Immersive Learning as a Way to Increase the Effectiveness of Inclusive Education

Anastasia Olkhovaya[1][a], Katrina Dobrova[2][b]
[1]*Moscow City University, Russia, Moscow*
[2]*FGBOU VO "RGU IM. A.N. KOSYGINA" RGU IM. A.N. KOSYGINA UNIVERSITET KOSYGINA, Russia, Moscow*
nas-tya92@mail.ru, kdobrova@mail.ru

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Abstract: The article discusses the approach to the organization and implementation of virtual reality technology and artificial intelligence in the process of inclusive education. Virtual classrooms, adaptive learning environments and virtual reality tools that meet diverse learning needs are explored, ensuring that education is accessible to all students, regardless of their abilities or background. The author describes the specifics of the introduction of virtual reality for children with disabilities.

1 INTRODUCTION

In the rapidly developing field of technology, the convergence of virtual reality (VR) and machine learning (ML) has revolutionized various industries, fundamentally changing the way we perceive and interact with the world around us. Education, as the cornerstone of social progress, is at the forefront of this transformative wave. The rapid evolution of virtual reality and ML technologies has ushered in a new era that promises not just innovation, but also a profound rethinking of the educational landscape. As we move deeper into the 21st century, the traditional boundaries of classrooms and textbooks are transcending, creating a fascinating, immersive and personalized learning experience.

Virtual reality, which once belonged to the field of science fiction, has become an accessible and indispensable tool. Virtual reality technologies have gone from experimental prototypes to practical applications, offering simulated environments that can reproduce real-world scenarios. At the same time, machine learning based on extensive data sets and complex algorithms has revealed the potential for understanding complex patterns, providing intelligent decision-making and adaptability.

In the field of education, virtual reality brings a dynamic dimension, allowing students to explore historical events, dissect biological organisms, or even travel to distant planets, all without leaving their classrooms. This immersive approach goes beyond the limitations of traditional teaching methods, engaging students intuitively and improving their understanding through experiential learning.

On the other hand, machine learning provides teachers with information derived from data analysis, which allows them to create an individual learning experience. ML algorithms analyze the interactions, preferences and problems of students, allowing them to adapt the content and teaching methods in real time. This personalized approach takes into account the diverse needs of students, ensuring that education is not a universal event, but an individual, interactive and inclusive process.

In today's educational landscape, engagement and personalization are not just buzzwords; they are imperatives. Engaged students are motivated, inquisitive and active participants in their education. Virtual reality attracts attention and stimulates curiosity, offering an exciting environment in which schoolchildren are not just passive observers, but also active researchers.

[a] https://orcid.org/0009-0001-5340-1436
[b] https://orcid.org/ 0000-0001-7249-0924

Personalized learning takes into account the individuality of each student. Using ML algorithms, teachers can recognize learning patterns, preferences and problems, adapting content and activities accordingly. This approach recognizes that students learn at different rates and in different ways, ensuring that no one is left behind. In addition, personalized learning develops a sense of belonging, allowing students to take responsibility for their educational path.

As we move deeper into this era of technological innovation, combining virtual reality and ML technologies with education promises a future in which learning is not limited to classroom walls, but extends to the realms of imagination and creativity. This research paper examines this exciting intersection, explores the tremendous opportunities it offers to create an educational experience that is not only exciting and engaging, but also uniquely personalized, ensuring that every student can succeed in the digital age.

2 UNDERSTANDING VIRTUAL REALITY AND MACHINE LEARNING

Virtual reality (VR) is a computer simulation of a three-dimensional environment or situation that can be interacted with in a seemingly real or physical way. Using specialized equipment such as virtual reality headsets and controllers, users are immersed in a digital environment where they can see, hear and even interact with virtual objects. The immersive nature of virtual reality lies in its ability to stimulate the user's senses, creating a sense of presence and immersion that traditional media cannot reproduce. This technology has found application in various fields, including games, healthcare, architecture and, importantly, in education, where it transforms learning from a passive experience into an interactive, exciting adventure.

Machine learning (ML) is a subset of artificial intelligence (AI) that allows systems to learn and improve based on experience without explicit programming. ML algorithms use statistical methods to identify patterns and extract lessons from the data, which allows them to make predictions or make decisions. In the context of education, ML algorithms analyze huge amounts of data generated as a result of students' interaction with digital learning platforms. By identifying patterns in this data, these algorithms can adapt educational content, pace, and methods to suit individual learning styles and needs. This adaptability is a distinctive feature of ML, as it constantly improves its understanding based on new information, providing a dynamic and personalized learning process.

The synergy between virtual reality and machine learning lies in their combined ability to create an immersive and adaptive educational experience. Virtual reality provides an immersive environment, immersing students in simulations and scenarios that make learning dynamic, exciting and memorable. Meanwhile, ML algorithms, driven by the data generated in these virtual reality environments, adapt and personalize content and interactions in the virtual space in real time. This adaptability in real time ensures that the learning process will not only be exciting, but also adapted to the pace of learning and the preferences of a particular student.

2.1 Immersion Power

In education, the power of immersion used through virtual reality (VR) transforms how students interact with learning materials and memorize information. Immersive virtual reality environments go beyond traditional teaching methods, stimulating multiple senses and creating an interactive experience that captivates students. When students immerse themselves in a virtual environment, they become not just spectators, but active participants, exploring, interacting and getting involved in the study of the subject. Scientific research and real-life examples consistently demonstrate the profound impact of immersion on student engagement and memorization. By incorporating sensory stimuli such as sight, sound and touch, the immersive environment deepens the understanding of complex concepts, making learning more vivid and memorable. With the further development of virtual reality technologies, these immersive learning environments are becoming invaluable tools in education, revolutionizing the ways students interact with educational content and paving the way for a deeper and lasting impact on learning outcomes.

In addition, the power of immersion in virtual reality goes beyond the mere fascination of schoolchildren; it fundamentally turns the learning process into a multisensory journey. Using auditory, visual and even tactile sensations, virtual environments create a holistic learning atmosphere in which information is not just seen or heard, but also experienced. Studies have shown that when multiple senses are involved, learning becomes more interactive, which leads to better memorization and understanding of complex

topics. For example, in the field of medical education, virtual simulators allow novice surgeons not only to see and hear procedures, but also to feel the resistance and texture of tissues, providing a realistic surgical experience without any consequences in the real world.
Real-world examples emphasize the effectiveness of immersive learning. Foreign language learners can find themselves in virtual markets, communicating with native speakers, strengthening vocabulary and language skills. In biology lessons, students can explore the complex details of cells, virtually dissecting them, feeling the texture and understanding spatial relationships. Historical events can be recreated, which allows students to walk through ancient civilizations, immersed in the culture, architecture and everyday life of historical periods. This experience, supported by research, shows that immersive learning not only attracts attention, but also improves retention and memorization of knowledge.
Moreover, the ability of virtual reality to foster empathy is a profound aspect of its immersive nature. With the help of simulations, students can find themselves in the place of other people, getting to know different cultures, social problems and historical events first-hand. Such a sensitive understanding of different points of view not only makes learning more meaningful and effective, but also increases their social and emotional intelligence.
In fact, the power of immersion in virtual reality lies in its ability to engage many senses, creating a rich palette of impressions that contribute to learning and understanding. As technology continues to evolve, the educational landscape stands on the threshold of a transformative era, when immersive virtual reality environments become not just tools, but also a gateway to deeper and more meaningful learning.

2.2 Adaptive Learning in Virtual Reality

Adaptive learning, supported by ML algorithms, changes the rules of the game in VR education, as it adapts the learning process to the individual needs, preferences and learning style of the student. Using the capabilities of predictive analytics, teachers can identify specific areas in which a student may experience difficulties and adapt the virtual reality learning environment in real time.
ML algorithms analyze extensive data sets about student interactions in a virtual environment, identifying patterns related to learning styles and preferences. Some students may excel at using visual aids, while others may prefer interactive simulators. By defining these preferences, VR content can be customized to match the optimal learning mode of each student, ensuring engagement and improving understanding.
In virtual reality, adaptive learning based on ML algorithms allows students to progress at their own pace. These algorithms constantly evaluate students' mastery of concepts and adjust the level of complexity of tasks and challenges in a virtual environment. For example, if a student grasps a concept quickly, the virtual reality module can automatically move on to more complex topics, keeping him interested and motivated. Conversely, if a student is experiencing difficulties, the system can provide additional recommendations and materials, ensuring that no student is left without attention.
One of the key advantages of adaptive ML-based learning in virtual reality is its adaptability in real time. When students interact with a virtual environment, algorithms instantly analyze their responses. If a student shows signs of confusion or frustration, the system can immediately intervene by offering explanations, hints, or alternative learning paths. This real-time feedback loop ensures that the learning process remains dynamic and responds to the changing needs of the learner.
Adaptive learning in virtual reality is not just technological progress; it represents a paradigm shift in which education becomes truly student-centered, educating a generation of students empowered, engaged and well-prepared to meet the challenges of the future.

2.3 Overcoming Difficulties

In a rapidly changing educational landscape, the integration of advanced technologies has become a beacon of hope, especially for inclusive education. Inclusive education, a philosophy that guarantees all students, regardless of their abilities or disabilities, equal learning opportunities, has undergone significant changes with the advent of artificial intelligence (AI) and virtual reality (VR). These technologies not only overcome traditional barriers, but also continue the path to empowering students in ways previously unimaginable.

One of the most serious problems in inclusive education is the satisfaction of diverse learning needs. Machine learning, with the ability to analyze huge amounts of data, can create personalized paths and spaces for learners to learn. It identifies individual strengths and weaknesses, which allows teachers to adapt their approach accordingly. Adaptive modern learning platforms based on artificial intelligence will be able to assess student performance in real time and provide customized materials, ensuring that no one will be left out.

In addition, virtual reality, due to its immersive nature, brings a new dimension to education. Schoolchildren and students can virtually travel to places, witness historical events or explore complex scientific concepts. For a student experiencing mobility problems, virtual reality acts as a pass to a world that would otherwise be inaccessible. Today, the phygital VR concept bridges the gap between the physical and virtual worlds, allowing to get an experience that is not limited to the classroom.

2.3.1 Improving the Work Experience in the Modern Classroom

The combination of artificial intelligence and virtual reality has revolutionized teaching methods. Imagine a history lesson where students can virtually participate in events such as the signing of the Declaration of Independence, or a physics lesson where complex theories turn into interactive modeling. Artificial intelligence algorithms can track the level of student engagement and generate VR content in real time, providing an optimal and individual learning experience for each person.

2.3.2 Promoting Social Integration

Inclusive education is not only academic education; it also promotes social integration. Artificial intelligence and virtual reality applications encourage collaboration and interaction between schoolchildren and students. Modern educational virtual classrooms, thanks to teamwork, provide a platform where students from different walks of life can participate in discussions, work together on projects and build meaningful relationships. Such interaction develops empathy, understanding among peers, breaking down social barriers that often isolate students with disabilities.

2.4 Successful Integration in Education

Virtual Reality represented by VR Concept is a Russian multi-user virtual prototyping application for teamwork with three-dimensional models in virtual reality. The application is made entirely on its own graphics engine. VR Concept is used by companies in the field of industry (mechanical engineering, construction, architecture, etc.) and technical educational institutions: universities, schools.

The software allows the teacher to conduct a lesson in a VR classroom by opening a demo model, a hall, a layout or a process.

In the virtual space, the teacher and students see each other in the form of avatars and can move together and interact interactively with the objects of the scene, including by transferring them to each other.

The VR Concept company together with the author conducted VR lessons with schoolchildren with disabilities in the Rehabilitation and Educational Center as part of the pilot program. The pilot project consisted of three lessons in Biology, Chemistry and Physics for grades 10-11.

Teachers had organized training, consisting of lectures, practical work (preparation and training of the methodology of the VR lesson scenario, training of the lesson in VR, where they told about the history of VR, where to take 3D models, how to create a script, and also fixed all this with practical classes).

Figure 1: Inclusive education.

In the Rehabilitation and Educational Center, VR lessons were held in modern classrooms

A modern classroom is a complex of equipment and software consisting of specialized computers, monitors, VR helmets, motion sensors, a switchboard that performs collective work and VR Concept software. One set of VR equipment per student, where the standard workplace is 1.2 square meters, and the VR zone for one VR helmet is 2 square meters.

When using VR equipment, a student should be able to stretch out his hands with controllers and not touch another student. In the pilot testing, schoolchildren with disabilities used ordinary school chairs, thanks to them, children studied in VR sitting, they were less mobile and this reduced the likelihood of injuring each other during a VR lesson. For the lessons, a safety technique was developed for conducting VR lessons at school for students with disabilities:

The author notes that when creating the methodology of the VR project, the need for drawing up two flowcharts was identified. The first block diagram is the structure of the educational event, the second diagram is the scenario of being in VR space.

The first block diagram, where there are such important points as the duration of the lesson, as well as the minimum and maximum number of people. The duration of the educational event can be from 45 minutes to 120 minutes, provided that helmets are not recommended to be more than 15 minutes per lesson of 45 minutes and more than 30 if the lesson is 120. In such cases, the author recommends taking breaks or doing castling.

The second scheme is a scenario of students finding themselves in VR space. An important point in the VR space scenario, where it is necessary to understand what will be shown and how students will interact in the VR space. The lesson scenario can be absolutely different - it can be an individual lesson or a group lesson where children take turns studying the material for a certain time for 15 minutes, and then change, perhaps it is also a group lesson, but in a different format where students and teachers are in VR space at the same time. Participation in this format can be different – it can be observation, study of certain parts of the elements, passing the scenario along a certain trajectory. The most important condition is that it should be no more than 15 minutes to 45 minutes from the general scenario of the educational event.

The pilot testing was conducted by high school students, since VR is not recommended for use on children younger than 12 years old. In the survey of those who have already tried to enter the VR space in any format, almost all children from grades 7 to 11 know what it is and have tried VR in virtual clubs.

An introductory lesson is necessary for the first acquaintance with VR. At the Rehabilitation and Educational Center, we did double lessons in order to conduct an introductory lesson and make sure that children feel comfortable in VR.

There are also differences in the lesson scenarios, thanks to the individuality of the teachers, we received three completely different lesson formats: quest, discussion and consolidation of the material.

The chemistry lesson was held in the format of a quest. The children discussed a new topic, solved a problem, and the resulting formula from the problem was considered in the structure of benzene in VR, and also at the end, with the help of the VR laboratory, it was necessary to find all the bottles with hydrocarbons.

Figure 2: Inclusive education. Chemistry Lesson.

The lesson began with the fact that the teacher asked the children for permission from their parents to attend such a lesson, as well as fill out a mini questionnaire to what extent they understand today's lesson topic and know what VR is. Since the children had never used VR before, the introductory lesson began, the teacher read the safety instructions, and invited everyone to the VR equipment, with the help of the equipment, the teacher told how to use the controllers and asked the children to put on a helmet. For each lesson, a special stage was created for practicing and testing being in VR space, where children tried to walk in virtual space, take objects and start animation.

The teacher told the children how to work with the controllers and asked how the children were feeling after a test run of immersion in VR. The teacher returned the children to their desks and told the plan of today's lesson, and also suggested that the children solve the problem to get the formula. After the children revealed the formula of benzene. The teacher suggested diving into VR to view the structure of benzene.

Figure 3: Inclusive education. Chemistry Lesson.

The most important thing is that the children in the VR space are together with the teacher, where they signed their names, and the teacher saw who was doing what without any problems. After a joint review of the structure of benzene. The teacher returns the children to the desk and continues to talk about the properties of benzene. When the entire theoretical part is read, the teacher gives the task to immerse in VR, there in a new modern laboratory to find all the homologues of benzene.

Children are immersed in VR for the second time. After successfully completing the quest. The children return to their desks, summarize the topic and fill out a questionnaire, as well as give feedback.

Pilot testing in a Rehabilitation and wellness center was the beginning of a transformation in inclusive education

2.5 Development Opportunities or Features of the Introduction of Artificial Intelligence

In recent years, during the period of informatization, it is clearly visible how educational institutions are trying to move to a new level of education using various services: online testing platforms, webinars, interactive whiteboards. With the advent of digitalization, there was a need to create and combine a modern digital educational learning platform, software for rapid content creation and a methodological course for quick immersion of learning this synthesis.

The author is working on creating an advanced digital education platform and bridging gaps with the help of inclusive virtual reality education

In the educational landscape, the modern digital educational platform is a beacon of innovation and inclusivity. Designed to meet the diverse learning needs of each student, the platform organically combines the capabilities of virtual reality (VR) technology with the generation of disparate content, creating an exciting, fascinating and truly inclusive educational experience.

The author's platform is based on automated content generation, a revolutionary approach that breaks down educational materials into small interactive modules. These modules cover a wide range of subjects, ensuring that the lessons are not only comprehensive, but also adaptable. Atomization allows teachers to customize lessons according to the individual requirements of students, providing targeted content that matches different learning styles and abilities.

The platform harnesses the full potential of virtual reality, offering an immersive learning experience that transcends the limitations of traditional audiences. With the help of virtual reality, students can visualize virtual worlds where historical events come to life, complex scientific concepts become tangible, and literature turns into interactive adventures. The immersive nature of virtual reality enhances engagement, stimulates curiosity and promotes a deep understanding of subjects, making learning both enjoyable and effective.

Inclusivity is the cornerstone of the digital education platform. With the help of virtual reality technology, we meet the diverse needs of students, including those with different abilities, learning styles and preferences. A specially selected virtual reality experience provides students with disabilities with equal access to educational content, contributing to the development of a sense of belonging and empowerment. The platform provides customizable interfaces, adaptive tools and assistive technologies, making learning accessible to everyone.

The central place in our platform is occupied by an extensive and constantly expanding library of lessons. These lessons cover a wide range of topics and training levels, offering a comprehensive educational resource for both teachers and students. Each lesson is carefully thought out, divided into interactive modules and integrated into virtual reality. From mathematics to history, from languages to natural sciences, our library guarantees teachers access to diverse and fascinating content, creating a rich and stimulating learning environment.

The platform uses the concept of personalized learning, allowing each student to progress at their own pace. Using adaptive algorithms and data-driven analytics, the platform selects learning paths based on individual performance and preferences. With real-time feedback and analytics, teachers can track student progress, identify areas for improvement, and provide targeted support, ensuring that no student is left behind.

In fact, the author's modern digital educational platform redefines the educational landscape, making an inclusive and exciting learning experience accessible to everyone. By combining the creation of disparate content with the capabilities of virtual reality, we empower teachers and inspire students by instilling a love of learning that knows no boundaries.

2.6 Prospects and Consequences of VR-ML Integration in Inclusive Education.

The integration of virtual reality (VR) and machine learning (ML) into inclusive education marks a paradigm shift, promising transformational evolution in how we perceive, implement and experience learning. The author examines the multifaceted prospects and profound consequences of this integration, drawing a far-sighted picture of the future educational landscape.

The integration of virtual reality and ML into inclusive education paves the way for the development of immersive learning environments. These environments are no longer just digital replicas of physical classrooms; instead, they become dynamic interactive spaces where students explore, create, and collaborate. Virtual reality technology combined with ML algorithms creates an adaptive, responsive environment that takes into account different learning styles, increasing engagement and understanding. As this integration progresses, we envision an immersive environment that blurs the line between the physical and virtual worlds, offering limitless opportunities for experiential and practical learning.

The central place in the integration of VR-ML into inclusive education is occupied by teachers with artificial intelligence, intelligent digital companions who offer students individual guidance and support. Artificial intelligence teachers use ML algorithms to analyze extensive data sets, understand student strengths, problems, and learning models. Offering real-time feedback, adaptive tasks and customized resources, artificial intelligence teachers become indispensable mentors, promoting independent learning and critical thinking. The author foresees that teachers with artificial intelligence will turn into sensitive and responsive people who are able to recognize students' emotions, adapt learning strategies accordingly and provide holistic support beyond traditional classrooms.

One of the most profound consequences of integrating VR-ML into inclusive education is the democratization of learning through accessible technologies. Virtual reality, once considered exclusive, is becoming all-encompassing, and affordable and easy-to-use devices are falling into the hands of students around the world.

ML algorithms based on inclusivity meet diverse needs, providing students with disabilities with equal access to educational content. This democratization removes barriers, turning education into a universal right. A future in which geographical, socio-economic and physical constraints will no longer limit educational opportunities. Instead, accessible technologies are becoming the cornerstone of an inclusive educational ecosystem, enabling students from all walks of life to thrive and make meaningful contributions to society.

3 CONCLUSIONS

In the ever-expanding universe of educational technologies, the combination of virtual reality (VR) and machine learning (ML) stands out as a beacon of innovation, changing the landscape of inclusive education. The author in his article emphasized the transformative potential inherent in the synergy of these advanced technologies. By combining the immersive power of virtual reality with the adaptive intelligence of ML, teachers are given unprecedented tools to create engaging, adaptive and personalized learning paths that meet the diverse needs of each student.

The transformative impact of this combination is enormous. Virtual reality technology immerses students in a dynamic interactive environment, opening up an area where learning transcends traditional boundaries. Meanwhile, ML algorithms delve into the subtleties of student interaction, revealing unique learning styles and preferences. This combination of an immersive environment and individual adaptability allows teachers to subtly navigate the complexities of inclusive education. Teachers are no longer limited to one-size-fits-all approaches, they can adapt their lessons to suit the individual needs of students, ensuring that each student is not only involved, but also has every opportunity to succeed.

In addition, this synthesis of virtual reality and ML offers more than just individual content; it provides a holistic educational experience. Inclusive education is not just about ensuring that every student has a seat at the table; it is about ensuring that they actively participate, succeed and make a meaningful contribution. Virtual reality develops a sense of belonging by creating exciting spaces where every student, regardless of their abilities, can explore, learn and interact. Data-driven ML algorithms enhance this experience, ensuring that it remains adaptive to the ever-changing needs of each learner.

The fusion of artificial intelligence and virtual reality in inclusive education is not just technological progress; it is a social leap towards equality, mutual understanding and progress. Using the power of these technologies, we are not just overcoming barriers; we are erasing them. Inclusive education, which was once a distant dream for many, is now available to every student, regardless of their abilities, socio-economic status or geographical location.

The path to an inclusive educational future will not be easy, but the reward is immeasurable. When we go down this path, it is important that the principles of equality, empathy and ethical responsibility are at the heart of our endeavors. By doing so, we are paving the way for a generation of students who are not only academically knowledgeable, but also compassionate, innovative and ready to build a better world for everyone. In the field of inclusive education based on artificial intelligence and virtual reality, the possibilities are endless, and the impact is transformative, not leaving any student without attention and giving every mind the opportunity to develop.

At the end of this research, it becomes obvious that the synergy of virtual reality and ML is not just technological progress; it is a pedagogical revolution. This means a transition from standardized education to a dynamic, adaptive and inclusive learning environment. The transformative power lies not only in the technology itself, but also in the opportunities it creates — opportunities for different students to succeed, for teachers to innovate, and education to become a truly inclusive force that embraces every student, regardless of their differences.

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