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Virtual and Augmented Reality in the Development of Distance Learning

Mykola Chumak
Doctor of Pedagogical Sciences, Professor, Professor of the Department of Information Technology and Programming, Dragomanov Ukrainian State University, Kyiv, Ukraine.
chumak.m.e@gmail.com,
https://orcid.org/0000-0002-9956-9429

Volodymyr Sushko
PhD, Acting Head of the Department of Social Sciences, Kherson Educational and Scientific Institute, Admiral Makarov National University of Shipbuilding, Kherson, Ukraine.
yuot.wsl5791@gmail.com,
https://orcid.org/0009-0003-7810-2111

Yuliia Sylenko
Senior Lecturer at the Department of Multimedia Design, Kyiv National University of Technologies and Design, Kyiv, Ukraine
PhD Student in the Educational and Scientific Program 015 Professional Education, Dragomanov Ukrainian State University, Kyiv, Ukraine.
yulchichok1@gmail.com,
https://orcid.org/0000-0002-5535-176X

Inna Fedorova
PhD in Philosophy, Senior Lecturer of Department of Social and Human Sciences, Odessa State Agrarian University, Odessa, Ukraine.
Innafedorova1976@ukr.net,
https://orcid.org/0000-0002-6345-2309

Abstract: *The article examines the emerging role of virtual and augmented reality technologies in distance learning. It addresses the challenges of adapting these technologies to enhance student learning outcomes. Particular attention is given to the neuropsychological mechanisms involved in reducing the "cognitive gap" and mitigating social isolation in online learning environments. The study further discusses the integration of empirical methods as a means of improving educational effectiveness. In addition, a six-step methodology is proposed to support the adoption of these technologies as core components of distance education. This methodology ranges from teacher training to the deployment of cloud-based immersive platforms. The findings indicate that augmented reality, particularly when implemented through mobile devices, can eliminate the need for physical laboratories. It maintains a strong sense of presence and ensures high levels of student engagement, regardless of geographical location. At the same time, the article critically analyses the limitations of immersive models, including rigid linear scenarios, students' cognitive passivity, and the lack of timely online feedback.*

Keywords: *higher education; new technologies; augmented reality; virtual reality; distance learning.*

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Yuliia Kolisnyk-Humeniuk
Doctor of Science in Pedagogy, Associated Professor, Associated Professor of the Department of Technological Education, Faculty of Technologies and Design, Dragomanov Ukrainian State University, Kyiv, Ukraine.
yuliya.kolisnyk@gmail.com,
https://orcid.org/0000-0001-8047-9143

Liudmyla Slobodianiuk
Doctor of Philosophy, Lecturer-Methodologist of the Highest Category, Kyiv Applied College of Communications, Kyiv, Ukraine.
ldmlslbdnk@gmail.com,
https://orcid.org/0009-0004-7603-1572

1. Introduction

Most previous studies have examined VR and AR as separate technological innovations or focused on their general educational potential. However, researchers have insufficiently addressed the systematic, phased implementation of these technologies in distance education, including the methodological justification of equipment acquisition and deployment.

Virtual and augmented reality technologies have recently emerged in the field of education. Their primary purpose is to enhance student learning outcomes. This is particularly relevant in the context of rapidly developing distance learning, where there is an urgent need to overcome the "screen barrier" between teacher and learner. These technologies introduce an experiential dimension to education, enabling students to acquire knowledge through active engagement rather than passive reception. As a result, multiple stakeholders are involved in this process, all of whom are essential for the success of such initiatives.

From the perspective of neuropedagogy, immersive technologies can facilitate the activation of neural networks that are typically underutilised during traditional online lectures. They transform remote observation into active empirical immersion.

First, students act as recipients and digital natives – learners who readily adopt new technologies influenced by societal technological progress. They increasingly expect such tools to be accessible within the standard educational environment. In distance learning contexts, VR/AR also serve as instruments for socialisation and collaborative learning in virtual spaces.

Secondly, teaching staff are academic professionals who require targeted training to integrate these innovations into their pedagogical practice. Their active participation in the design and implementation of such solutions is essential. Teachers possess detailed knowledge of areas where students may require additional support and can therefore identify where immersive experiences are most pedagogically effective. In distance learning, the teacher's role shifts towards that of a moderator of virtual experiences, guiding students through a three-dimensional information environment.

Thirdly, institutions that invest in these types of technologies must integrate them within their educational innovation models. It is not sufficient to provide a limited number of trial devices for users. As an alternative, institutions should focus their efforts on delivering both technological solutions and training that enhance educational quality to the highest possible level.

Finally, manufacturers play a significant role through the development of devices, applications, and initiatives that may contribute to reducing barriers to the adoption and expansion of these emerging technologies. However, the most critical aspect of virtual and augmented reality is not their potential, the hardware, or even the existing applications. Rather, it concerns the conceptual understanding of these technologies and their functional roles within educational and practical contexts.

In this article, VR/AR technologies are considered as a methodological basis for reducing cognitive load and enhancing neuroplasticity during remote learning of complex abstract knowledge. The primary objective is to improve student outcomes throughout the educational process. Conceptually, this involves building holistic digital ecosystems within which virtual laboratories may serve as complete substitutes for traditional classrooms. This shift requires a reconsideration of didactic principles in distance education and a transition from information transmission to the modelling of virtual experience.

In the neuropedagogical context, hypothesised mechanisms of sensorimotor integration may support this transition. Unlike flat interfaces, immersive technologies can activate mirror neurone systems and motor cortical areas even in the absence of physical movement. This facilitates the formation of stable neural connections through the mechanism of "embodied cognition", whereby the brain is expected to process virtual manipulation of objects as a form of real-world experience. This is particularly important for overcoming cognitive passivity in online learning environments. Ultimately, these technologies are tools, and the continuous improvement of student learning outcomes remains the central and ongoing goal of this field.

2. Theoretical Framework

2.1. Virtual Reality vs. Augmented Reality

Based on the definitions presented above, some comparisons can be made: virtual reality operates in new environments that are entirely computer-generated. Everything the user can perceive or interact with is virtual. Augmented reality uses virtual elements only to enhance the real world and the user experience (Sikora et al., 2024).

Virtual reality provides a fully immersive experience by displacing the physical world, a characteristic not shared by augmented reality. The difference in levels of immersion determines a different impact on the cognitive load of the student. VR provides a high degree of sensory isolation from external distractions, which may contribute to entering the “flow state”. Meanwhile, AR is based on the principles of expanding working memory. By superimposing digital data onto real objects, AR unloads the prefrontal cortex of the brain, as the student does not need to spend cognitive resources on visualising complex schemes in their minds – they become part of their physical space. Users are completely separated from the real/physical world in VR and connected to the physical world through augmented reality. They are fully aware of their surroundings and can perceive, feel, and interact with the real world using all the digital information provided by the application.

Virtual reality requires a high-performance processor. Although some applications can be launched on mobile devices, their functionality remains limited due to hardware constraints. Augmented reality, by contrast, can provide a wide range of interactive services through tablets and smartphones. It is not limited to Microsoft HoloLens or Meta 2 but also includes other specialised devices that are highly demanding in terms of technical requirements. Other augmented reality applications run on mobile phones with a full range of features. From a broader perspective, virtual reality is characterised by a high proportion of virtual content and a minimal degree of real-world input. Meanwhile, augmented reality is characterised by a greater proportion of real-world context combined with digital elements. It should be noted that these proportions vary depending on the specific application. These values represent general estimates based on current market applications (Redko, 2023).

To systematise the theoretical foundations presented, a comparative overview is provided in Table 1. This overview also aims to clearly distinguish the functional capabilities of these technologies in distance education.

To better understand the specific applications of immersive technologies in education, it is necessary to clarify their characteristics and conduct a comparative analysis. Although VR and AR are often considered within the broader context of the digital transformation of education, they differ in several key parameters. These include the nature of the environment created, the degree of learner immersion, hardware requirements, and didactic functions.

To consolidate the theoretical principles outlined above, Table 1 presents a comparative analysis of VR and AR. The table also highlights their functional capabilities in distance learning. VR provides a high degree of sensory immersion and largely isolates the learner from the physical environment. It requires relatively powerful hardware, which makes VR particularly suitable for simulating complex, hazardous, or otherwise inaccessible situations.

By contrast, AR integrates digital objects into the learner’s physical environment. It therefore provides partial immersion and greater accessibility. AR can be used with conventional mobile devices. This facilitates the real-time visualisation and manipulation of three-dimensional models.

Based on the above data, it is evident that virtual reality has found a new field within education in which to fully realise its potential. The educational sector contains all the necessary conditions in which this technology adds value and becomes a significant differentiating factor (Bernuy et al., 2021).

Table 1. Comparative characteristics of immersive technologies in education

Comparative parameter	Virtual reality (VR)	Augmented reality (AR)
Nature of the environment	Fully artificial, computer-generated digital environment	Overlay of digital objects onto the real physical world
Level of immersion	100% immersion (complete isolation from the physical world)	Partial immersion (connection with the physical environment is maintained)
Ratio (real/virtual)	~10% real world / 90% virtual content	~75% real world / 25% virtual objects
Hardware requirements	Requires high computational power (PCs, VR headsets)	Available on mobile devices (smartphones and tablets)
Role in learning	Simulation of dangerous or inaccessible situations (simulators)	Visualisation of complex 3D models in real time

Source: The authors' own conception

The greatest impact in educational systems is exerted by teaching methods that place students in real or realistic situations. These situations must be solved using acquired theoretical knowledge or require the development of skills that were previously absent or insufficiently developed (Tamra et al., 2026). Until now, such situations have typically been presented through text descriptions or, in some cases, audio materials, with or without video support. With the help of virtual reality technology, specific scenarios can be programmed with multiple variables and environments in which students are able to act and make decisions.

2.2. Augmented Reality in Distance Education

Augmented reality, although at an earlier stage of development than virtual reality, has been present in the educational sector since its emergence. Within educational processes, augmented reality enables students to engage in learning activities that enhance their creative potential without exposure to production risks and high costs. The risks associated with inexperience, which can significantly increase the complexity of project implementation and lead to various consequences, can be substantially reduced. Using this technology, students can visualise the final result in real space without completing the physical production process (Parmaxi & Demetriou, 2020).

Similarly, medical and engineering classes allow teachers to share knowledge with students using images superimposed onto the reality of their classrooms. Through a three-dimensional digital model of the human body, the teacher can access any type of information about its components. The teacher can isolate individual parts to show details or even allow students to interact with the model to develop various learning activities.

In engineering education, similar applications include digital models of engines, printed circuit boards, or architectural structures. These models allow for interaction among students and integrate the social aspect of real-time experience sharing with classmates (Dubiel et al., 2025).

An important neuropsychological effect in this context is the reduction of the "cognitive gap" between abstract theory and spatial representation. Three-dimensional visualisation stimulates the neural mechanisms associated with spatial cognition. This enables students to more rapidly construct a holistic mental model of complex systems (e.g., anatomical structures or engineering nodes). This further reduces the effects of social isolation, as collaborative work on a virtual model may engage brain areas involved in non-verbal communication and empathy, even at a distance.

An effective example of using such technologies in the healthcare field is AR Liver. This tool creates accurate anatomical models and improves future doctors' professional communication skills (Iso-Form, 2026). Another optimal solution is 4D Anatomy (2026). Further examples can be found in other applied educational domains, such as aeronautical engineering (Makransky & Petersen, 2021). In particular, Holoflight allows users to visualise real flight data in 3D as holograms (Valorem, 2026). Finally, Holostudy offers a series of lessons in geology, physics, chemistry, and biology (Holostudy, 2026).

Undoubtedly, these applications are designed to challenge the current paradigm of education. The current challenge is to determine which technology is most suitable for each subject area. It is therefore reasonable to assume that the increasing availability of applications on the market will improve balance in these early stages. However, it is crucial to identify empirical evidence supporting the different proposals of developers (Khmil et al., 2023).

The benefits of virtual reality are still being explored and are primarily directed towards improving student learning outcomes. Although only a few years have passed since the first experimental applications in formal education, important contributions have already been made. These contributions relate to the understanding of abstract concepts and learning in authentic contexts. By using a custom-built environment, students can experience learning across several sensory modalities. Although this may appear marginal, such experiences can become essential for understanding the previously unfamiliar concepts (Zekeik et al., 2025).

The navigation of complex mathematical functions or exploration of the human body are only some of the most successful applications observed in the early stages of VR implementation in education. Thus, one of the main advantages of virtual reality lies in its use as a tool for improving the understanding of abstract and complex concepts.

With regard to virtual reality systems, there has been significant progress from early devices that enabled only one-way information transmission and served primarily as passive viewing tools. At present, the technology has evolved into more advanced versions, in which interactive engagement with the environment is actively developed. This provides substantial additional value, as it enables users to experience themselves as active participants in a simulated situation rather than passive observers.

The systems designed for this technology primarily consist of visual and audio components, to which additional elements are integrated, enabling user interaction with the virtual environment (Radianti et al., 2020).

Therefore, augmented reality and virtual reality should coexist as complementary technologies. To systematise the practical application of immersive technologies across different fields of knowledge and to define their didactic value, Table 2 is presented below.

The practical use of immersive technologies in distance learning demonstrates their versatility across different subject areas. Virtual and augmented reality tools can be adapted to the specific requirements of each discipline. They can transform the passive acquisition of theoretical knowledge into interactive and practice-orientated activities. The didactic value of AR/VR is not limited to improving visualisation. These technologies can also help address important educational challenges, from ensuring safety during experiments to reducing the costs of educational provision.

Immersive technologies can be effectively used in the natural sciences, medicine, engineering, architecture, and the humanities. In medicine and biology, 3D anatomy atlases enable learners to study internal body structures in detail without biological risks. In engineering, aviation, architecture, and design, holographic models and interactive spatial environments can support the study of complex mechanisms and the design of objects. They can also reduce the need for costly physical prototypes and specialised equipment. In the natural sciences, virtual labouratories provide a safe environment for conducting experiments. In mathematics, AR/VR tools can represent abstract functions and formulas as three-dimensional objects, making them easier to visualise and understand.

The functional capabilities and didactic effects of AR/VR technologies across different subject areas in distance education are presented in Table 2.

Table 2. Functional capabilities of AR/VR across subject areas in distance education

Field of knowledge	Technological solution	Educational effect (didactic value)
Medicine and biology	3D anatomy atlases (ARLiver, 4D Anatomy)	Visualisation of internal structures without biological risk
Engineering and aviation	Holographic models, Holoflight	Study of complex mechanisms; reduction of equipment costs
Architecture and design	Spatial design of objects	Possibility of iterative design without physical prototypes
Natural sciences	Virtual laboratories (Holostudy)	Experimental verification of laws in a safe environment
Mathematics	Visualisation of abstract functions	Transformation of formulas into spatial objects to support understanding of functions

Source: The authors' own conception

3. Stages of Implementing New Technologies in Distance Education

To systematise the process of digital transformation in education and facilitate the transition towards immersive learning models, a comprehensive six-stage methodology is proposed. This methodology covers the entire implementation cycle, ranging from the preparation of human capital to technical deployment and empirical data collection (see Table 3).

The systematic introduction of immersive technologies into education requires shifting away from spontaneous equipment purchases and the isolated use of individual applications. To ensure effective use of these technologies and reduce the risk of unsuccessful implementation, a phased methodology has been developed. It covers the entire integration process, from teacher training to monitoring learning outcomes in distance education.

Each stage involves coordinated actions by the main participants in the educational process, including teachers, methodologists, developers, and students. Each stage also has a specific practical objective.

The initial phases (I–III) focus on developing the conceptual framework, designing the educational experience, and defining technical requirements with the participation of an educational architect. The next phases (IV–VI) include production, pilot testing, teacher training, and the implementation of the solutions in an online course.

The structure, key participants, and expected outcomes of the six-stage methodology for integrating VR/AR into distance education are presented in Table 3.

Table 3. A six-step methodology for the integration of VR/AR into distance education

Stage	Title and content	Key participants	Expected outcome
I	Theoretical and applied training	Academic teaching staff	Mastery of conceptual terminology and familiarisation with devices and platforms
II	Conceptual design	Subject specialist	Development of a methodological prototype (objectives, content, and assessment rubrics)
III	Technical and pedagogical development	Lecturer, programmer, educational architect	Formulation of functional requirements and technical specifications for development
IV	Production and pilot testing	Developers, students	Creation of a functional version, correction of errors, and deployment of the final product
V	Methodological preparation	Lecturers	Training in active methodologies for integrating the developed immersive experience into an online course
VI	Implementation	Lecturers, students	Applying active methods and learning experiences in an online course

Source: The authors' own conception

The first phase involves training teachers in the use of these emerging technologies. Due to their novelty, the majority of teaching staff do not yet possess sufficient knowledge of these tools and are therefore unaware of their potential pedagogical applications. This phase consists of two distinct components.

On the one hand, it describes the basic concepts that form the elements of the technology. They include devices, mobility, environments, types of interaction, existing platforms, and upcoming trends. On the other hand, it is important to complete the first stage of learning using existing application examples that can illustrate the previously presented concepts (Garlinska et al., 2023).

Both real and virtual environments influence the development of solutions. An additional requirement concerns the ways users interact within these environments, including tools and task-based actions. At the same time, solutions across different areas of knowledge are also relevant (Latif et al., 2024).

After completing this first phase, teachers can recognise the potential of both technologies. This knowledge leads to an individual design phase aimed at developing initial applications to be integrated into their courses. It is important to strengthen areas that enhance students' understanding of the subject through immersive methods. These technologies should be viewed as tools for constructing learning experiences, rather than as communication channels such as face-to-face or online interaction (Stojšić et al., 2022).

The second phase involves the development of an initial conceptual prototype of the experience that the teacher intends to implement within the course. This prototype may involve the development of a new solution, the adaptation of an existing one, or the direct use of a commercial application. The outcome comprises not only the functional requirements of the experience from a software perspective. It also includes the methodology used to introduce the course, the learning objectives to be achieved, and an assessment rubric for evaluating the learning outcomes derived from the experience. To achieve this, teachers are required to analyse in detail the structure and content of their subject (Taranhul & Romaniuk, 2022).

The most important elements at this stage include content selection, learning activities, and the pedagogical use of available immersive technologies. These include scenarios, interaction types, conceptual elements to be integrated into the solution, timeframes, the required number of participants, and other key design parameters. The duration of this stage should preferably not exceed 20 days to preserve the knowledge acquired during the initial training phase. Due to the lack of widespread home access to this technology, essential concepts may be forgotten, subsequently reducing the effectiveness of experience design (Khmelnytska, 2023).

The third phase involves collaborative work within a multidisciplinary team. This group consists of a subject matter expert (teacher), a technical specialist responsible for development and adaptation of technology-based solutions, and an educational architect. The educational architect is responsible for guiding the teacher by recommending optimal practices for improving the proposed learning experience. The output of this phase is a set of functional requirements that serve as input for the production and/or adaptation stage. Such processes may be carried out internally within an institution or outsourced to external providers. Given the novelty of the technology, strict quality assurance procedures are essential, as the initial implementation of a new methodology significantly influences its acceptance by both teachers and students (Bannikov, 2022).

At this stage, the educational architect must also consider neurobiological limits of perception. Scenario design should be based on the principle of segmentation. Under this principle, complex immersive experiences are divided into short learning episodes. This approach helps prevent digital fatigue and supports optimal neuroplastic adaptation during the acquisition of new competencies.

The production phase (phase four) creates results through two stages. First, it is necessary to develop a prototype version and test it within a small group of students in a controlled environment. Emphasis should be placed on identifying and eliminating possible programming errors. At the same time, the technical interpretation of functional requirements and the teacher's conceptual design should be coordinated. Second, a fully functional version is prepared for the implementation

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within the corresponding course. This version must be further reviewed and updated based on evaluation results and feedback from stakeholders.

The fifth phase begins with pre-developed learning experiences embedded within the subject area. Teachers need to be trained to integrate such solutions into their pedagogical practice. According to Bouchrika (2026), it is critical to create face-to-face and/or online courses that involve active learning methods and advanced technologies. The initial stage of training introduces the main technological features and tools.

After building a basic foundation of knowledge, the learning process should include relevant pedagogical components. They are as follows: 1) setting learning goals, 2) practical assignments, 3) rubric design, 4) collaborative activities, and 5) discussion of authentic challenges addressed through virtual scenarios (Magaña et al., 2025).

Finally, after completion of the first five phases, the experience is implemented within a regular academic course with students (phase six). It is essential to clearly communicate to students the intended learning objectives and the rationale for using these technologies. In addition, systematic feedback should be collected to refine and improve the experience.

During implementation, intensive and carefully structured technical and pedagogical support must be provided to both teachers and students. Regardless of the quality of the technological solution, the surrounding learning environment must be highly stable and well-prepared. It should also be noted that improvements in student learning outcomes will significantly support the further adoption of such innovations in education. The opportunities within the educational sector clearly indicate two distinct implementation pathways. Each pathway has different characteristics that can be strategically used to maximise the potential of these technologies.

First, the potential of immersive technologies for face-to-face learning should be considered. Such learning revolves around the conceptual creation of simulators designed to mirror actual scenarios in defined areas. The aim is to place students in highly realistic conditions.

Future development is closely linked to the creation of platforms that allow such environments to be configured rapidly, without the need to develop new solutions from scratch each time. In practical terms, this should lead to a shift whereby laboratories are predominantly virtual. This transition would contribute to greater system flexibility, lower costs, and improved learning experiences for students.

In parallel with this development, and in connection with augmented reality, future developments are expected to focus on the real-time sharing of digital visualisations. These include interactive models applicable in fields such as healthcare, engineering, and architecture. Students will be able to interact with these models in real time, while the entire class will be able not only to observe but also to engage with them collaboratively.

A clear example is the study of an engine or the human body within a theoretical framework, where learners can select and manipulate individual components of the model. In addition to visualisation, students also receive detailed information about each element (Tene et al., 2024).

4. Augmented and Virtual Reality in Online Education

The online education sector is arguably the area with the greatest potential for growth through the application of immersive technologies. Market trends indicate that the distance learning segment is expanding at a double-digit rate across most global markets. This growth leads to an increasing number of users and, consequently, a broader range of educational offerings driven by emerging business opportunities. Intensified competition, following basic market logic, is expected to improve the quality of educational products as providers seek to capture a larger market share. However, price reduction has a natural lower limit, beyond which educational products risk losing credibility and professional value, particularly when qualifications are used as labour market requirements.

This situation is likely to change significantly with the integration of immersive educational experiences using virtual and augmented reality. From a technological perspective, the main breakthrough has been the adaptation of these technologies to a device with over 95% global penetration – the smartphone. Continuous advances in mobile processors and display quality have further accelerated this development.

From a conceptual and service perspective, the future of virtual and augmented reality in online education involves the integration of fully immersive learning experiences into standard educational programmes. Such experiences can enhance the quality of distance education. New VR-based systems embedded in digital learning environments will enable students to attend classes virtually. They are expected to create a sense of presence similar to that of a physical classroom, allowing interaction with peers and teachers in real time.

Simple applications already exist that demonstrate the feasibility of this concept. Classrooms may be relocated to any point on the planet, reducing the sense of isolation that is often associated with web pages or online learning platforms. The goal, and with it the future of online education, is to combine the advantages of both approaches (Khmil et al., 2023).

The recommended duration of immersive sessions (no more than 15–20 minutes continuously) is based on the principles of Mayer's (2014) cognitive theory of multimedia learning, particularly the segmentation effect, as well as limitations of working memory capacity (Miller's (1956) law of 7 ± 2). Prolonged passive screen viewing may contribute to cognitive fatigue and reduced attentional engagement. In contrast, interactive AR/VR environments can promote active engagement and support processes associated with spatial learning and neuroplasticity. These effects are linked to the activation of neural mechanisms involved in spatial representation and the formation of new connections.

The proposed methodology helps avoid a common implementation error in educational technologies, namely the acquisition of hardware without sufficient methodological grounding. Stage III is particularly significant, as the educational architect functions as a bridge between the teacher's academic expertise and the programmer's technical capabilities. In distance education, this approach supports the creation of high-quality virtual laboratories that are not inferior to, and in some cases may surpass, traditional physical classrooms in their didactic value.

5. Limitations and Risks of Immersive Technologies in Distance Education

Despite the recognised advantages of augmented reality, its integration into online learning environments involves several important limitations. If these factors are not considered, virtual learning experiences may become less effective and may not fully support the educational process.

The distance format creates a specific screen barrier. Students (digital natives) can process visual information and concepts at a high speed, which may exceed the pace of a standard immersive scenario. As a result, learners may perceive the material as less engaging when their cognitive processing progresses faster than the system's dynamics.

The situation is further complicated by the limited availability of immediate feedback (feedback loop). Unlike a physical classroom, where teachers can observe non-verbal signs of fatigue or misunderstanding, online environments restrict this form of communication. Instead of supporting active "embodied cognition", immersive learning may still lead to passivity, with students becoming observers rather than active participants.

The proposed six-step methodology requires the involvement of a large team of specialists (programmers, architects, and teachers) and a lengthy production cycle. As a result, the developed content may become static, as its structure is difficult to modify during the learning process. However, real educational contexts require a high degree of flexibility. If a completed virtual model does not correspond to the cognitive level, learning pace, or specific needs of a particular group of students, teachers may not be able to quickly adapt the scenario. The use of non-adaptive software may therefore result in reduced motivation and difficulties with cognitive engagement.

Traditional VR/AR scenario design is often based on the assumption that knowledge acquisition follows a linear and predictable process. In contrast, students' thinking when solving complex or non-standard problems is inherently non-linear.

When students raise unexpected questions during virtual experiments, the system may face limitations due to the absence of pre-developed immersive content. In such cases, the platform may return to a basic text-based response format. For learners accustomed to 3D representations and spatial simulations, a sudden transition to dense text may create a "cognitive gap" and hinder conceptual understanding.

Table 4 systematises the above-mentioned limiting factors and presents possible methods for their compensation.

Table 4. Limitations, risks, and cognitive barriers to VR/AR integration

Risk manifestation area	Type of limitation	Neuropedagogical and instructional consequences
Cognitive-communicative	A gap between information processing speeds; the absence of immediate feedback for the teacher	Increased student passivity; an illusion of engagement despite actual cognitive disengagement
Methodological	High cost of content modification; limited adaptability of ready-made 6-step solutions to the needs of a specific group	Course rigidity; inability to promptly adjust the learning trajectory according to learners' needs
Instructional-visual	Neglect of the non-linear nature of thinking; forced return to a text-based format when addressing non-standard questions	Cognitive dissonance among visually orientated learners due to a sudden change in content modality

Source: The authors' own conception

6. Conclusion

Therefore, the integration of virtual and augmented reality technologies into distance education is not merely a technological trend but a necessary stage in the evolution of the educational process. The introduction of immersive technologies transforms distance learning from a passive form of content delivery into an active ecosystem for acquiring professional experience. In this model, the cognitive gap between theory and practice is reduced through the activation of neuropsychological mechanisms of perception.

It is evident that successful implementation depends not so much on hardware as on the methodological depth and systematic nature of the process. The proposed six-step methodology serves as a reliable framework that minimises the risks associated with the unstructured adoption of innovations. It enables both academic staff and educational administrators to organise the process from staff training to the full deployment of cloud-based simulations.

The future of today's education lies at the intersection of technological advancement and a neuropedagogical approach. Within this context, augmented reality in distance education functions as a "digital bridge". This bridge connects students, teachers, and complex professional environments within a unified interactive space, regardless of geographical boundaries.

The scientific novelty of this study lies in defining immersive technologies as a tool for targeted neuromodulation of the educational process. It is demonstrated that the use of VR/AR in distance learning does not merely compensate for the absence of physical laboratories. It creates a specific digital learning architecture aligned with human information processing, which can support deeper knowledge internalisation compared with traditional methods. Further research in this field should focus on the empirical validation of long-term learning outcomes in immersive environments. It should also address the development of universal quality standards for virtual educational ecosystems.

Statement on the Use of Artificial Intelligence

The authors state that AI tools were employed solely to enhance language quality and academic style. The responsibility for the integrity of the content, analysis, and conclusions remains entirely with the authors.

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