

Educational Systems in the Era of Technological Transformation – Current Challenges and Opportunities

Oana-Larisa STOICA

Bucharest University of Economic Studies, Romania

oanalarisa.stoica@csie.ase.ro

In an era marked by accelerated technological transformations, education is undergoing a process of metamorphosis that fundamentally redefines its current structure. The objectives of the present research are oriented toward analysing how participants in the educational process, teachers and learners, are facing new challenges and limitations. The article explores the relevant literature to identify the obstacles and inefficiencies of the educational process and examines how emerging technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), and Blockchain can contribute to overcoming these barriers in the context of an ongoing technological revolution. The study aims to provide an in-depth understanding of how these technologies can support educational activities (teaching–learning–assessment) and the adaptation of education to ongoing transformations, thereby improving educational performance and shaping the future of the educational system.

Keywords: Technology, Educational Systems, Challenges, Emerging Technologies, Artificial Intelligence, Internet of Things, Blockchain

DOI: 10.24818/issn14531305/30.1.2026.04

1 Introduction

Education has long been one of the primary sources of personal development, opening pathways to knowledge, reflection, and self-improvement. It is not limited to the transmission of information but also involves the cultivation of critical thinking, creativity, and the ability to adapt to change. Through education, individuals define their personal and professional identities, shape their values, and construct their own sense of purpose in relation to society.

Throughout history, education has been organized and structured in various institutional forms that have evolved according to the historical, social, and cultural context of each era. These organized forms, known as educational systems, reflect how societies understand and manage the educational process. They encompass a set of norms, institutions, methods, and resources designed to educate individuals, with the aim of preparing them for social and professional integration.

The Technological Revolution witnessed over recent decades has provided, alongside numerous complex variations, solutions that, once integrated, help societies adapt to an ever-changing context. Initially, this

transformation began with the creation of a digital environment in which information is just a click away. Over time, the focus has shifted toward the implementation of innovative technologies that offer adaptability, personalization, enhanced accessibility, innovation, and continuous progress.

The Educational Revolution has progressed through several stages alongside technological advancement, each shaped by the major transformations generated by the Technological Revolution (Figure 1). Education 1.0 can be directly associated with the Technological Revolution 1.0, being centered on teaching and memorization within a uniform and standardized educational system [1]. The subsequent stage, Education 2.0 (corresponding to the 19th–20th centuries), marks the emergence of communication technologies and the first uses of the Internet for educational purposes. During this period, education becomes more accessible and more connected to the digital environment [2].

Education 3.0 is based on the accumulation and management of knowledge using personal computers, online platforms, and digital resources, leading the entire educational process to become more efficient and interactive. At

present, we are in the stage of Education 4.0, characterized by a strong emphasis on innovation and advanced digital competencies. This stage integrates Artificial Intelligence (AI), Augmented Reality (AR), the Internet of

Things (IoT), and personalized learning, aligning seamlessly with the concept of smart industry, where technology and humans collaborate to create a dynamic and adaptable educational environment [3].

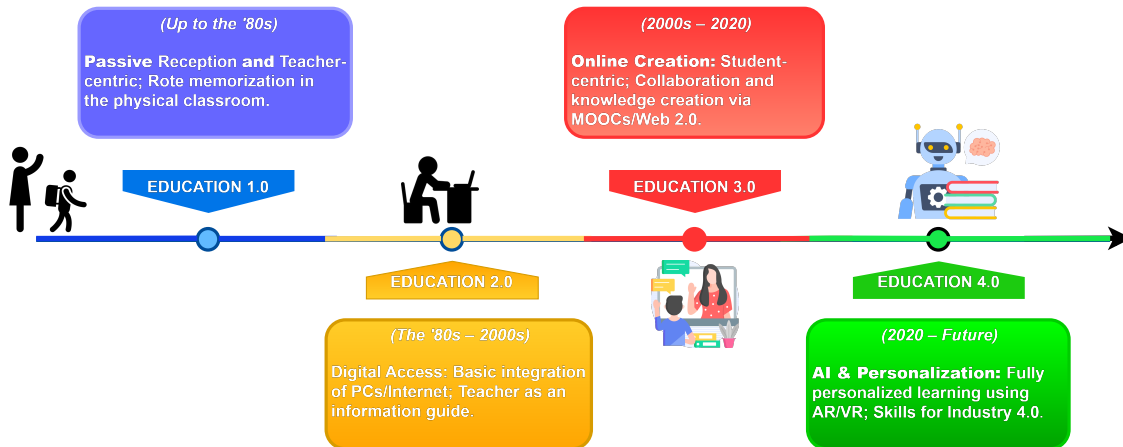


Fig. 1. Chronology of education transformation (1.0 – 4.0)

There is no doubt that the use of technology is becoming increasingly prominent in the current era. It is easy to observe that the prevailing trend is to integrate technology and innovation into education to adapt to the specific changes of modern times. Certainly, both learners and teachers show strong interest in its integration. To develop the necessary competencies and respond to continuously evolving needs, their orientation is toward change, both in teaching and learning methods [4].

Considering the challenges faced by both learners and teaching staff, it is necessary to adopt a balanced approach that addresses the needs of both parties and generates benefits throughout the entire educational process (teaching–learning–assessment). Analyzing the current dynamic and constantly changing context, it becomes relevant to focus on the solutions offered by the digital environment, which can rapidly adapt to these transformations. In this regard, education has gradually evolved and continues to move toward E-Learning, with this digital transformation being viewed both as a necessity and as a solution to the identified barriers.

It is worth noting the clearly increased interest in integrating emerging technologies into education, especially at the research level (1,567

articles published between 2000 and 2024) [5]. Research focuses on the implementation of these innovative tools, the challenges of their adoption, and the evaluation of their perceived effectiveness following use. Therefore, there is a pressing need for a detailed analysis of these aspects, as well as for dedicated studies that specifically address the integration and impact of emerging technologies in education.

In this context, the present study aims to analyze existing educational systems alongside the challenges and limitations they currently face, while also highlighting opportunities for integrating innovative technologies that can contribute to the modernization of the educational process and the improvement of learning performance. The article is structured into three main sections. The Literature Review section presents the current state of educational systems, emphasizing the numerous limitations encountered, as well as emerging solutions that may have a positive impact on education. Once implemented, these innovative elements have the potential to increase learner engagement, support teachers in adapting methods to contemporary needs, and contribute to a more efficient, personalized, and equitable educational process.

The Opportunities and Benefits section presents three major emerging technologies (Artificial Intelligence, Internet of Things and Blockchain) that address the challenges experienced in education and support both teachers and learners. This section highlights the usefulness and effectiveness of integrating these technologies, as well as the multiple benefits they can bring to the educational process. The Discussions and Conclusions section outlines the key findings of the study, focusing on educational systems, the challenges they face, opportunities for improvement, and the ongoing benefits of using emerging tools within the educational context.

2 Literature Review

Educational systems play an essential role in shaping and developing society, alongside various factors such as economic, cultural, and political ones. All these subsystems (economic, cultural, community and educational) work together to foster a sustainable and prosperous society. Their primary and shared objective is to develop human capital, transmit cultural values, and cultivate the competencies necessary for social and professional integration [6]. On the other hand, the educational system is influenced by state policies, available economic resources, the cultural values of the community, and the evolution of Information and Communication Technologies (ICT). At the same time, it is important to note, and widely acknowledged, that a high-performing educational system contributes significantly to economic development and social cohesion.

2.1 Current Issues in Education

It is widely recognized that within the contemporary educational system, multiple issues affect the quality of the instructional process. Thus, it is important to analyze the problems faced by participants in the educational process, highlighting the obstacles encountered in learning, as well as the deficiencies and challenges faced by teachers, which directly influence the quality of the educational act. This structure allows for a systematic and comparative evaluation of existing gaps, providing

the basis for identifying appropriate solutions and developing strategies for educational improvement.

2.1.1 Limitations from the Learners' Perspective

Among the existing limitations, those primarily experienced by the direct beneficiaries of education deserve special attention. Learners should have access to all educational resources, and the educational process should involve modern and effective methods tailored to their needs and generational characteristics.

The first significant issue to be mentioned concerns access to basic informational resources, such as the Internet or personal computers. Unfortunately, despite the rapid evolution of technology, there are still some situations in which students lack access to these resources either at school or at home [7]. Some of these situations are visible, while others remain unnoticed; however, in both cases, educational accessibility is neither sufficiently expanded nor equitably distributed among participants in the learning process, which represents an indispensable factor.

Furthermore, a clear disparity can be observed between regional environments, particularly urban and rural areas. Even within the same territorial unit, access to education varies considerably depending on the context in which students live. In rural areas, access to educational resources and opportunities is significantly reduced or almost nonexistent compared to urban areas [8].

Another issue faced by the younger generation of pupils and students relates to inadequate teaching methods. Over the years, generations have changed, as have their interests. Consequently, new instructional approaches must be adopted to address current needs and align with modern ways of understanding and learning [9]. While traditional education emphasized memorization and the acquisition of basic concepts, today's learners are more inclined to explore and engage with topics related to contemporary concepts and those that reflect personal interests.

Closely related to the limitation discussed

above is the insufficient attention given to individualized learning needs, particularly the lack of adaptations for students with disabilities or special educational needs. Although such cases are relatively rare, they must be addressed appropriately in a manner that ensures learners' right to education, understanding, and support [10]. Unfortunately, these situations often require additional time when traditional approaches are used and, in many cases, are not identified early enough to design specific and personalized interventions.

Other key aspects concern learners' motivation and engagement, which tend to be increasingly low. The pressure to achieve high grades and academic performance can diminish natural curiosity and intrinsic motivation to learn. At the same time, the lack of emphasis on practical and digital skills leaves learners unprepared for the real demands of the labor market or higher education. This issue is closely linked to motivation, as students who do not perceive the practical relevance of what they are learning are less likely to actively engage [11].

2.1.2 Perceived Pedagogical Challenges

From a complementary perspective, teachers also face significant challenges that hinder their ability to provide learners with high-quality and effective educational experiences. First, the heavy workload and burden of administrative tasks are particularly notable. If these activities were to be fully or partially automated, they could significantly reduce teachers' perceived workload. In this way, extensive obligations - including reporting, performing repetitive tasks, completing forms, and managing documentation (all of which are time-consuming) - once automated, would allow teachers to focus more on direct interaction with pupils or students, thereby increasing the quality and value of the teaching process rather than being absorbed by administrative duties [12].

The second critical challenge is the lack of adequate resources and infrastructure. Many educational institutions continue to rely on outdated textbooks and teaching materials, which often contain examples that are no longer

relevant or representative of the needs of contemporary society. Teachers perceive the lack of stable Internet access, or an insufficient number of devices required for educational activities as major impediments [13]. They also face specific contextual challenges, such as the need to respond to the diverse requirements of learners with learning difficulties. The presence of such situations requires time, adapted instructional approaches, adequate support, and appropriate professional training [14].

Moreover, insufficient preparation in innovation-related competencies represents a significant barrier. Given the rapid pace of technological advancement, teachers must continuously stay up to date and be proficient in using relevant software and online platforms. Mastery of these tools is essential to maintaining a dynamic, innovative, and up-to-date classroom environment. Although basic digital skills are generally covered and technology continues to advance rapidly, there are still insufficient specialized training programs to prepare teachers to pedagogically integrate Artificial Intelligence into teaching, to use these tools ethically and effectively, and to adapt them to the specific context of each discipline. This lack of training creates a gap between the potential of technology and teachers' ability to fully leverage it [15].

2.2 Emerging Technologies: a necessity and a solution

As the Technological Revolution reconfigures the global landscape, every sector is increasingly compelled to integrate advanced digital tools. Emerging technologies, such as Artificial Intelligence, Virtual Reality (VR), and Adaptive Learning platforms, represent direct responses to these major changes. In the specific context of education, emerging technologies are defined as "tools, technologies, innovations, and advancements used in various educational settings to serve a variety of educational purposes" [16], highlighting key characteristics such as novelty, rapid development, and transformative potential.

Below are three solutions that can support the resolution of existing problems in education:

Artificial Intelligence, Internet of Things and Blockchain (Figure 2).

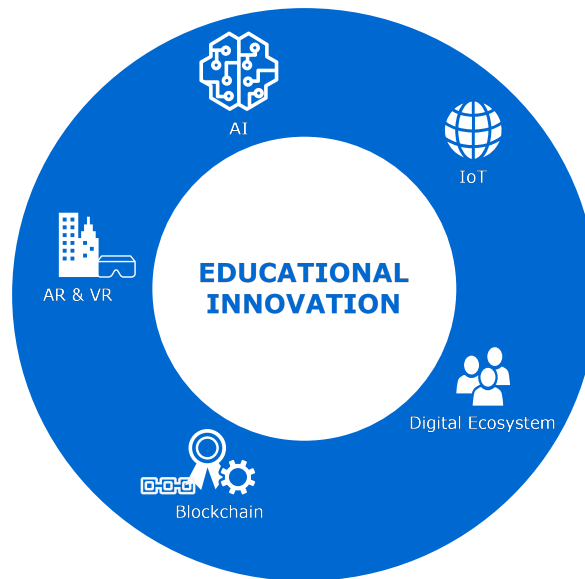


Fig. 2. The technological pillars of educational innovation

AI is analyzed along with all its revolutionary components and applications, IoT is considered an indispensable element of the current modern framework, and Blockchain represents a key factor that can be easily integrated alongside IoT for the development of complex solutions.

2.2.1. Automated and Intelligent Tools – AI

The first aspect to consider when discussing emerging technologies leads us to the concept of Artificial Intelligence and everything it entails. The term AI was coined to describe systems that mimic cognitive functions generally associated with human attributes, such as learning, speech, and problem-solving [17]. In fact, Artificial Intelligence is itself a product of human creativity and natural intelligence. Therefore, when the two are compared, they can never occupy an equal position. AI should be regarded as a collaborator of human intelligence, working synergistically to form a more coherent and efficient whole [18].

Among the most representative examples illustrating Artificial Intelligence are AlphaGo and IBM Watson. AlphaGo demonstrated AI’s ability to learn and analyze complex strategies by defeating one of the world’s top Go players. IBM Watson, on the other hand, is a system capable of processing large volumes of data, answering complex questions,

and providing evidence-based recommendations, being applied in fields such as medicine, data analytics, and education [19]. This category also includes advanced technologies such as Machine Learning, Deep Learning, Natural Language Processing (NLP), Computer Vision, Speech Recognition, and Generative Algorithms, which can interact with the physical environment, recognize objects, interpret voice commands, and perform autonomous tasks.

At this level, Chatbots can also be mentioned. These are software programs capable of conducting human-like conversations in a realistic manner. They can be considered virtual tutors, able to quickly and efficiently respond to students’ questions and recommend additional lessons based on their mistakes or areas of interest. A basic example is Duolingo, a learning Chatbot that provides trainees with conversational exercises and feedback. Another type of Chatbot can be found on the official platforms of certain universities, assisting students with administrative aspects such as enrollment, timetables, or course-related information (examples of such innovations already in use include Georgia Tech’s Ponce Chatbot, eCampus, or MyUni, belonging to the University of Adelaide, Australia) [20].

Furthermore, AI enables the personalization of each learning experience, considering that

every educational beneficiary has individual needs and a unique learning style; factors that cannot always be fully addressed in a standardized classroom setting with a single instructor teaching an entire group. In this way, personalization can provide content recommendations, notify users about their study schedules, and perform various other important functions. AI can learn to optimize how users assimilate information, making the educational process more efficient and productive [18]. In addition, Artificial Intelligence supports teachers by successfully handling administrative tasks or providing continuous and consistent feedback. Using these advanced methods, repetitive tasks such as assessment, attendance tracking, and data analysis are automated, allowing teachers to focus their time on what truly matters: building stronger relationships with learners and, ultimately, shaping a highly competent and well-rounded generation.

Moreover, from an inclusion perspective, assistive technologies such as text-to-speech, speech-to-text, zoom functions, predictive text, spell checkers, and search engines represent just a few examples of tools originally designed to support individuals with disabilities [19]. Over time, having demonstrated their usefulness, these technologies have been integrated into nearly all information systems and are now accessible to everyone. Currently, according to [21], to further support inclusion, AR and VR technologies have proven particularly effective, as they create immersive learning experiences and can enhance the understanding of concepts in a more accessible manner for students, considering their need for personalized support through alternative methods of engagement and comprehension.

2.2.2. IoT

The ability of the Internet to allow connected devices to interact and share information to make "smart decisions" is known as IoT. This concept encompasses all physical objects equipped with sensors, software, and connectivity that enable them to collect and exchange data via the Internet.

In education, IoT ranges from basic elements

like smartboards and occupancy sensors to advanced systems like facial recognition and environmental monitoring [22]. These monitor both physical factors (temperature, air quality) and educational indicators (student performance or concentration levels). The role of IoT includes energy saving, health and safety monitoring, campus environment optimization, and facilitating remote participation. As described in [23], IoT is a facilitator for sustainable and smart education, addressing management, teachers, and learners alike. For educational management, IoT ensures safety through smart cameras and detection systems to identify incidents like physical abuse, bullying, or fires. Additionally, smart school transportation can be monitored to prevent situations that compromise student safety [24]. For direct beneficiaries, IoT benefits include smart scanners, interactive whiteboards, and systems designed to manage curricula efficiently. IoT components are particularly valuable for individuals with physical or cognitive disabilities; for example, sensor-equipped gloves paired with a voice-generating tablet can help students with speech or hearing difficulties communicate in class. For teachers, IoT automates attendance through biometric systems or barcode identification integrated with facial recognition.

Overall, there is a strong drive toward a smart educational framework integrating IoT, blockchain, and adaptive solutions. Notable examples include the ICampus initiative (Curtin University, Australia) [26], and similar Smart Learning Environments in Finland (Tellus) [27] and Singapore (SmartCampus). In parallel, research has proposed data-driven predictive systems for air quality that are intended to monitor in real time the physical environment of educational institutions, contributing to the creation of a safer and healthier environment for all stakeholders involved in the educational system [28].

2.2.3. Blockchain

Another highly important and topical element is represented by Blockchain technology. Although it is primarily known for its use in cryptocurrencies, it has been integrated into

numerous fields to ensure transparency, security, and automated data verification. In education, once implemented, Blockchain technology offers multiple benefits.

For instance, students and academic staff can access courses at any institution within the network, as their academic records are available to authorized persons regardless of the institution or location, being managed through Blockchain mechanism. Moreover, the system allows institutions to issue certificates for graduating students based on Blockchain and enables other academic institutions or employing organizations to verify the authenticity and integrity of these certificates [29].

Such implementations demonstrate how emerging technologies can transform traditional school infrastructure into a smart and sustainable ecosystem, adapted to the daily changes and needs of the educational environment. All these advanced technologies, including the ones and beyond, bring us closer to the manifold benefits of smart and highly efficient educational ecosystems. Their integration into the learning process can lead to measurable improvements in the performance of education beneficiaries and learning efficiency, the specific metrics of which will be detailed below.

2.3. Notable Performances of Emerging Implementations

The use of emerging technologies in the educational process has also been examined from the perspective of learners' performance, and the results largely indicate significant improvements. Learners have become more motivated, more efficient, and more engaged in the learning experience.

IoT represents one of the key elements that has enhanced the learning process and has made numerous contributions through the transition of education to the online environment. In practice, it has expanded access to education by facilitating the delivery and sharing of information through remote sessions, improving efficiency by up to 20%, according to [23].

The use of personalized learning systems can also increase course participants'

performance. One example is Carnegie Learning's AI-based mathematics software, an educational program designed to help learners study mathematics in a precise and individualized manner, tailored to each person's needs. According to [20], its use can increase end users' mathematics performance by up to 30%. Similarly, the same source mentions Duolingo, another software application developed to support users in learning foreign languages in a more accessible and personalized way, offering a learning experience adapted to each student's proficiency level, interests, and learning style.

Once Blockchain is integrated into education, it can enhance the performance of educational stakeholders by supporting the gamification of the learning process, offering tokens as rewards for achievements and progress. Blockchain technology ensures that these tokens are distributed transparently, fairly, and securely, eliminating errors or fraud [29]. As a result, participants become more motivated and engaged, which improves their learning outcomes, making the educational experience more effective, interactive, and personalized. Gamification in education, together with various implementation approaches (digital leaderboards, adaptive tests, or interactive games), has been shown to lead to a more interactive and engaging learning experience. It increases participants' interest in school subjects, enhances self-efficacy, engagement, and motivation, and ultimately encourages them to achieve better academic results. In addition, Virtual Reality appears to increase motivation and active participation, while also improving knowledge acquisition and retention [30].

From a learning analytics perspective, teachers can access and use real data on learners' engagement and motivation through Key Performance Indicators (KPIs) provided by digital platforms. In this way, platforms become intelligent environments capable of anticipating behaviours, identifying issues, and optimizing academic performance. In study [31], data from a group of learners on Moodle (including clicks, activities, downloads, and forum participation) were transformed into KPIs such as task and assignment completion

frequency (number and pace of completed tasks), interaction with educational resources (accesses and downloads), participation in collaborative activities (forum posts and replies), time spent on the platform (session duration), and work pace relative to deadlines (fluctuations in activity levels). These KPIs effectively reflect each participant's learning style. The use of these innovative methods supports teachers by enabling data-driven pedagogical decisions and the personalization of the learning experience to meet learners'

specific needs, improving both the efficiency of the educational process and individual performance.

3 Opportunities and Benefits

Based on the correlation between the identified problems and the appropriate technological solutions, it follows that their implementation in an educational context offers, beyond the mitigation or resolution of existing issues, extensive operational and pedagogical benefits (Figure 3).

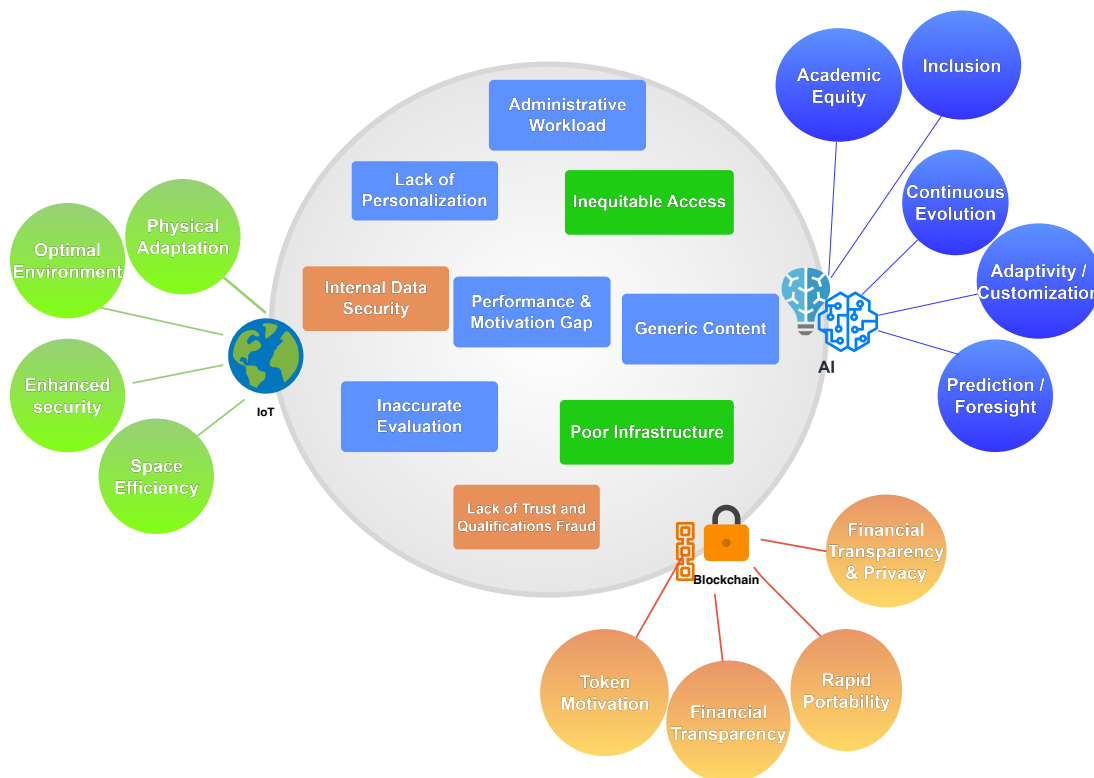


Fig. 3. Current challenges, solutions and benefits of IoT, Blockchain and AI in education

As illustrated in the figure above, each of the three technologies addresses at least one critical challenge found in modern education. IoT primarily manages issues regarding increased accessibility to the Internet and digital learning resources, while facilitating the creation of a "future-ready" environment that optimizes operational costs and campus physical safety. Blockchain complements this by addressing security concerns and qualification fraud, ensuring the transparency of financial transactions and the protection of intellectual property. Artificial Intelligence emerges as the most versatile technology, addressing most

limitations, including the lack of personalization, subjective assessment, and the heavy administrative workload of educators.

Furthermore, these technologies provide distinctive added value through benefits such as continuous adaptation and the profound personalization of the didactic act, alongside enhanced security for internal information regarding certifications and materials. These are joined by complex yet essential capabilities, such as academic equity, agile content development, and immediate, data-driven objective assessment. This fundamentally transforms evaluation from a mere classification tool into

a strategic instrument for development and intervention.

The emerging technologies discussed (AI, IoT and Blockchain) prove to be both useful and indispensable within the described educational context, resulting in a strategic convergence of digital solutions. The transition to Education 4.0 represents more than simple digitalization; it is a systemic transformation that prioritizes efficiency, equity, and the individual development of future-ready competencies.

4 Conclusions

We are at a turning point in terms of Technological Evolution, where adaptation to new demands is essential across all fields, and education is no exception. The present research demonstrates that the identified issues are felt by all participants in the educational process. A central finding is that each emerging technology offers a strategic solution to traditional limitations: IoT addresses infrastructure and operational efficiency, AI covers the needs for personalization and didactic automation, and Blockchain resolves challenges related to data trust and integrity. Consequently, closing traditional gaps and overcoming essential barriers provides synergistic benefits for all stakeholders, signaling a systemic transformation of the educational process.

A limitation of the current study lies in its contextual nature, being heavily influenced by the rapid pace of AI development and the continuous shifts in the field. For this reason, it is necessary to note that some results and conclusions may quickly become outdated. In this regard, future research will aim to refine and deepen this initial analysis. Key objectives will include assessing participant perception through surveys and detailed data analysis to evaluate the limitations experienced by direct participants. Additionally, future work will aim to categorize and organize emerging technologies (AI, IoT and Blockchain) based on education levels (primary, secondary, higher education) to determine where these technological solutions are most appropriately applied. Education 4.0 is not an option but an inevitable necessity. It stands as an imperative

condition that redefines the human role, forcing the academic environment to choose between stagnating in the past and shaping the future.

References

- [1] L. Ninda, A. Qurotul, R. Untung, W. Lidya, N. Efa Ayu, and A. Mohammed Iftequar, "Transformation of blockchain and opportunities for education 4.0.," *Int. J. Educ. Learn.*, vol. 3, no. 3, pp. 222–231, Dec. 2020, doi: <https://doi.org/10.31763/ijele.v3i3.283>.
- [2] E. Mukul and G. Büyüközkan, "Digital transformation in education: A systematic review of education 4.0," *Technol. Forecast. Soc. Change*, vol. 194, p. 122664, 2023, doi: <https://doi.org/10.1016/j.techfore.2023.122664>.
- [3] A. N. Ghanbaripour *et al.*, "A Systematic Review of the Impact of Emerging Technologies on Student Learning, Engagement, and Employability in Built Environment Education," *Buildings*, vol. 14, no. 9, 2024, doi: 10.3390/buildings14092769.
- [4] S. M. Munawar Hussain Zainab Mehmood Qureshi, "The impact of educational technologies on modern education: Navigating opportunities and challenges," *Glob. Educ. Stud. Rev.*, vol. IX, no. III, pp. 21–30, 2024, doi: [https://doi.org/10.31703/gesr.2024\(IX-III\).03](https://doi.org/10.31703/gesr.2024(IX-III).03).
- [5] A. F. Mena-Guacas, L. López-Catalán, C. Bernal-Bravo, and C. Ballesteros-Regaña, "Educational Transformation Through Emerging Technologies: Critical Review of Scientific Impact on Learning," *Educ. Sci.*, vol. 15, no. 3, 2025, doi: 10.3390/educsci15030368.
- [6] N. Shust, L. Tymchuk, I. Maidaniuk, I. Sydorenko, Y. Puzyrenko, and O. Nevmerzhytska, "Education as an Effective Component of Political Development and Socio-Economic Prosperity in Society," *Rev. Romaneasca Pentru Educ. Multidimens.*, vol. 14, no. 4, pp. 463–476, Dec. 2022, doi: 10.18662/rrem/14.4/651.
- [7] S. Guo, T. Sun, J. Gong, Z. Lu, L. Zhang, and Q. Wang, "Remote Co-teaching in

- Rural Classroom: Current Practices, Impacts, and Challenges,” in *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems*, in CHI '22. New York, NY, USA: Association for Computing Machinery, 2022. doi: 10.1145/3491102.3501924.
- [8] A. Ahmed, “The Digital Divide: Access to Technology in Rural vs. Urban Areas,” *Rev. J. Soc. Psychol. Amp Soc. Works*, vol. 1, no. 2, pp. 61–73, Mar. 2024, doi: 10.71145/rjisp.v1i2.18.
- [9] J. J. Jaramillo and A. Chiappe, “The AI-driven classroom: A review of 21st century curriculum trends,” *PROSPECTS*, vol. 54, no. 3, pp. 645–660, Dec. 2024, doi: 10.1007/s11125-024-09704-w.
- [10] S. Ahmed, Md. S. Rahman, M. S. Kaiser, and A. S. M. S. Hosen, “Advancing Personalized and Inclusive Education for Students with Disability Through Artificial Intelligence: Perspectives, Challenges, and Opportunities,” *Digital*, vol. 5, no. 2, 2025, doi: 10.3390/digital5020011.
- [11] C. J. Fong, E. A. Patall, K. E. Snyder, M. A. Hoff, S. J. Jones, and R. E. Zuniga-Ortega, “Academic underachievement and its motivational and self-regulated learning correlates: A meta-analytic review of 80 years of research,” *Educ. Res. Rev.*, vol. 41, p. 100566, Nov. 2023, doi: 10.1016/j.edurev.2023.100566.
- [12] A. Machado *et al.*, “Workload perception in educational resource recommendation supported by artificial intelligence: a controlled experiment with teachers,” *Smart Learn. Environ.*, vol. 12, no. 1, p. 20, Feb. 2025, doi: 10.1186/s40561-025-00373-6.
- [13] H. G. van de Werfhorst, E. Kessenich, and S. Geven, “The digital divide in online education: Inequality in digital readiness of students and schools,” *Comput. Educ. Open*, vol. 3, p. 100100, Dec. 2022, doi: 10.1016/j.caeo.2022.100100.
- [14] J. M. Fernández-Batanero, M. Montenegro-Rueda, J. Fernández-Cerero, and I. García-Martínez, “Assistive technology for the inclusion of students with disabilities: a systematic review,” *Educ. Technol. Res. Dev.*, vol. 70, no. 5, pp. 1911–1930, Oct. 2022, doi: 10.1007/s11423-022-10127-7.
- [15] Y. Aljemely, “Challenges and best practices in training teachers to utilize artificial intelligence: a systematic review,” *Front. Educ.*, vol. 9, p. 1470853, 2024, doi: 10.3389/educ.2024.1470853.
- [16] G. Veletsianos, *Emerging technologies in distance education*. 2010. [Online]. Available: https://fji.oer4pacific.org/id/eprint/32/1/Emerging_Technologies_in_Distance_Education.pdf
- [17] S. J. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, 4th ed. Harlow, England: Pearson, 2020.
- [18] T. Nur Fitria, “Artificial Intelligence (AI) In Education: Using AI Tools for Teaching and Learning Process,” Dec. 2021.
- [19] S. A. D. Popenici and S. Kerr, “Exploring the impact of artificial intelligence on teaching and learning in higher education,” *Res. Pract. Technol. Enhanc. Learn.*, vol. 12, no. 1, p. 22, Nov. 2017, doi: 10.1186/s41039-017-0062-8.
- [20] A. Harry, “Role of AI in Education,” *Interdisciplinary J. Hummanity Inj.*, vol. 2, pp. 260–268, Mar. 2023, doi: 10.58631/injury.v2i3.52.
- [21] A. Moriña and V. H. Perera, “Promoting inclusive practices with emerging technologies in higher education: Faculty professional development through blended-learning,” *Internet High. Educ.*, vol. 67, p. 101019, 2025, doi: <https://doi.org/10.1016/j.iheduc.2025.101019>.
- [22] A. Majeed and M. Ali, “How Internet-of-Things (IoT) making the university campuses smart? QA higher education (QAHE) perspective,” in *2018 IEEE 8th Annual Computing and Communication Workshop and Conference (CCWC)*, 2018, pp. 646–648. doi: 10.1109/CCWC.2018.8301774.
- [23] K. Zeeshan, T. Hämäläinen, and P. Neittaanmäki, “Internet of Things for Sustainable Smart Education: An Overview,” *Sustainability*, vol. 14, no. 7, 2022, doi:

- 10.3390/su14074293.
- [24] M. V. Vyawahare, S. Lambat, M. Belsare, K. Latwe, and R. Vairagade, "IOT Based School Bus Monitoring and Security System," *Int. J. Innov. Sci. Res. Technol.*, vol. 4, no. 3, p. 244, Mar. 2019.
- [25] J. Ajayakumar, H. Abdi, and N. V. D. Surendra Anna, "An IOT Enabled Smart School Bag to Help Kids, Parents and Schools," in *2019 International Conference on Internet of Things Research and Practice (iCIOTRP)*, 2019, pp. 1–6. doi: 10.1109/iCIOTRP48773.2019.00009.
- [26] M. Kent, "Internet of Things (IoT): Education and technology," *Academia.edu*, 2018, [Online]. Available: https://www.academia.edu/86353494/Internet_of_Things_IoT_Education_and_technology
- [27] E. Gilman *et al.*, "Internet of Things for Smart Spaces: A University Campus Case Study," *Sensors*, vol. 20, no. 13, 2020, doi: 10.3390/s20133716.
- [28] L. C. Tagliabue, F. R. Cecconi, S. Rinaldi, and A. L. C. Ciribini, "Data driven indoor air quality prediction in educational facilities based on IoT network," *Energy Build.*, vol. 236, p. 110782, 2021, doi: <https://doi.org/10.1016/j.enbuild.2021.110782>.
- [29] U. M. Osama A. Khashan Sultan Alamri, Waleed Alomoush, Mutasem K. Alsmadi, Samer Atawneh, "Blockchain-Based Decentralized Authentication Model for IoT-Based E-Learning and Educational Environments," *Comput. Mater. Contin.*, vol. 75, no. 2, pp. 3133–3158, 2023, doi: 10.32604/cmc.2023.036217.
- [30] G. Lampropoulos and Kinshuk, "Virtual reality and gamification in education: a systematic review," *Educ. Technol. Res. Dev.*, vol. 72, no. 3, pp. 1691–1785, June 2024, doi: 10.1007/s11423-024-10351-3.
- [31] S. Val and A. Quintas, "Key performance indicators for optimizing academic performance and course design in online educational platforms," *Cogent Educ.*, vol. 12, July 2025, doi: 10.1080/2331186X.2025.2529420.



Oana-Larisa STOICA is a PhD student in Economic Informatics at the Bucharest University of Economic Studies, within the Faculty of Cybernetics, Statistics and Economic Informatics. Her academic foundation includes both a Bachelor's degree (2023) and a Master's degree (2025) in Economic Informatics from the same institution. Her research spearheads the digital metamorphosis of the entire educational cycle (teaching, learning and assessment) by engineering high-impact frameworks for pedagogical adaptability, AI-driven personalization, and inclusion. Complementing her academic and teaching roles, she brings high-level technical expertise to the corporate sector as an IT Business Services Consultant-Database Administrator at SAP. By bridging the gap between theoretical innovation, classroom instruction, and enterprise-level database management, she is committed to developing secure and scalable technological solutions for the Education 4.0 era.