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FUTURE TENDENCIES IN EDUCATION: VIRTUAL AND ARTIFICIAL INTELLIGENCE TECHNOLOGIES

Abstract. This article offers an in-depth exploration of the role and future prospects of virtual and artificial intelligence (AI) technologies within the context of ongoing transformations in the education sector. The global digitalization of education — particularly the integration of AI into teaching and learning processes — has facilitated the modernization of traditional instructional models and supported the development of more flexible, personalized approaches. From a scientific perspective, the article examines key areas of AI application in education, including adaptive learning systems, automated assessment algorithms, natural language processing, the design of individualized learning environments, and support platforms for educators. Additionally, the study analyzes the interactive, skill-enhancing, and motivational dimensions of virtual and augmented reality technologies in educational settings. It also investigates the operational mechanisms and pedagogical effects of AI-based learning platforms successfully implemented internationally and proposes theoretical and methodological frameworks for their adaptation to the Azerbaijani education system. These frameworks take into account the specific characteristics of the local educational context, including technological infrastructure, teachers' digital readiness, and socio-cultural factors, providing context-sensitive recommendations. The findings of the study suggest that the effective implementation of educational technologies is not solely dependent on their availability but rather on their systematic integration into educational strategies and the establishment of sustainable governance models. In this regard, the conceptual framework and analytical approaches presented in the article offer a significant scientific and practical foundation for shaping educational policy and guiding future directions for educational development in Azerbaijan.

Keywords*: artificial intelligence, virtual reality, augmented reality, digital transformation, adaptive learning systems, personalized learning, educational analytics, automated assessment, educational technologies, pedagogical model, education policy.*

1. Introduction

Since the beginning of the 21st century, education systems across the globe have undergone rapid technological transformations, a process that has been significantly intensified by advancements in information and communication technologies (ICT) and artificial intelligence (AI).

According to UNESCO's 2023 report "The Future of Education", technological innovations are reshaping not only the modes of delivering education but also the structure of educational content, the personalization of learning processes, and the reconfiguration of education policies [17]. Adaptive learning systems powered by AI technologies are already being implemented across various educational levels — including early childhood, general secondary, and higher education — in the majority of developed countries.

According to a number of international studies (OECD, World Bank, McKinsey & Company), the application of artificial intelligence (AI) in education significantly impacts the learning speed of students and improves educational outcomes. For instance, a study conducted by Harvard University in 2022 found that classrooms using AI-based learning platforms saw an average increase of 30% in student achievement. At the same time, virtual reality (VR) and augmented reality (AR) technologies play a crucial role in enhancing interactivity and motivation within the learning environment. The use of these technologies in education is regarded as an effective method, particularly in the development of practical skills and the visualization of abstract concepts.

Currently, platforms such as Coursera, EdX, Duolingo, Saylor Academy, and Khan Academy, which are implemented globally, enhance accessibility and inclusivity in education by delivering AI-based learning to a wide audience [12-16]. Artificial intelligence also enables the automated creation of teaching resources for educators, improves the efficiency of assessment processes, and facilitates more accurate decision-making through educational analytics.

Azerbaijan, aligning with global trends, has also made significant strides in the digitalization of education. The "Social and Economic Development Strategy of the Republic of Azerbaijan for 2022–2026" emphasizes the development of education in a digital format. This document identifies digital transformation and human capital development as key priorities in socio-economic policy, setting specific goals for enhancing the infrastructure and content of virtual education. In this context, the "Artificial Intelligence Strategy of the Republic of Azerbaijan," along with the broader framework outlined in the "Artificial Intelligence Strategy for 2025–2028," approved by the Decree of the President of the Republic of Azerbaijan on March 19, 2025, represents key legal and conceptual documents for the deep integration of AI technologies into virtual education in the near future. These documents encompass various goals, such as the creation of personalized learning systems, the establishment of adaptive education platforms, the automation of instructional algorithms, and the support of teaching activities. In this regard, the systematic application of innovative technologies in education policy and pedagogical practices is an area that requires further research. This article presents a scientifically grounded approach to the application of artificial intelligence and virtual technologies in education, analyzing global practices and local realities, while exploring potential future education models [1,2,3,6].

2. Problem Statement

2.1. Comparative Analysis of International and Azerbaijani Practices

The transformation of education systems has become a global necessity in the contemporary era. The difficulty of traditional teaching models in meeting the demands of the information society, the growing emphasis on the development of digital skills, and the need to ensure equal access to educational resources have further heightened the relevance of technological integration in education [1-6]. In this context, artificial intelligence (AI) and virtual technologies are significantly influencing the content, methodology, and management mechanisms of education. However, for the

effective application of these technologies, it remains crucial to adapt the infrastructure, pedagogical models, and legal-regulatory frameworks, as well as to enhance the digital literacy of educational stakeholders (educators, learners, administrators) and address ethical issues.

The core of the problem lies in the fact that the application of AI technologies in education is still at an experimental stage in many countries, and large-scale implementation requires careful strategic planning. The use of technologies such as virtual reality, adaptive learning systems, natural language processing (NLP), automated assessment algorithms, and educational analytics not only creates innovative opportunities but also introduces new social, pedagogical, and technological risks. In this context, the primary issue is not the mere availability of technology, but its systematic and quality-based application, integration into the existing educational structure, and adaptation to local conditions.

In international practice, several countries possess advanced experience in integrating artificial intelligence and virtual reality technologies into education. For instance, China and the United States are already implementing personalized learning environments through AI-based adaptive learning platforms (Knewton Alta, ALEKS, Carnegie Learning, Edmodo, Squirrel AI). These systems assess students' knowledge levels in real-time and present lesson materials tailored to their individual needs. In countries like Finland and South Korea, virtual classrooms and augmented reality-based laboratories are applied in the teaching of STEM subjects (Figure 1).

Figure 1. Virtual Classrooms and Augmented Reality-Based Laboratories

This approach strengthens the experiential learning model and enhances student motivation. On the other hand, the application of these technologies also raises ethical and normative challenges. For example, the European Union's "AI Act" framework emphasizes the protection of human rights and data privacy concerning the use of AI in education. In Canada, national-level professional development programs are implemented to enhance teachers' digital literacy.

The integration of artificial intelligence and virtual technologies into the education system has started to develop in Azerbaijan in recent years. Within the framework of the "Digital Skills" project, modern technology-based lessons are being conducted in several general education schools. At the same time, through the "STEAM Azerbaijan" project, students' skills in programming, robotics, and digital creative thinking are being enhanced. In higher education institutions, specialized courses in artificial intelligence have been organized in some faculties. However, a well-structured national strategy and large-scale implementation mechanisms have not yet been fully realized in this area. Problems such as unequal distribution of resources, technological infrastructure disparities across regions, insufficient training of pedagogical staff, and limited legal frameworks are factors that slow down this process. Comparative analyses show that international experience in the application of technology focuses not only on technical resources but also on pedagogical models and social adaptation. In contrast, the Azerbaijani experience focuses on the presentation of

technology and initial implementation steps. Therefore, the development and expansion of scientifically grounded teaching models for the effective use of these technologies are crucial (Figure 1).

As seen in the table, there are certain differences and similarities between the international and Azerbaijani experiences regarding the application of virtual and artificial intelligence technologies in education. These technologies are implemented in various ways and at different scales across different countries. In international practice, artificial intelligence (AI), virtual reality (VR), augmented reality (AR), and adaptive learning systems are widely utilized. For example, in China and the USA, education platforms based on AI and VR, as well as 3D modeling technologies in Finland, are actively used in the educational process. These technologies personalize the teaching process by providing learning materials tailored to the learning pace and level of students, which enhances the quality of education. In contrast, Azerbaijan's experience mainly shows progress in the areas of digital platforms and robotics. Currently, the application of these technologies is accelerating primarily through projects like STEAM Azerbaijan and the operation of AI laboratories in certain universities. However, despite the introduction of technologies such as 3D modeling in some schools and universities, there are still certain limitations in the overall approach.

In international practice, the application of technologies spans from primary to higher education, and these technologies typically offer adaptive learning opportunities. For example, companies such as "Squirrel AI" and "Knewton Alta" provide personalized learning programs. In contrast, in Azerbaijan, technologies are primarily applied through pilot projects and in a limited number of schools and universities. This still poses a barrier to the widespread application of these technologies. Regarding teacher training and professional development, international practice includes various government programs and training courses for educators on AI and VR technologies. These initiatives facilitate the integration of new technologies for teachers.

Table 1

Comparative Analysis of International and Azerbaijani Practices

Criterion / Area	**International Experience**	**Azerbaijani Experience**
Applied Technologies	Artificial Intelligence (AI), Virtual Reality (VR), Augmented Reality (AR), Adaptive Learning Systems	Digital platforms, robotics, 3D modeling, basic-level AI applications
Practical examples	Squirrel AI' (China), 'Knewton' (USA), 'Carnegie Learning', '3DBear' (Finland)	“STEAM Azerbaijan”, “Digital Skills” project, AI laboratories in selected universities.
Application level	Wide application from primary school to higher education, with adaptive and personalized learning opportunities	Limited to pilot projects and selected schools, primarily implemented from a technological perspective.
Teacher Preparation and Professional Development	State programs and training courses on AI and VR technologies for teachers	Limited number of training sessions, primarily focused on technical components
Infrastructure and technical provision	Continuous investments and universal infrastructure development	Although some schools and universities have technological equipment, the overall approach has not yet been fully developed.

Alignment of textbooks and content with technology	Personalized learning materials based on AI and VR, interactive platforms	Traditional content is maintained, and integration with technologies has not been fully realized.
Results of the activity	Personalization in learning, increased motivation, real-time performance analysis, inclusive teaching.	Increased interest in technology, but no real and widespread results have been achieved yet.
State policy and strategic documents	Recognition of AI and VR technologies as a priority in education strategies	The role of technology is mentioned in Education Development Strategies, but specific AI/VR plans are still limited.

In Azerbaijan, teacher training programs are primarily focused on technical components and are still not widespread. In terms of infrastructure, international experience shows that there are continuous investments and a well-developed infrastructure for the application of technologies. As a result, educational institutions have successfully integrated technologies and incorporated them into the teaching process. However, in the Azerbaijani context, although some schools and universities are equipped with technological tools, a comprehensive approach has yet to be established. The alignment of textbooks and teaching materials with technologies is also more advanced in international practice. Personalized learning materials and interactive platforms based on AI and VR are widely used. In Azerbaijan, traditional textbooks still play a central role, and full integration of technology into the educational process has not yet been realized. Finally, international experience suggests that the application of technologies leads to increased personalization and motivation in learning, which, in turn, improves the quality of the educational process. Although there is growing interest in technology in Azerbaijan, widespread and tangible results have not yet been achieved. In terms of government policy and strategic documents, international practices indicate that AI and VR technologies are prioritized in educational strategies, with development plans related to these technologies already in place. In Azerbaijan, although the role of technology is acknowledged in educational development strategies, specific plans and large-scale projects are still lacking. This comparison illustrates that international experience is geared toward the broader and deeper application of technologies in education, while in Azerbaijan, initial steps are being taken, and there are certain limitations in the development process.

2.2. The Principle and Mechanism of Operation of Artificial Intelligence-Based Educational Systems on International Platforms

The integration of technology—particularly artificial intelligence—into contemporary educational systems plays a crucial role in advancing the teaching and learning process. International educational platforms such as Coursera, EdX, Khan Academy, Duolingo, Saylor Academy, and similar systems have revolutionized the field of education by incorporating AI technologies into the learning environment (Figure 2). Each of these platforms enables learners to receive instruction tailored to their individual learning styles and needs. By leveraging AI-based systems, these platforms ensure a high level of precision and transparency in lesson planning, assignment delivery, and progress monitoring. The application of artificial intelligence enhances the role of the instructor within the learning process by facilitating the delivery of educational content in a more efficient and personalized manner. The primary aim of these educational platforms is to

optimize the learning experience and provide students with opportunities to achieve higher levels of academic performance.

With the application of artificial intelligence, each student can progress at their own pace and in their areas of interest. These systems track users' learning styles, identify their strengths and weaknesses, and personalize lessons based on this information. The goal is to make the teaching process more effective and tailored to the student. The operational mechanism of these platforms is based on artificial intelligence algorithms. First and foremost, the platforms track students' learning behaviors – this includes data such as which lessons are being followed, which assignments are completed, and which topics attract the student's attention the most. This information is collected and analyzed by AI algorithms. Based on the student's previous activities, the system provides more suitable educational content.

This process also identifies the student's weak areas and provides additional resources and tasks tailored to them. For instance, if a student is struggling with a particular topic, the platform offers supplementary materials and explanations on that topic. The application of artificial intelligence also analyzes students' performance, adjusting the difficulty level of lessons to match their abilities. Moreover, "AI teaching assistants" or "intelligent tutoring systems" used by these platforms monitor students' reactions to each lesson and provide immediate feedback. This allows the student to receive assistance right away when encountering difficulties, thus improving the learning process. As a result, the application of artificial intelligence in education plays a significant role in meeting students' individual needs and enhancing their learning effectiveness. The use of these technologies makes the teaching process more adaptive, interactive, and personalized, paving the way for a more individualized and globally accessible education in the future.

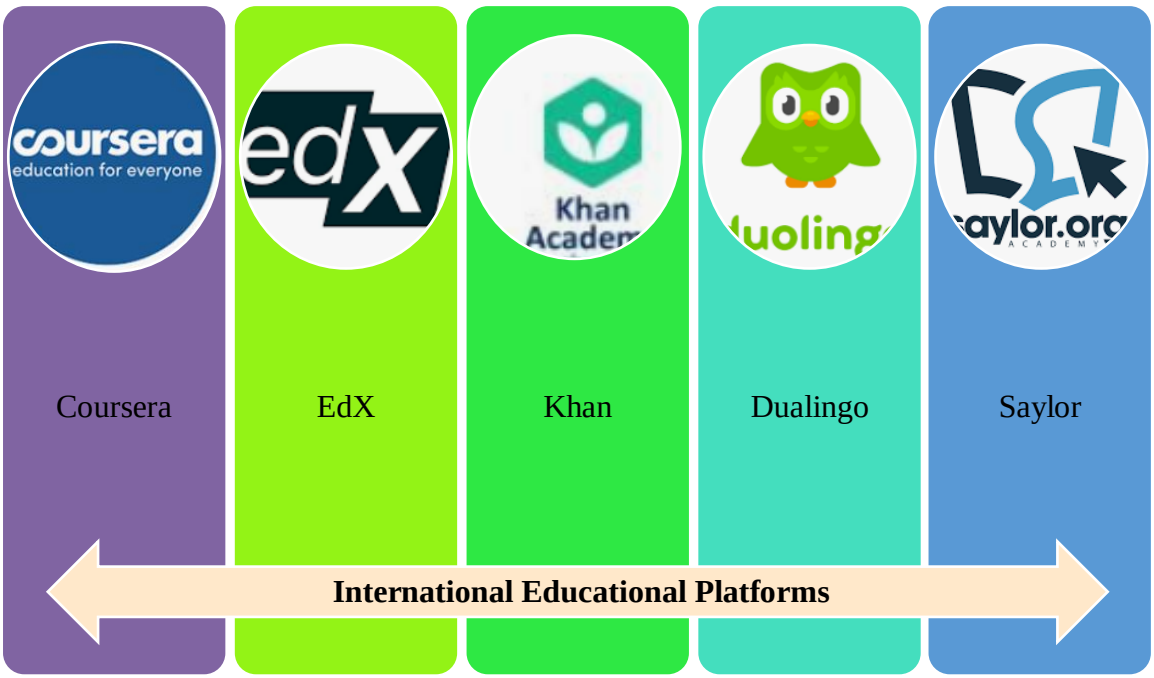

Figure 2. International Educational Platforms

The application of artificial intelligence technologies in education continues to create profound transformations globally in the modern era. These technologies offer significant opportunities for adapting, personalizing, and organizing the teaching process in a more flexible

manner. AI-based models implemented on international educational platforms analyze users' knowledge levels, learning speeds, and interests, thereby forming personalized learning pathways that aim to increase the efficiency of education. In the Azerbaijani education system, the application of these technologies must be based on a number of theoretical and methodological foundations. For the integration of the traditional education structure into the modern technological environment, personalized teaching approaches and real-time feedback mechanisms are of particular importance. The analysis of students' educational outcomes through artificial intelligence enables timely identification of gaps in their learning process and provides the opportunity to support them with appropriate resources. Additionally, the integration of virtual reality elements into the educational process creates a favorable environment for visualizing the learning environment and organizing experience-based learning. These technologies automate teachers' lesson planning and assessment activities, allowing them to focus more on teaching. As a result of the application of artificial intelligence, open educational resources are expanded, and education becomes more accessible and democratic. The implementation of these models in Azerbaijan should be carried out not only technologically but also pedagogically, based on theoretical foundations and strategic approaches. To this end, it is necessary to enhance the digital competencies of pedagogical staff, align educational programs with artificial intelligence, and equip the learning environment with flexible models. Thus, the integration of artificial intelligence technologies in education should be regarded not only as a technological innovation but also as a fundamental step in modernizing the philosophy of teaching. The principle and mechanism of operation of AI-based educational systems (AIEES) are depicted in Figure 3.

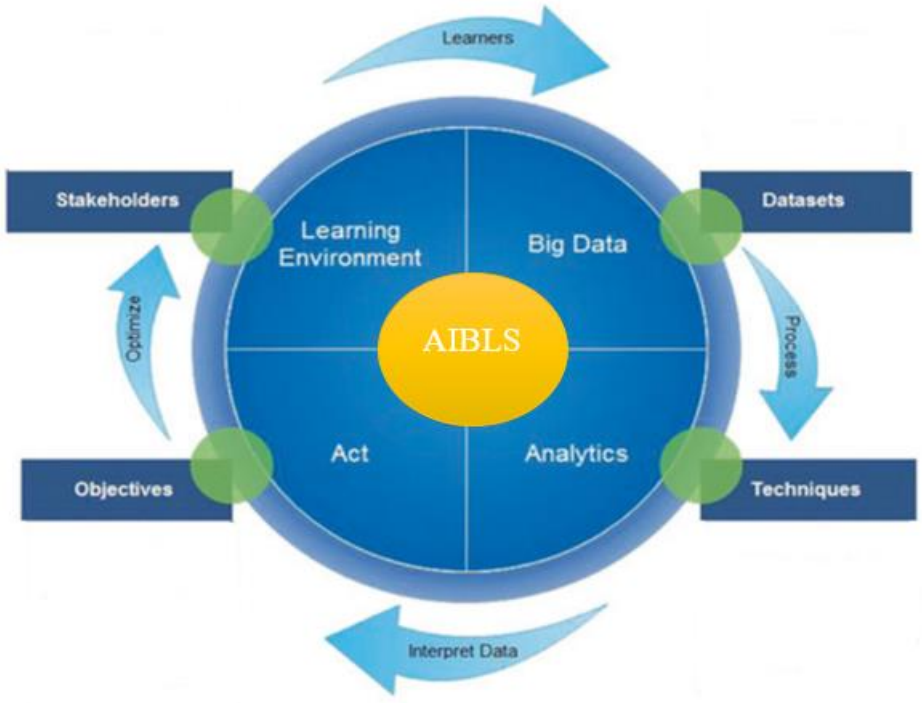

Figure 3. The Principle of Operation of Artificial Intelligence-Based Learning Systems (AIBLS)

3. Solutions to the Problem

3.1. Future Trends in Education – Virtual and Artificial Intelligence Technologies

The application of virtual and artificial intelligence technologies in education has the potential to fundamentally transform and modernize the educational process. However, there are several challenges associated with the implementation of these technologies. The following methods can be proposed to address these challenges:

- Teacher training and development.
- Improvement of infrastructure.
- Development of personalized education systems.
- Ensuring data security.
- Supporting innovation and research.
- Providing students with adaptive learning platforms.
- Creation of additional resources and social initiatives.

For the effective implementation of virtual and artificial intelligence technologies, it is crucial to enhance teachers' knowledge and skills regarding these new technologies. Teachers should be provided with training sessions and seminars on how to use these technologies, offering them practical knowledge on how to integrate them into the teaching process. Moreover, these training programs should be continuous and dynamic, assisting teachers in adapting to technological innovations.

The application of virtual and artificial intelligence technologies requires a comprehensive infrastructure. Therefore, modern infrastructure that can support the use of these technologies should be created in schools and universities. Tools such as computers, VR headsets, interactive boards, and high-speed internet are necessary. Ensuring this infrastructure through public and private sector collaboration and adapting educational institutions to these technologies should be a primary priority.

By leveraging the power of artificial intelligence, personalized education programs that cater to students’ individual learning styles and levels should be created. AI-based teaching platforms should monitor students’ learning speed and adjust lesson materials to meet their needs. This will not only increase students' motivation but also enable more effective learning.

The use of virtual and artificial intelligence technologies in education requires extensive data collection and analysis, which in turn raises concerns about data security. Strong encryption systems and reliable servers must be used to protect data and ensure the security of personal information in education. Additionally, legal and ethical issues related to the use of these technologies must be addressed, and appropriate legislative frameworks should be developed.

Research should be encouraged to develop new innovative approaches to the use of virtual and artificial intelligence technologies in education. Educational institutions and research institutes must conduct studies in this area and achieve positive outcomes regarding the implementation of new technologies. This will also ensure the continuous development of educational research, considering international experiences and current development trends.

Adaptive learning platforms should be provided to students through the application of virtual and artificial intelligence technologies. These platforms assess students’ knowledge, identify their gaps, and then offer personalized lesson plans to help them improve. This approach will create an environment where learning becomes more effective and allows each student to progress at their own pace.

The full integration of virtual and artificial intelligence technologies into the education system must be ensured. This involves not only the application of technologies but also the implementation of modern teaching methods. Additionally, it is important to leverage the latest technological innovations in educational programs to make the teaching process more interactive, engaging, and enjoyable.

Additional resources should be created and social initiatives organized to support the use of virtual and artificial intelligence technologies in education. Educational institutions can organize various seminars, business games, and competitions to introduce students to these technologies and encourage their use. These events will increase students' interest in using technologies and boost their motivation in education.

4. Conclusion

The research conducted has shown that the integration of artificial intelligence and virtual technologies into the education system will significantly contribute to making education more flexible, effective, and personalized in the future. These technologies have the potential to not only reshape the technical aspects of the learning process but also reformulate the philosophy and methodology of teaching. International experiences demonstrate that the application of artificial intelligence in education enhances student achievements, reduces teachers' workload, optimizes teaching strategies, and ensures transparency in management processes. In Azerbaijan, however, successful application of these technologies requires a comprehensive and systematic approach. It is recommended that a national strategy for the implementation of artificial intelligence and virtual technologies in the Azerbaijani education system be developed, covering pedagogical, technological, and legal components. It is essential to pilot adaptive learning systems in educational institutions, organize training programs to enhance teachers' digital competencies, and create teaching resources tailored to new technologies. Additionally, normative regulations regarding the use of artificial intelligence, considering ethical, social, and psychological aspects, should be established within education policies. Ultimately, the integration of virtual and artificial intelligence-based technologies into education should be seen not just as a technological innovation but also as a strategic necessity for the innovative development of the national education system.

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