or college	The findings demonstrate that virtual reality and wireless communication technologies improve teacher quality of instruction as well as students' experiences and motivation. This offers a crucial point of

		wireless communication technologies in the context of college education reform.		reference for reforming higher education.
Jiang, L. (2021).	Scopus	This essay covers the main virtual reality technologies, presents the pertinent theoretical underpinnings, and lists the benefits and drawbacks of the most widely used virtual reality devices at the moment.	Vocational university students	It is now crucial to take steps to raise the standard of vocational education and the calibre of instruction in order to prepare for the next wave of industrial and technological development.
Soliman, M., Pesyridis, A., Dalaymani-Zad, D., Gronfula, M., & Kourmpetis, M. (2021).	Scopus	Constructivism and variant learning theory have been effectively applied in engineering education, and there is sufficient evidence to support their applicability in virtual reality teaching.	university student	In this work, we make the case and provide evidence from a large body of research that virtual reality is a great teaching tool for engineering. By using VR in place of actual laboratories, the university or institution can also benefit from lower responsibility, infrastructure costs, and expenses. Equal educational opportunities also benefit students with special needs and distance learners who may not have access to physical laboratories.
Al-Oudat, M., & Altamimi, A. M. (2022).	Scopus	They looked into what influences higher education institutions' adoption of virtual reality. To do this, we developed a set of assumptions and added four new elements to the technology	503 Jordanian students.	Perceived enabling conditions, perceived effort anticipation, and perceived compatibility were found to have a substantial impact on the intention to use VR systems and tools for education, according to the results. We think

		Acceptance Model (TAM). Next, utilising a dataset gathered from 503 Jordanian students, the hypotheses are assessed.		that our research will assist policymakers in developing educational and learning environments that are viable for Jordanian universities.
Cicek, I., Bernik, A., & Tomicic, I. (2021).	Scopus	The theoretical section looks into the elements of the traditional educational system. in industry and education.	55 interviewees	Through the use of 27 questions, three hypotheses about the use of VR technology, as well as the efficacy, immersion, and user impact of the VR system, were tested. The results showed that the VR system is advantageous to the user in improving immersion and assisting students in learning.
Canedo-García, A., García-Sánchez, J.-N., & Pacheco-Sanz, D.-I. (2022).	Scopus	Examining the advantages, satisfaction, and constraints of intergenerational contacts brought about by the use of virtual tools was the goal of this study.	Spanish social groups of different ages.	The majority of individuals who took part in virtual interactions between generations mentioned how their social interactions, relationships, emotions, mental health, and academic education all improved.
Cabero-Almenara, J., Llorente-Cejudo, C., Palacios-Rodríguez, A., & Gallego-Pérez, Ó. (2023).	Scopus	This study aims to assess students' adoption of learning objects created in 360° and virtual reality, as well as examine their assessment and the relationships that have been developed.	136 medical students	High levels of acceptance are seen in the results for 360° and VR objects. With strong relationships found among the various characteristics, the students thought the training exercise was very beneficial. This work opens up new avenues for future research and shows how VR may be used as an instructional tool.

Bartels, N., & Hahne, K. (2023).	Scopus	how instructors and students felt about a 360° prototype video that they had viewed in virtual reality goggles while an educational project was still in the planning stages.	health care and social work students	The participants shared the opinion that students might be better prepared for real-world practice in social work and health care by using the virtual reality educational tool.
Lie, S. S., Røykenes, K., Sæheim, A., & Groven, K. S. (2023).	Scopus	This paper discusses the effect of digital design and construction teaching using virtual world as a teaching tool.	Civil engineering students	This paper provides a teaching method for integrating BIM and the meta-universe into the curriculum.
Ogrizović, D., Hadžić, A.P., Jardas, M. (2021).	Scopus	In a discrete-event simulation of logistics operations, this article examined users' impressions of the possible application of fully immersive virtual reality head-mounted displays.	Users of fully immersive virtual reality head-mounted displays	Because virtual worlds are dynamic, users must actively participate to increase engagement, motivation, and interest. Interaction and challenges also help to foster these positive outcomes.vital to create and test suitable development tools, investigate their advantages and efficacy, and incorporate them into current teaching methods.
Antonopoulou, A., & Dare, E. (2022).	Wos	Enhanced monitoring through "artificial intelligence" transaction data and student debt analysis.	university student	The authors agree that knowledge is not beautiful; rather, it is an illusion of stability that serves a neoliberal, anti-academic, and rapacious worldview that should be exposed and given frank discussion, free from managerial wishful thinking and hype. It is impossible to portray truth and beauty as

				steady, uniform, or global as doing so would be akin to colonial knowledge projection and mono-logic that centres all truth on the Global North.
Dzyuba, N., Jandu, J., Yates, J., & Kushnerev, E. (2022).	Wos	The purpose of this review is to assess how these technologies are now used in dental education, investigate how they affect teaching and learning, and consider how they might develop in this area.	Undergraduate/General Dental Practitioner	In dentistry, VR/AR is a helpful supplement to traditional education. But there are obstacles standing in the way of VR/AR's broad adoption and uses, like a dearth of trials, a lack of standards, and certification issues with equipment and content.
Fransson, G., Holmberg, J., & Westelius, C. (2020).	Wos	This paper investigates the requirements and difficulties of using HMD VR from the viewpoint of a teacher in order to provide guidance for the process of deploying it in K–12 environments.	K-12 school	This technology is becoming more useful in training and educational settings as it gets more accessible, immersive, and user-friendly.
Skosana, X. N., Mpofu, K., Trimble, J., & van Wyk, E. A. (2022).	Wos	In response to the growing demand for virtual environments, higher education institutions are developing courses and divisions dedicated to the development of virtual reality (VR). The creation of two comparable VATS was seen as a solution to this problem, and a framework outlining the roles, responsibilities,	expert developers and five engineering students	Research indicates that when given the right tools—a combination of synchronous and asynchronous learning—engineers without any programming experience may learn VATS.

		activities, and deliverables involved in the process was proposed.		
Bennie, S. J., Ranaghan, K. E., Deeks, H., Goldsmith, H. E., O'Connor, M. B., Mulholland, A. J., & Glowacki, D. R. (2019).	Wos	This article reports an additional course in real-time interactive molecular dynamics simulations utilizing virtual reality (iMD-VR). study	22 third-year UK undergraduate chemistry students	Most students found that iMD-VR components stimulated their interest in computers more than traditional methods
Kluge, M. G., Maltby, S., Kuhne, C., Evans, D. J. R., & Walker, F. R. (2023).	Wos	The current work includes a thorough intrinsic case study that describes the steps and important factors that influenced the choice of appropriate instructional materials, software development, hardware fixes, and implementation. The decision-making process, components deemed useful, obstacles encountered, and key takeaways are described in detail.	The University of Newcastle, Australia	Organisations and individuals looking to create procedures and pathways to incorporate XR technology may find these insights helpful, especially when it comes to enhancing their current training and educational programmes.
Neroni, M. A., Oti, A., & Crilly, N. (2021).	Wos	We talk about our experiences with the workshops and the potential that comparable VR game platforms have for studying design cognition in general and ideation, prototyping, issue reframing, intrinsic motivation, and	VR Participants	The VR gaming platform provides a foundation for training interventions in design education and practice, in addition to being a great complement to current research alternatives.

		proven vulnerability in particular.		
Udeozor, C., Toyoda, R., Abegao, F. R., & Glassey, J. (2021).	Wos	how chemical engineering professionals and students view the usage of VR games for health and safety training and teaching. The study also explores the practical consequences of its results.	VR game user	According to the survey, both professionals and students think that IVR games can help with learning. Professionals were shown to be more receptive to technology than students when the two groups were compared.
Garcia-Bonete, M. J., Jensen, M., & Katona, G. (2019).	Wos	Teachers of structural biology who lack extensive expertise of information technology can benefit from this guide.	teachers of structural biology	Although specialised laboratories have long employed VR、AR techniques, it is only recently that these technologies have become more widely available and inexpensive for consumers.
Boetje, J., & van Ginkel, S. (2021).	Wos	Using a pre-test post-test methodology, this experimental field study investigated the potential benefits of an additional VR practice session on the advancement of 35 graduate students in OPS.	35 graduate students in OPS	The benefits of practicing in front of a virtual audience a third time were evident from the results. Participants who were nervous and those who weren't made equivalent progress in their presentation abilities and VR intervention experiences. The ideal quantity of practice presentations, however, is still up for debate and needs more research.
Agbo, F. J., Oyelere, S. S., Suhonen, J., & Tukiainen, M. (2022).	Wos	The goal of this project is to support CT knowledge by creating and deploying iThinkSmart, a virtual	University of Nigeria Computer Science students (47)	Results point to an increase in students' enthusiasm and, consequently, in their CT skills. These findings add to our

	reality (VR) game-based application.		understanding of the educational potential of VR and, in particular, show how visualisation of CT ideas can support programming instruction.
Webb, M., Wos Tracey, M., Harwin, W., Tokatli, O., Hwang, F., Johnson, R., Barrett, N., & Jones, C. (2022).	The study looked at how children, ages 12 to 13, learned important ideas in nanoscale cell biology when they added haptic input to a 3D virtual reality (VR) simulation.	Students (N = 64), in two secondary schools	Pre- and post-test results on conceptual knowledge revealed considerable knowledge gains; however, the addition of haptic input had no discernible impact on the knowledge gains. The research made it possible to identify crucial factors to take into account while creating and utilising haptic-enabled 3D virtual reality settings for group education.

4. Data Analysis Procedure

All selected articles are exported to the reference software Mendeley. matic analysis was performed .

research questions:

Question 1: Benefits of VR Applications in Higher Education?

Question 2: Challenges of using VR in higher education?

This review provides an interpretative analysis of the articles and categorises the topics in response to the re-search question

According to the first research question, the advantageous features that VR technology has in higher education were classified into three categories. For the Question 2, the challenges of VR technology in higher education mentioned in the article are explained in five sections, according to which the difficulties encountered in the current use of VR technology in higher education classes and experiments are analysed.

Results

1 Question 1:Benefits of VR Applications in Higher Education ?

In this systematic review, VR technology has the following three advantageous features in higher education

Table 4
Benefits of VR Applications in Higher Education

Type	Related articles
Immersion	[1-10,25,27,28]
Interaction	[4,7,9,10,15-24,27]
Conceptualisation	[3,11,12,16,17,29]

(i) Immersion

According to literature sources [1-10,25,27,28], VR relies on the physiological and psychological properties of human vision and hearing. The process involves the use of computers to produce authentic three-dimensional stereoscopic images.The virtual environment elicits a sense of realism, and users feel completely immersed. [1,3,8] greatly improves students' motivation to learn.[1,2,5-10,25,27,28]

(ii) Interaction

Various studies [4,7,9,10,15-24,27] have noted that human-computer interaction in VR virtual reality systems is close to a natural experience. This means that users are able to interact with the system not only through conventional means such as a keyboard and mouse, but also through specialized sensing devices such as helmets and gloves that respond to hand, head, speech, eye, and body movements.Asynchronous teaching can be made possible by this technology, which can be tailored to meet the individual needs of students.[7,10,15,27]

(iii) Conceptualisation

In the literature [3,11,12,16,17,29], It is said that VR is a design tool in addition to a medium for presentations. It is a visual representation of the designer's concepts; virtual reality has the ability to transform this notion into tangible virtual worlds and products, whereas traditional sand table design was the only option available in the past. Improve to the ideal state of digital technology, resulting in a significant increase in the effectiveness and calibre of planning and design. [3,11,12,29]

2 Question 2:Challenges of using VR in higher education?

In this systematic review, VR technology in higher education has the following five challenges

Table 5
Challenges of using virtual reality in higher education

Type	Related articles
Limited space for practical training and teaching	[6,13,28]
the high price of practical training equipment	[2,29]
the updating speed of the equipment cannot keep up with the rapid development of science and technology	[2,9-13,29]
the danger of operating the equipment	[2,4]
Insufficient investment in experimental teaching	[3-5,12-16]

First, the limited space for practical training and teaching, as well as the excessive size of the practical training equipment, leads to the fact that only students in the vicinity of the equipment can observe the whole process of the teacher's operation of the equipment in close proximity, while other students can only look at the whole practical training process and lack a comprehensive understanding.[6,13,28]

Second, the price of practical training equipment remains high, which makes it very difficult to solve the financial problems of equipment configuration. At the same time, the complex structure of the equipment requires specialised personnel to operate, manage and maintain it, which brings additional high expenses.[2,29]

Thirdly, The high cost of practical training equipment means that equipment updates too slowly to keep up with the speed at which science and technology are developing. Schools must spend a lot of money to keep its equipment up to date with technology, and upgrading the outdated equipment will be a huge waste of funds..[2,9-13,29]

Fourthly, for students who lack practical experience, it is dangerous to operate the equipment. Usually, the teaching process is based on the teacher's demonstration, and students can only simply imitate and lack the opportunity to explore on their own, thus reducing the effectiveness of the experiment.[2,4]

Fifthly, some majors of liberal arts nature have not invested enough in experimental teaching, for example, finance and management majors are more inclined to teach mainly language, with relatively few experimental opportunities. As for students majoring in tourism, experiments usually require field trips, but the high cost has become an important factor restricting students' participation in practical activities.[3-5,12-16]

Discussion

The results of the study highlight the use of VR technology in higher education, and in general, the findings suggest that the use of VR technology contributes to higher education. The benefits include：(i) Immersion；(ii) Interactivity；(iii) Conceptualisation

It is likely that VR technology will be used on a larger scale in higher education in the future, linking VR technology and higher education more closely. Innovate the methods, actively introduce, apply VR technology to improve the teaching ability of education and provide the most convenient way to cultivate talents.

Next, this review also explores Challenges of using VR in higher education , the reasons are summarised into five points, including : (i) Limited space for practical training and teaching ; (ii) the high price of practical training equipment ; (iii) the updating speed of the equipment cannot keep up with the rapid development of science and technology ; (iv) the danger of operating the equipment ; (v) Insufficient investment in experimental teaching

The first and second reasons are the problems faced by most of the higher education schools, and the updating of funds and technology is also the focus and difficulty of using VR technology in higher education.

With the ubiquitous nature of social media, many educators are coming to see this technology as an avenue to make learning more accessible to their students.(John&Yunus,2021)Applying VR technology to actual teaching has high requirements for capital investment, technology, equipment and teachers. Whether it is the pressure of capital, technology or teaching, these are the great challenges and difficulties encountered in the actual application of VR technology, which need to be constantly practiced and explored.

Conclusions

This paper reviews the literature on the application of VR technology in higher education. Thus,to support the evolution of teaching strategies and methods, and to provide insights and recommendations for the use of VR in higher education. filling the gap left by the lack of a comprehensive review of VR and higher education. Two databases, web ofScience (Wos) and scopus, were used in this review, which included 29 articles.

Question 1: Benefits of VR Applications in Higher Education

(i) Immersion ; (ii) Interactivity ; (iii) Conceptualisation

Virtual environments can create a sense of reality, and users are fully immersed in them, greatly improving students' motivation to learn. The human-computer interaction in VR virtual reality system is close to the natural experience. This technology makes asynchronous instruction possible and can be tailored to the individual needs of students. At the same time, VR is a design tool and a display medium that improves to the ideal state of digital technology, thus significantly improving the efficiency and level of planning and design.

Question 2: Challenges of using virtual reality in higher education

(i) Limited space for practical training and teaching ; (ii) the high price of practical training equipment ; (iii) the updating speed of the equipment cannot keep up with the rapid development of science and technology ; (iv) the danger of operating the equipment ; (v) Insufficient investment in experimental teaching

Through the above two questions, this paper comprehensively analyzes and discusses the practical application of VR virtual reality technology in higher education. Study the advantages and characteristics of VR technology, and make practical attempts to further expand its application in higher education, and realize the goal and pursuit of applying VR technology in college classrooms faster and better.

According to the findings of this review, there are more opportunities for the application of virtual reality technology in higher education.

There are several restrictions on this study. There is no mention of education level as a trend in this study because the majority of studies on the use of VR technology in higher education have concentrated on undergraduate students at universities and colleges. This restriction undoubtedly creates new avenues for investigation in the future, particularly with

regard to the selection of several study tiers about the application of VR technology in higher education. Second, Web of Science and Scopus are reputable journals from which the papers in this review are drawn. As a result, if additional databases like Google Scholar and Science Direct are employed, the outcomes could alter slightly. Notwithstanding its shortcomings, this systematic review contributes significantly to the body of knowledge about VR technology in higher education, helping practitioners in related domains and opening up new avenues for investigation. In order to fully realise the application and development of VR technology in higher education, this review also closes any gaps about the advantages and disadvantages of the technology.

References

De Back, T. T., Tinga, A. M., Nguyen, P., & Louwerse, M. M. (2020). Benefits of immersive collaborative learning in CAVE-based virtual reality. *International Journal of Educational Technology in Higher Education, 17(1).* https://doi.org/10.1186/s41239-020-00228-9

Al-Khiami, M. I., & Jaeger, M. (2023). Safer Working at Heights: Exploring the Usability of Virtual Reality for Construction Safety Training among Blue-Collar Workers in Kuwait. *Safety, 9(3)*. https://doi.org/10.3390/safety9030063

Issleib, M., Kromer, A., Pinnschmidt, H. O., Süss-Havemann, C., & Kubitz, J. C. (2021). Virtual reality as a teaching method for resuscitation training in undergraduate first year medical students: a randomized controlled trial. Scandinavian Journal of Trauma, *Resuscitation and Emergency Medicine, 29(1). https://doi.org/10.1186/s13049-021-00836-y*

Soto, J. H. B., Ocampo, D. C. T., del Carmen Beltrán Colón, L., & Oropesa, A. v. (2020). Perceptions of immerseme virtual reality platform to improve english communicative skills in higher education. *International Journal of Interactive Mobile Technologies, 14(7),* 4–19. https://doi.org/10.3991/IJIM.V14I07.12181

Caño de las Heras, S., Gargalo, C. L., Caccavale, F., Kensington-Miller, B., Gernaey, K. v, Baroutian, S., & Krühne, U. (2022). From Paper to web: Students as partners for virtual laboratories in (Bio)chemical engineering education. *Frontiers in Chemical Engineering, 4.* https://doi.org/10.3389/fceng.2022.959188

Paszkiewicz, A., Salach, M., Dymora, P., Bolanowski, M., Budzik, G., & Kubiak, P. (2021). Methodology of implementing virtual reality in education for industry 4.0. *Sustainability (Switzerland), 13(9).* https://doi.org/10.3390/su13095049

Li, G. (2022). Methods of College Education Reform under the Background of Wireless Communication and VR. *Wireless Communications and Mobile Computing, 2022.* https://doi.org/10.1155/2022/2589533

Jiang, L. (2021). Virtual Reality Action Interactive Teaching Artificial Intelligence Education System. *Complexity, 2021.* https://doi.org/10.1155/2021/5553211

Soliman, M., Pesyridis, A., Dalaymani-Zad, D., Gronfula, M., & Kourmpetis, M. (2021). The application of virtual reality in engineering education. *Applied Sciences (Switzerland), 11(6).* https://doi.org/10.3390/app11062879

Cicek, I., Bernik, A., & Tomicic, I. (2021). Student thoughts on virtual reality in higher education—a survey questionnaire. *Information (Switzerland), 12(4).* https://doi.org/10.3390/info12040151

Al-Oudat, M., & Altamimi, A. M. (2022). Factors influencing behavior intentions to use virtual reality in education. *International Journal of Data and Network Science, 6(3),* 733–742. https://doi.org/10.5267/j.ijdns.2022.3.008

Canedo-García, A., García-Sánchez, J.-N., & Pacheco-Sanz, D.-I. (2022). Benefits, satisfaction and limitations derived from the performance of intergenerational virtual activities: Data from a general population spanish survey. *International Journal of Environmental Research and Public Health, 19(1).* https://doi.org/10.3390/ijerph19010401

Cabero-Almenara, J., Llorente-Cejudo, C., Palacios-Rodríguez, A., & Gallego-Pérez, Ó. (2023). Degree of Acceptance of Virtual Reality by Health Sciences Students. *International Journal of Environmental Research and Public Health, 20(8). https://doi.org/10.3390/ijerph20085571*

Lie, S. S., Røykenes, K., Sæheim, A., & Groven, K. S. (2023). Developing a Virtual Reality Educational Tool to Stimulate Emotions for Learning: Focus Group Study. *JMIR Formative Research, 7.* https://doi.org/10.2196/41829

Bartels, N., & Hahne, K. (2023). Teaching Building Information Modeling in the Metaverse—An Approach Based on Quantitative and Qualitative Evaluation of the Students Perspective. *Buildings, 13(9).* https://doi.org/10.3390/buildings13092198

Ogrizović, D., Hadžić, A.P., Jardas, M. (2021). FULLY IMMERSIVE VIRTUAL REALITY IN LOGISTICS MODELLING AND SIMULATION EDUCATION *Promet - Traffic - Traffico, 33 (6), pp.* 799-806.https://hrcak.srce.hr/file/392737

Antonopoulou, A., & Dare, E. (2022). The Riverine Archive: nausea and information loss on the neoliberal ship of fools. *VISUAL COMMUNICATION, 21(3)*, 418–436. https://doi.org/10.1177/14703572221088941

Dzyuba, N., Jandu, J., Yates, J., & Kushnerev, E. (2022). Virtual and augmented reality in dental education: The good, the bad and the better. *EUROPEAN JOURNAL OF DENTAL EDUCATION.* https://doi.org/10.1111/eje.12871

Fransson, G., Holmberg, J., & Westelius, C. (2020). The challenges of using head mounted virtual reality in K-12 schools from a teacher perspective. *EDUCATION AND INFORMATION TECHNOLOGIES, 25(4)*, 3383–3404. https://doi.org/10.1007/s10639-020-10119-1

Skosana, X. N., Mpofu, K., Trimble, J., & van Wyk, E. A. (2022). An empirical framework for developing and evaluating a Virtual Assembly Training System in learning factories. *INTERACTIVE LEARNING ENVIRONMENTS.*
https://doi.org/10.1080/10494820.2022.2039946

Bennie, S. J., Ranaghan, K. E., Deeks, H., Goldsmith, H. E., O'Connor, M. B., Mulholland, A. J., & Glowacki, D. R. (2019). Teaching Enzyme Catalysis Using Interactive Molecular Dynamics in Virtual Reality. *JOURNAL OF CHEMICAL EDUCATION, 96(11),* 2488-+. https://doi.org/10.1021/acs.jchemed.9b00181

Kluge, M. G., Maltby, S., Kuhne, C., Evans, D. J. R., & Walker, F. R. (2023). Comparing approaches for selection, development, and deployment of extended reality (XR) teaching applications: A case study at The University of Newcastle Australia. *EDUCATION AND INFORMATION TECHNOLOGIES, 28(4),* 4531–4562.
https://doi.org/10.1007/s10639-022-11364-2

Neroni, M. A., Oti, A., & Crilly, N. (2021). Virtual Reality design-build-test games with physics simulation: opportunities for researching design cognition. *INTERNATIONAL JOURNAL OF DESIGN CREATIVITY AND INNOVATION, 9(3),* 139–173.
https://doi.org/10.1080/21650349.2021.1929500

Udeozor, C., Toyoda, R., Abegao, F. R., & Glassey, J. (2021). Perceptions of the use of virtual reality games for chemical engineering education and professional training. *HIGHER EDUCATION PEDAGOGIES, 6(1),* 175–194.

https://doi.org/10.1080/23752696.2021.1951615

Garcia-Bonete, M. J., Jensen, M., & Katona, G. (2019). A practical guide to developing virtual and augmented reality exercises for teaching structural biology. *BIOCHEMISTRY AND MOLECULAR BIOLOGY EDUCATION, 47(1),* 16–24. https://doi.org/10.1002/bmb.21188

Boetje, J., & van Ginkel, S. (2021). The added benefit of an extra practice session in virtual reality on the development of presentation skills: A randomized control trial. *JOURNAL OF COMPUTER ASSISTED LEARNING, 37(1),* 253–264. https://doi.org/10.1111/jcal.12484

Agbo, F. J., Oyelere, S. S., Suhonen, J., & Tukiainen, M. (2022). Design, development, and evaluation of a virtual reality game-based application to support computational thinking. *ETR&D-EDUCATIONAL TECHNOLOGY RESEARCH AND DEVELOPMENT.* https://doi.org/10.1007/s11423-022-10161-5

Webb, M., Tracey, M., Harwin, W., Tokatli, O., Hwang, F., Johnson, R., Barrett, N., & Jones, C. (2022). Haptic-enabled collaborative learning in virtual reality for schools. *EDUCATION AND INFORMATION TECHNOLOGIES, 27(1),* 937–960. https://doi.org/10.1007/s10639-021-10639-4

Albus, P., Vogt, A., & Seufert, T. (2021). Signaling in virtual reality influences learning outcome and cognitive load. *COMPUTERS & EDUCATION,* 166.

https://doi.org/10.1016/j.compedu.2021.104154

Rajendran, T., & Yunus, M. M. (2021). A systematic literature review on the use of mobile-assisted language Learning (MALL) for enhancing speaking skills among ESL and EFL learners. *International Journal of Academic Research in Progressive Education and Development, 10(1),* 586-609.

Santhanasamy, C., & Yunus, M. M. (2022). A Systematic Review of Flipped Learning Approach in Improving Speaking Skills. *European Journal of Educational Research, 11(1),* 127-139.

John, E., & Yunus, M. M. (2021). A systematic review of social media integration to teach speaking. *Sustainability, 13(16),* 9047.

Ramalingam, S., Yunus, M. M., & Hashim, H. (2022). Blended learning strategies for sustainable English as a second language education: a systematic review. *Sustainability, 14(13),* 8051.