frontiers | Frontiers in Education

TYPE Systematic Review
PUBLISHED 23 July 2024
DOI 10.3389/feduc.2024.1391560



OPEN ACCESS

EDITED BY
Genaro Zavala,
Monterrey Institute of Technology and Higher Education (ITESM), Mexico

REVIEWED BY
Jose Carlos Vazquez-Parra,
Monterrey Institute of Technology and Higher Education (ITESM), Mexico
Claudio Aguayo,
Auckland University of Technology,
New Zealand

*CORRESPONDENCE
Augusto Cabrera-Duffaut
acabrerad@ucacue.edu.ec

RECEIVED 26 February 2024
ACCEPTED 09 July 2024
PUBLISHED 23 July 2024

CITATION
Cabrera-Duffaut A, Pinto-Llorente AM and Iglesias-Rodríguez A (2024) Immersive learning platforms: analyzing virtual reality contribution to competence development in higher education—a systematic literature review.
*Front. Educ.* 9:1391560.
doi: 10.3389/feduc.2024.1391560



# Immersive learning platforms: analyzing virtual reality contribution to competence development in higher education—a systematic literature review

Augusto Cabrera-Duffaut[1]*, Ana María Pinto-Llorente[2] and Ana Iglesias-Rodríguez[3]

[1]School of Dentistry, Educational Innovation Observatory, CIITT, Universidad Católica de Cuenca, Cuenca, Ecuador, [2]GRIAL Research Group, University Institute of Education Sciences (IUCE), Universidad de Salamanca (University of Salamanca), Salamanca, Spain, [3]Inforal Research Group, University Institute of Education Sciences (IUCE), Universidad de Salamanca (University of Salamanca), Salamanca, Spain

**Background:** This study evaluates the effectiveness and pedagogical integration of Virtual Reality (VR), exploring its application in various educational contexts. In this systematic literature review, the role of virtual reality in enhancing competency development within higher education is examined.

**Methods:** The search was conducted in two databases (Scopus and Web of Science) following the PRISMA method guidelines. Inclusion criteria were limited to studies that used virtual reality as a tool within the classroom, analyzing the competencies developed through its application.

**Results:** Out of the 1,671 articles retrieved, 61 full texts were selected for review, resulting in 27 academic articles published in the last five years. The findings highlight the capacity of virtual reality to foster interpersonal skills while simultaneously addressing the challenges of its integration.

**Discussion:** The adoption of Virtual Reality (VR) in higher education is notable for its immersive learning experiences. Despite VR's significant contribution to education, its widespread integration faces challenges, including the high costs of VR technology and the lack of specialized educational software, which limits its accessibility across various academic disciplines.

**Conclusion:** The advent of global technological advancements has unveiled numerous opportunities within the educational sector, with VR emerging as a transformative technology that offers immersive learning experiences, propelling educational methodologies beyond traditional boundaries. Through this SLR, it becomes evident that the application of VR in education transcends mere knowledge transfer, facilitating the development of critical competencies.

**Systematic review registration:** http://bit.ly/3SyKPhv.

KEYWORDS

**virtual reality, educational technology, skills, higher education, knowledge society**

# 1 Introduction

Virtual reality (VR) emerges as a three-dimensional digital environment that captures the visual and auditory senses, offering an enriched psychological and physical experience through advanced technologies (Lavoie et al., 2024). This tool transforms the educational landscape, innovates pedagogical methodologies, and significantly improves learning experiences. VR creates immersive environments that facilitate the practical application of theory, promoting more profound and more applied learning. In the current era, where the challenges of the 21st century are eminent, VR has evolved from a novelty to an essential element in pursuing academic excellence. However, a complete understanding of its impact on higher education, especially in competency development, remains limited, posing a dual challenge: on the one hand, it restricts the strategic implementation of VR-based interventions to optimize educational outcomes; on the other hand, it complicates informed decision-making regarding resource allocation, curricular integration, and teacher training (Abdelrazeq et al., 2019; Ponce Lara and Feixa, 2019). This systematic gap has academic consequences and directly impacts institutional reputation and student success, underscoring the need for further research and understanding in this area (Chen et al., 2020; Carlos and Cuauro, 2022). Additional studies highlight how VR contributes to creating more creative and innovative educational environments, promoting autonomous learning, and enhancing computer-mediated education, thus expanding pedagogical possibilities and student success trajectories (Campazzo et al., 2011).

In this context, we have conducted a Systematic Literature Review (SLR), which is timely and essential. By synthesizing a broad spectrum of research, it seeks to offer clarity where there is confusion and direction where there is divergence. The objectives are clear: to delineate the definitive benefits, highlight potential limitations, and elucidate the broader implications of integrating VR into higher education. This involves reviewing outcomes and delving deeper into the processes, pedagogies, and best practices that have emerged at the nexus of virtual reality and education (Zempoalteca et al., 2017; González, 2018).

Furthermore, the importance of this review transcends the academic realm. As global economies evolve, the competencies developed in higher education institutions play a crucial role in shaping professional landscapes, industrial innovations, and social advancements. This review informs educational strategies by examining the role of VR in competency development. It provides insights into how the next generation of professionals might be equipped to face the challenges of a rapidly changing world.

In the following sections, we delve into the methodology that forms the backbone of this SLR, describe the research questions guiding our exploration, and draw insights from a curated body of literature. This journey culminates in a comprehensive overview that, we believe, will serve as a touchstone for future debates, decisions, and developments regarding VR in higher education.

# 2 Theoretical framework

The VR in education represents a transformative approach that aligns well with established learning theories to enhance student engagement and comprehension (Pintado et al., 2023). VR technology offers an immersive environment where theoretical knowledge is applied in simulated real-world scenarios, making learning more interactive and impactful (Lyapunov et al., 2023). This technology allows for a diverse range of educational applications, from basic educational content to complex simulations, ensuring that learners of different levels and capabilities are catered to effectively.

The theoretical underpinnings of VR in education are crucial for understanding its efficacy in various learning environments. The integration of VR into educational settings relies on cognitive theories that emphasize active learning and engagement, enabling a deeper understanding of complex subjects through direct interaction and experience (Stelios et al., 2023). Moreover, VR can transform traditional learning methods by offering a dynamic and flexible learning space that can be tailored to individual learning needs, promoting autonomy and critical thinking (Mondragon Regalado et al., 2023).

The adoption of VR in education is more than just a simple technological addition; it represents a paradigm shift in teaching and learning methodologies. VR not only transforms traditional pedagogical methods, but also challenges our preconceived notions of the interaction between knowledge and the student, providing a scenario where theory and practice intertwine in a revolutionary way (Predescu et al., 2023).

One of the great advancements that VR offers is its ability to eliminate the physical barriers of the traditional classroom, allowing for previously inaccessible learning experiences, such as the virtual exploration of complex biological structures or trips to remote historical sites. This level of immersion not only improves knowledge retention but also facilitates a deeper understanding of concepts that are difficult to visualize.

Beyond improving conceptual understanding, VR has the potential to democratize education. It can provide equal access to enriching educational experiences for students from diverse geographical and socioeconomic backgrounds, which is especially relevant in contexts where educational resources are limited (Fei et al., 2023).

However, the effective integration of VR in the educational environment requires overcoming significant challenges. The need for appropriate technological infrastructure and teacher training is crucial to maximize the benefits of this technology. Additionally, it is vital to consider the potential psychological and cognitive effects of immersive experiences on students to ensure that the use of VR supports the holistic development of learning and not just academic aspects (Konstantinidis and Apostolakis, 2022).

As we assess the extensive possibilities that this technology offers for education, we must be aware of its limitations and challenges, and how it is being integrated into curricula and its long-term impact on teaching and learning processes is crucial to ensure that the education of the future is not only innovative but also inclusive and effective.

# 3 Methodology

A thorough review of existing research was conducted to explore how VR is being used to improve skills in higher education. The goal was to review and understand past studies and set up a guide for future research was proposed in order to extract the most relevant

literature on the application of this technology (Marcos-Pablos and García-Peñalvo, 2018).

The review followed a well-known method called PRISMA 2020, which is often used for detailed reviews, especially when combining results from different studies. This method helped organize and scrutinize the research.

The review process had three main steps. First, it started with identifying relevant studies using specific search terms to find articles in selected databases. This step was crucial in gathering various studies related to VR in education.

Next, the screening phase involved applying specific criteria to decide which studies should be included or excluded. This was important to make sure that only high-quality and relevant studies were considered for the review.

Finally, the chosen studies were analyzed in detail in the eligibility phase. This involved looking closely at the data, evaluating the quality of the evidence, and summarizing the findings to understand the trends, gaps, and practical uses of VR in education.

Throughout this process, a careful analysis was done to ensure the review aligned with the research goals. This helped provide a clear understanding of how VR can be used in education and pointed out areas where more research is needed.

## 3.1 Research questions

The research questions (RQ) were related to specific topics of this study. Four specific questions were formulated in order to collect relevant information on the use of VR in higher education.

- RQ1. In what areas of knowledge has the application of VR as a learning method been researched?
- RQ2. How is VR applied in the context of higher education?
- RQ3. What skills or competences were developed by applying VR in higher education?
- RQ4. What are the research limitations on the application of VR in higher education?

## 3.2 Selection of research studies

The selection of the research studies was an interactive and incremental process with the objective of identifying the most relevant research that answered the questions about the application of VR in teaching-learning processes and its relationship with the development of competences. Based on this, 12 selection criteria were established, 6 inclusion criteria (IC) and 6 exclusion criteria (EC), to identify the most relevant research on the subject under study.

The choice of Scopus and Web of Science as primary sources for this systematic review is justified by their broad international coverage and for hosting high-quality studies, ensuring both scientific rigor and extensive visibility. These databases are recognized for including a wide range of high-impact international journals, thus promoting a wider dissemination of work published in English. In contrast, publications in other languages such as Spanish may face limitations in terms of international visibility (Céspedes, 2021). Additionally, publications on these platforms are subject to rigorous peer-review processes. Publishing in English allows for the standardization of methodologies and terminologies, facilitating the comparison and synthesis of studies in technically complex areas such as VR (Navas-Fernández et al., 2018).

## 3.3 Inclusion criteria

- IC1. This research was published in the last 5 years.
- IC2. This research is written in English.
- IC3. The content of this research can be fully accessed through the subscription of our institution or the associations of which we are members.
- IC4. This research is related to VR and the development of skills or competences in the field of higher education learning.
- IC5. This research includes an adequate structure according to its research method.
- IC6. This research was peer-reviewed.

## 3.4 Exclusion criteria

- EC1. This research was not published in the last 5 years.
- EC2. This research is not written in English.
- EC3. The content of this research cannot be fully accessed through the subscription of our institution or the associations of which we are members.
- EC4. This research is not related to VR and the development of skills or competences in the field of higher education learning.
- EC5. This research does not include an adequate structure according to its research method.
- EC6. This research was not peer reviewed.

## 3.5 Quality assessment questions

The selected research studies that passed the inclusion and exclusion criteria were evaluated using nine quality criteria (QC). Each research study scored 1 point if it met the criterion, 0.5 points if it partially met it, and 0 points if it did not. The rationale for setting the maximum score at 9 points is to ensure that only studies demonstrating comprehensive methodological rigor are included, reflecting a commitment to high-quality research standards. The minimum threshold of 8 points was established to maintain consistency and coherence across the included studies, ensuring that each possesses a baseline level of quality necessary for contributing valuable insights to the review. This approach also facilitates excluding studies with significant limitations, thereby minimizing potential biases and enhancing the credibility of the SLR findings. By adopting this scoring system, we aim to apply a standardized and transparent quality assessment, facilitating the replication of this SLR and providing a clear basis for the inclusion of studies. Studies scoring below 8 points were discarded to uphold these quality standards, reinforcing the integrity and relevance of the research selected for inclusion in this SLR.

### 3.6 Quality criteria

- QC1. Are VR research objectives specified?
- QC2. Do the conclusions evidence that the established objectives were met?
- QC3. Are research questions answered?
- QC4. Is the context of VR clearly specified in this research?
- QC5. Does the study evidence the development of skills or competences by means of VR?
- QC6. Is the study population described in detail?
- QC7. Was the research applied in a real higher education context?
- QC8. Are conclusions accurate and based on the results?
- QC9. Do the authors discuss the problems and limitations of the research carried out?

### 3.7 Database selection

After establishing the criteria for selecting scientific articles, the following requirements for selecting databases were considered:

- Is this database relevant in this research field and does it only contain high-quality academic research?
- Does this database allow similar or equal search strings and logic-based words for searching?
- Does this database allow access to its research studies by logging in with institutional accounts or personal subscriptions?
- Does this database allow to perform a full search on scientific articles or only on specific sections?

Considering the previous questions for conducting the SLR, the Scopus and Web of Science databases were selected by consensus. Both databases met the requirements indicated above and are considered high-impact databases that provided high-quality studies for this research.

### 3.8 Search terms

The main objective of this SLR was to analyze previous research on the application of VR to teaching-learning processes for the development of competencies in higher education. Therefore, the term "Virtual Reality" VR, defined as a computer-generated environment perceived by the human mind as a real-world scenario, was included in every search (Cabrera Duffaut et al., 2020). This type of simulation provides immersive learning; therefore, its application is considered beneficial for higher education. Given that this study focused on applying this technology to learning processes, the word "learning" was also included. When learning, students develop skills or competencies, defined as knowing how to act and know-how abilities. They use the learning attained to transfer their knowledge to a specific context. Therefore, the terms "skills" and "competence" were also included (Sá and Serpa, 2018).

Finally, it was essential to specify that this research was going to be performed in the context of higher education institutions; therefore, the terms "higher education," "universities," or "university" were included. Based on these specifications, search strings were created to collect relevant information.

### 3.9 Search strings

Search strings were created by using Boolean operators (AND / OR) to connect different search terms. To determine the number of research studies that had been carried out on the pre-established keywords, no restrictions were made on search strings and three combinations for each of the Scopus and Web of Science databases were created (Table 1).

## 4 Results

To perform this study, information was collected and analyzed through a process established by the PRISMA 2020 statement (Yepes-Nuñez et al., 2021; Figure 1).

A spreadsheet was created based on the SLR performed by Tinoco-Giraldo et al. (2020) to record each step of the article selection process, where search string results were displayed. Inclusion, exclusion, quality, and selection criteria were applied based on research questions, creating an organized report with the collected information. This file can be accessed through the following link.[1]

In this file, the identification phase appears at the beginning. This was the first step to record information collected from the databases where search strings were applied. In total, 1,671 studies were found in both databases: 944 in Scopus and 727 in WoS (Table 2). Then, the studies were divided into two separate spreadsheets according to their database, and duplicates were removed.

Next, the studies from both databases were combined into one spreadsheet, and duplicates were removed. In total, 715 studies remained. Then, in the screening phase, inclusion and exclusion criteria were applied. Subsequently, those studies that did not meet the requirements were removed.

As a result, 61 research studies were selected. Next, quality criteria were applied, where the methodology and the impact of VR on learning were assessed in each study. Research studies that scored below 8 points were excluded.

For the last phase (Included), the remaining 27 research studies were analyzed. These were considered the most relevant research studies on the topic of interest. They led to determining the current state of VR application to teaching-learning processes for competence development in higher Education.

### 4.1 RQ1. In what areas of knowledge has the application of VR as a learning method been researched?

As evidenced in Figure 2, most of the analyzed research studies were related to health sciences, such as Medicine (Buescher et al.,

1 http://bit.ly/3SyKPhv

TABLE 1 String combinations.

| Source | Research terms |
|---|---|
| Scopus | Combination 1<br>TITLE-ABS-KEY ("virtual reality" AND "learning" AND "higher education" AND "skills") |
| | Combination 2<br>TITLE-ABS-KEY ("virtual reality" AND "learning" AND "universities" AND "skills") |
| | Combination 3<br>TITLE-ABS-KEY (("virtual realities" OR "virtual reality") AND "learning" AND ("university" OR "universities") AND ("skills" OR "competence")) |
| Web of science (WoS) | Combination 1<br>TS = ("virtual reality" AND learning AND "higher education" AND skills) |
| | Combination 2<br>TS = ("virtual reality" AND learning AND university AND skills) |
| | Combination 3<br>TS = ("virtual realities" OR "virtual reality") AND TS = (learning) AND TS = (university OR universities) AND TS = (skills OR competence) |

2018; Alfalah et al., 2019; Chiu et al., 2019; Francis et al., 2020) and Nursing (Dubovi et al., 2017; Hanson et al., 2019; Rim and Shin, 2021). In these cases, VR provides real-life training scenarios, which help students develop their cognitive skills and improve their knowledge acquisition, even for understanding complex subjects such as programming. Furthermore, cognitive processes and understanding are facilitated when classes are taught using virtual games (Srimadhaven et al., 2020). Similarly, this technology has been widely used in the field of Social Sciences, applying it for learning new languages, evidencing that an immersive VR platform is ideal for developing foreign language skills (Dobrova et al., 2016; Bendeck Soto et al., 2020), in addition to acquiring other skills that are necessary for the student's future jobs (Alkoyak-Yildiz et al., 2019).

## 4.2 RQ2. How is VR applied in the context of higher education?

The analyzed studies show that VR is used in many different ways in education, starting by transforming learning into an experiential process in VR classrooms as show in Figure 3, thereby improving knowledge assimilation by applying gamification techniques developed in a digital environment, or turning theory into an entertaining practice (Grivokostopoulou et al., 2019). Consequently, students can also interact with other people or virtual avatars who live in different parts of the world. Thus, VR is also a useful tool for learning new languages, enabling interaction with people who live in other places (Liaw, 2019).

Likewise, these computer-generated environments are used to create virtual biology and chemistry laboratories, where students can perform experiments without exposing themselves to risks, with learning results similar to those obtained in a natural laboratory (Paxinou et al., 2020; Seifan et al., 2020).

On the other hand, it was found that this technology is most frequently used in the medical field. For instance, advanced simulators, such as ARTHRO-VR or DVSS (LeBel et al., 2018; Chiu et al., 2019), are operated by medicine students to perform virtual surgeries without requiring an actual patient. This way, they can become familiar with managing equipment used in real surgeries such as Laparoscopic surgery (Buescher et al., 2018).

In addition, three-dimensional models, such as a 3D heart model, have increased information retention, higher satisfaction levels, and improved self-efficacy among students who have trained virtually before performing surgeries in real operating rooms. This has allowed them to better cope with the levels of stress they undergo (Alfalah et al., 2019; Chiu et al., 2019).

Similarly, thanks to the application of VR, electrical engineering students have been able to attend welding courses assisted by this tool at a low cost. The learning outcomes have been successful and highly satisfying in acquiring skills in this field (Huang et al., 2020).

## 4.3 RQ3. What skills or competences were developed by applying VR in higher education?

Higher education plays a pivotal role in developing transversal competencies in students, equipping them to perform effectively in professional environments (Sá and Serpa, 2018). The analyzed research demonstrates that (VR) serves as a facilitator for this goal, not merely aiding in acquiring knowledge but also providing an authentic learning environment where students can practice and hone generic competencies classified as instrumental, interpersonal, and systemic (Alkoyak-Yildiz et al., 2019).

Among these competencies, public speaking stands out, highlighting the importance of differentiating between mere theoretical content acquisition and the development of actual practical skills (Jakubowski et al., 2019). Furthermore, it emphasizes the need to overcome challenges like fear of failure, motivation for improved performance, and specific obstacles like foreign language learning or fostering creativity and creative thinking (Bujdosó et al., 2017; Liaw, 2019).

The application of VR in fields such as physical culture or sports illustrates rapid and practical skill development, such as sword handling for self-defense, showcasing VR's versatility in competency development (Hamad et al., 2019).

In academic contexts, VR proves its effectiveness through tools that address problems three-dimensionally and teach ethics in simulated environments, offering a deeper understanding and application of ethical concepts (Shvetsova, 2019; Sholihin et al., 2020). In engineering, VR is notable for its ability to facilitate learning in subjects with solid spatial components, such as materials science, electricity, and technical drawing, enhancing interactive spatial visualization and creativity among students (Molina-Carmona et al., 2018; Grivokostopoulou et al., 2019; Huerta et al., 2019; Tarng et al., 2019; Huang et al., 2020).

In Health Sciences, VR is extensively used for motor skill development, allowing students to quickly and efficiently acquire skills through simulators, matching the training of traditional methods but in considerably less time (LeBel et al., 2018; Chiu et al., 2019). In Pharmacology, virtual immersion significantly enhances the understanding and management of concepts necessary for medication management, a critical competency for prescribing and treatment in their future professional roles (Hanson et al., 2019).

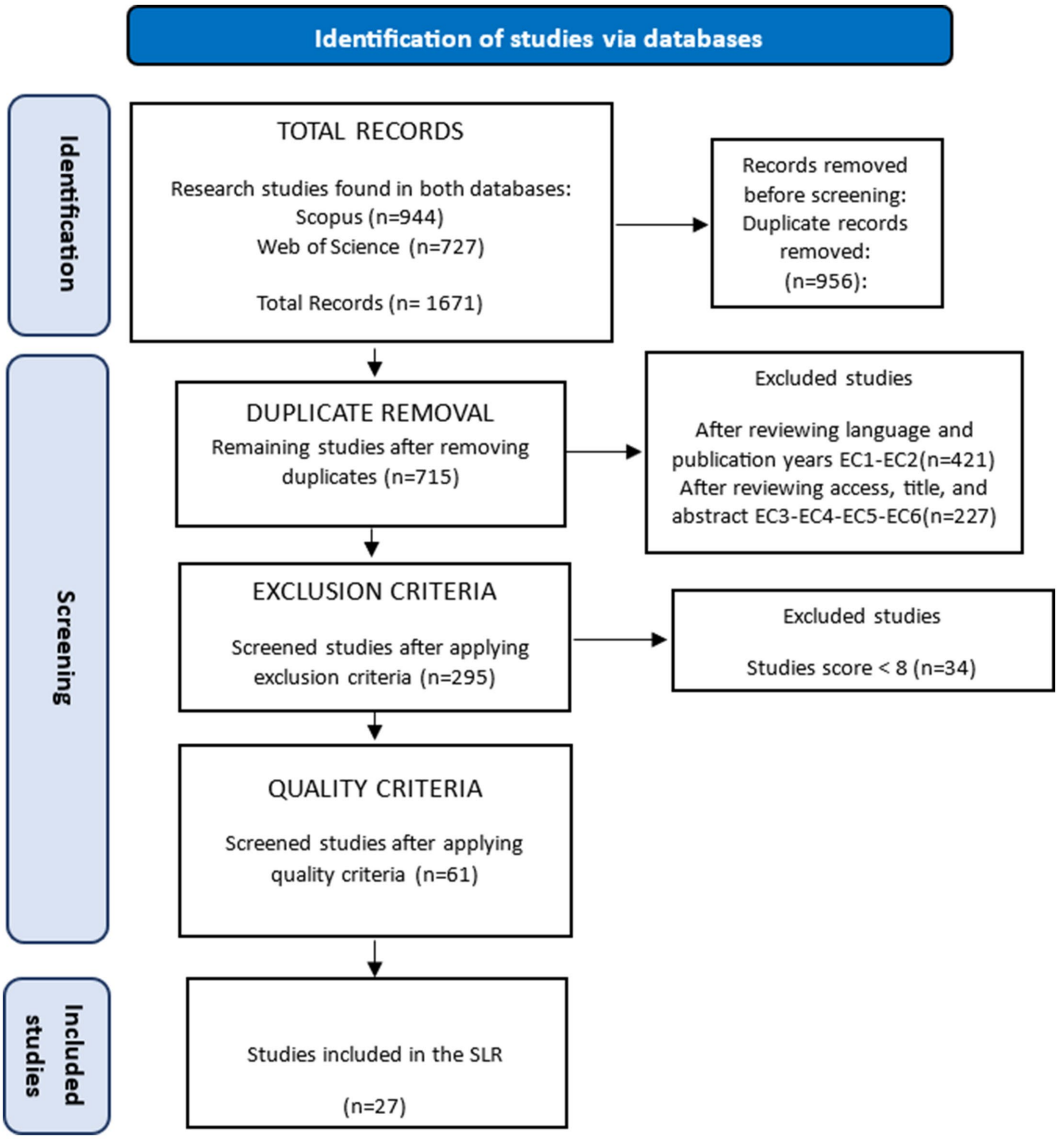


FIGURE 1
PRISMA flow diagram.

TABLE 2 Distribution of studies identified in databases.

| source | Research terms | Number of studies |
|---|---|---|
| Scopus | Combination 1 | 124 |
| | Combination 2 | 389 |
| | Combination 3 | 431 |
| | Total | 944 |
| WoS | Combination 1 | 95 |
| | Combination 2 | 304 |
| | Combination 3 | 328 |
| | Total | 727 |
| Total | | 1,671 |

This analysis delves into the distinction between content acquisition and effective competency development, underscoring the significant contribution of VR in comprehensively preparing students for the challenges of the professional and academic world.

Table 3 shows the number of research studies on VR and the different competencies that were developed based on the classification established by the Tuning project (González et al., 2004).

## 4.4 RQ4. What are the research limitations on the application of VR in higher education?

The integration of emerging technologies such as VR in higher education presents multifaceted challenges. A notable limitation is the

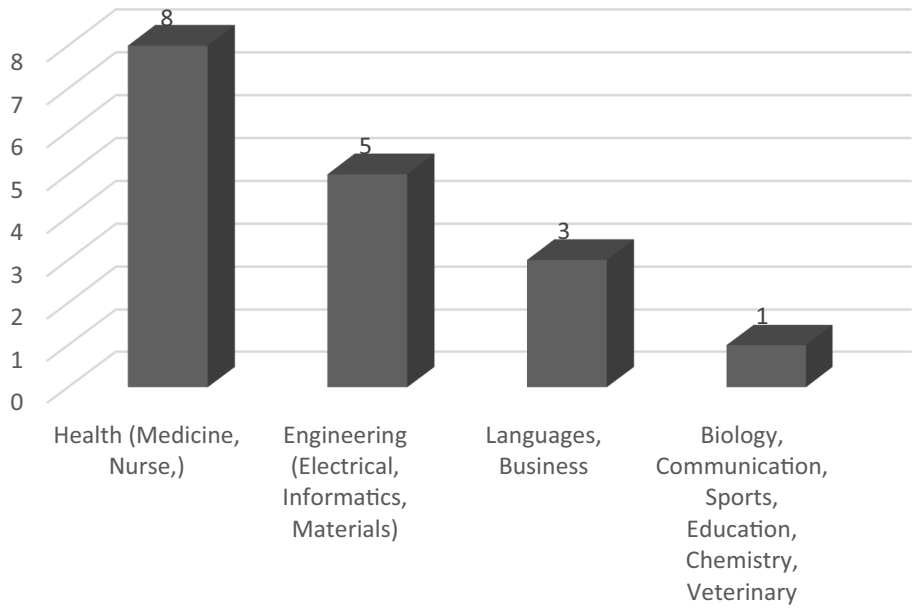


FIGURE 2
VR research.

FIGURE 3
VR classroom.

market's tendency to prioritize VR applications in video games over educational uses, mainly due to the inherent complexities of adapting them to curricula (Jakubowski et al., 2019). This prioritization results in a scarcity of educational VR software tailored only to specific academic disciplines, limiting researchers to relying on customized applications for their studies.

Moreover, although the cost of VR technology is decreasing, it remains a significant barrier to its widespread adoption in educational settings (Huang et al., 2020). The dynamic nature of technological advancements requires continuous updates of immersive environments or their devices, and adaptation by educators and students alike, introducing additional layers of complexity in their implementation (Boetje and Ginkel, 2021). This ongoing technological evolution, along with generational differences in digital literacy, underscores the need for educators to develop the necessary competencies to integrate it effectively into their pedagogical practices.

Another critical concern is the limited scope of existing research, which often focuses on its application in health sciences, as exemplified by Onlabs, an application developed by an interdisciplinary team from the Hellenic Open University for educational purposes (Paxinou et al., 2020). The predominance of health science applications may reduce its perceived utility in other academic domains.

## 4.5 Theoretical and practical implications

- Competency Development: It is crucial for educators to develop the necessary competencies to effectively integrate VR into their

TABLE 3 Number of research studies on the acquisition of skills through VR.

| Skills | Capabilities | Number of studies | Authors |
|---|---|---|---|
| Instrumental | Communication | 3 | Alkoyak-Yildiz et al. (2019); Jakubowski et al. (2019); Boetje and Ginkel (2021) |
| | Language | 3 | Dobrova et al. (2016); Liaw (2019); Bendeck Soto et al. (2020). |
| | Learning | 2 | Alfalah et al. (2019); Hanson et al. (2019). |
| | Problem solving | 3 | Majernik et al. (2017); Shvetsova (2019); Srimadhaven et al. (2020). |
| Interpersonal | Ethics | 1 | Sholihin et al. (2020). |
| | Decision making | 2 | Francis et al. (2020); Rim and Shin (2021). |
| Systemic | Intellectual stimulation | 3 | Molina-Carmona et al. (2018); Tarng et al. (2019); Seifan et al. (2020). |
| | Quality development | 7 | Dubovi et al. (2017); Buescher et al. (2018); LeBel et al. (2018); Chiu et al. (2019). |
| | Creativity and invention | 2 | Bujdosó et al. (2017); Huerta et al. (2019). |
| | Entrepreneurship | 1 | Grivokostopoulou et al. (2019). |

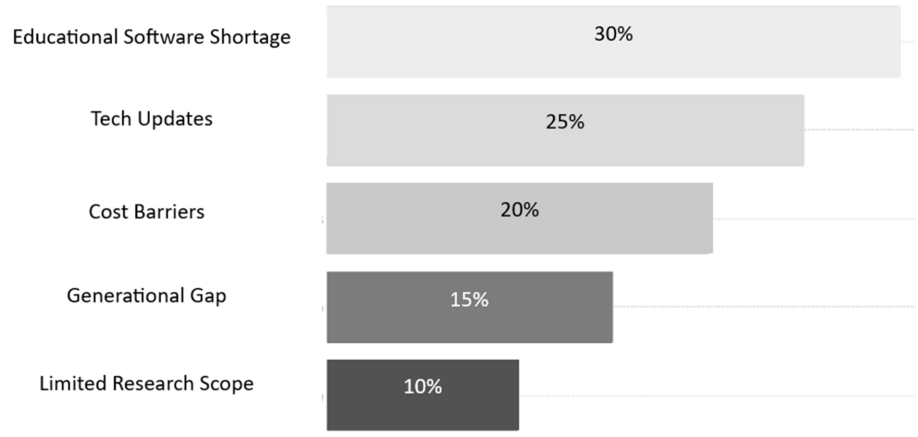


FIGURE 4
Infographic: proportional limitations of VR in higher education.

pedagogical practices. This involves not only familiarizing themselves with the technology but also adapting their teaching methods to leverage the immersive capabilities of this technology.
- Curricular Adaptation: Educational institutions should consider integrating curricula that include the use of VR in ways that complement and enrich the learning experience, rather than merely serving as an additional technological tool.

## 4.6 Future research directions

- Expansion of Applications in Diverse Disciplines: More research is needed to explore the use of VR beyond health sciences, opening potential for its application in areas such as the exact and social sciences, arts, and humanities.
- Long-Term Studies: More longitudinal studies that assess the effects of implementing VR in higher education over time would be beneficial, allowing a better understanding of its long-term impact and effectiveness.
- Impact Assessment on Digital Competence: Investigating how the implementation of VR affects the digital competence of students and educators could provide valuable insights for the development of training programs and technological adaptation in educational institutions.

In summary, the limitations of the research as observed in Figure 4, are characterized by a shortage of educational applications, continuous updates of technology, implementation costs, adaptation, the generational nature of teachers, and limited research demonstrating its effectiveness. These factors together pose significant challenges for the integration of virtual reality into educational practices, requiring a concerted effort to develop customized solutions that address these barriers.

# 5 Discussion

Adopting Virtual Reality (VR) in higher education is notable for its immersive learning experiences, particularly in health sciences and language learning, where it offers realistic simulations and cultural

immersion, enhancing both skill mastery and communicative competencies (Dobrova et al., 2016; Bendeck Soto et al., 2020). Despite VR's educational promise, its widespread integration faces challenges, including the high costs of VR technology and a lack of specialized educational software, which limit its accessibility across various academic disciplines (Bujdosó et al., 2017; Jakubowski et al., 2019).

Research diversity in VR underscores its adaptability, suggesting that with ongoing technological advancements, many current barriers, such as cost, could become less prohibitive, allowing for broader application in education (Grivokostopoulou et al., 2019; Liaw, 2019). VR's strength is facilitating experiential learning, fostering critical competencies like spatial reasoning and problem-solving, and providing a dynamic platform for students to engage with complex concepts in a practical context (Huerta et al., 2019; Boetje and Ginkel, 2021).

For VR to be most effective in education, it should not replace but complement traditional teaching methods, enriching the overall learning experience by blending immersive VR experiences with conventional educational content (Jakubowski et al., 2019). The successful integration of VR into teaching and learning processes necessitates targeted training for educators to effectively use VR technology, ensuring its pedagogical benefits are fully realized (Boetje and Ginkel, 2021).

Although only VR analysis has been incorporated into this SLR, the incorporation of additional technologies such as Mixed Reality (MR) and Extended Reality (XR) offers a more integrated approach. MR and XR combine real and virtual worlds to create interactive and fluid experiences that can be incorporated more naturally into the classroom, enhancing the learning process. References to these technologies in educational settings show that they can significantly improve user engagement and learning outcomes, thereby preparing students more effectively for their future careers (Chang et al., 2023).

The positive response from students toward these technologies, marked by increased engagement and motivation, highlights their potential to significantly enhance educational outcomes. Thus, addressing the challenges of integrating VR, MR, and XR is crucial for leveraging their full potential to improve both teaching and learning experiences (Grivokostopoulou et al., 2019; Hamad et al., 2019).

## 6 Conclusion

Global technological advancements have unveiled many opportunities within the educational sector, with VR as a technology capable of crafting interactive, three-dimensional environments. This technology offers immersive learning experiences, propelling educational methodologies beyond traditional boundaries. Through the lens of this SLR, it becomes evident that the application of VR in education transcends mere knowledge transfer, facilitating the development of critical competencies such as spatial reasoning, problem-solving, creativity, innovation, and oral presentation skills (Huerta et al., 2019; Boetje and Ginkel, 2021).

While VR's significant impact has been notably observed within the health sciences domain—owing to its pivotal role in simulating clinical scenarios and enhancing pre-clinical training (Alfalah et al., 2019), it is imperative to recognize that the technology's potential is not confined to this field alone. The inclination toward health sciences stems from the immediate applicability and observable benefits in skill acquisition crucial for medical practice. However, this should not overshadow VR's versatility and profound implications across various disciplines.

Educators are encouraged to tailor VR tasks to align with students' proficiency levels, facilitating peer observation learning methods that cater to individual needs (Chiu et al., 2019). Such customization fosters creativity and innovation, as students are inspired to navigate and manipulate spatial information within these novel virtual environments, creating unique outputs (Bujdosó et al., 2017). Students gain a sense of security and confidence from practicing within VR environments (Majernik et al., 2017). Bridges the gap between theoretical knowledge and practical application, ensuring the retention of acquired skills for extended periods (Buescher et al., 2018).

Furthermore, VR's utility enhances students' comprehension of complex structures and concepts, making it an invaluable tool for improving overall academic performance across all student levels (Alfalah et al., 2019; Tarng et al., 2019; Srimadhaven et al., 2020). However, it is crucial to acknowledge the limitations in VR's capability to convey highly theoretical or complex knowledge systems, suggesting a complementary role alongside traditional educational methods (Jakubowski et al., 2019).

The inclusion of VR in educational settings has been met with enthusiasm, evidenced by increased student engagement, motivation, and the development of essential skills and competencies (Hamad et al., 2019; Shvetsova, 2019). This technology has been accepted and embraced for its usability and potential as a learning tool (Alkoyak-Yildiz et al., 2019; Paxinou et al., 2020).

In conclusion, while virtual reality has made significant progress in improving educational experiences and outcomes, it is essential to continue exploring its integration into various disciplines beyond the health sciences. A limitation of this SLR is its exclusive focus on the term Virtual Reality (VR), without considering Mixed Reality (MR) and Extended Reality (XR), which may have reduced the spectrum of studies reviewed, limiting a more complete understanding of the integrative benefits of MRI and XR in the classroom. Therefore, a comprehensive understanding of its applications, benefits and limitations is crucial, ensuring that the implementation of virtual reality in higher education is practical and sustainable. Ongoing research and adaptation to the rapid evolution of immersive technologies are critical to realizing their full potential to transform educational paradigms and equip students with the competencies necessary for success in their professional and personal lives.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author.

## Author contributions

AC-D: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project

administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. AP-L: Conceptualization, Data curation, Investigation, Methodology, Project administration, Supervision, Validation, Visualization, Writing – review & editing. AI-R: Conceptualization, Data curation, Investigation, Methodology, Project administration, Supervision, Validation, Visualization, Writing – review & editing.

## Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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