

Information Technology Tools in Higher Education*

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Abstract

The development of information technology (IT) in recent years has significantly influenced the functioning of educational systems worldwide. The purpose of this article is to present the evolution of education under the influence of IT and to discuss changes in the teaching and learning process. The article analyzes the role of information technology in the transformation of modern education, with a particular focus on higher education. It presents the impact of the dynamic development of digital tools on the shift in teaching models—from traditional approaches to interactive, personalized, and hybrid forms. The article discusses the significance of e-learning platforms, social media, the Internet of Things, and solutions based on artificial intelligence, augmented reality, and virtual reality in the teaching process. Particular attention was paid to the individualization of teaching and the changing role of the academic instructor, who increasingly serves as a mentor and facilitator of the learning process. The paper also presents experiences related to remote teaching during the COVID-19 pandemic, highlighting both the potential and the limitations of digital education. It emphasizes the importance of a systematic approach to technology implementation and the need to develop the digital competencies of faculty and students. It also highlights key challenges associated with the use of information technology, such as digital exclusion, threats to data privacy, and information overload. The results of the analysis indicate that IT can significantly support the educational process, but its effectiveness depends on the method of implementation, the quality of the infrastructure, and alignment with educational objectives. The article emphasizes the need for the conscious, responsible, and integrated use of digital tools in education as a prerequisite for improving the quality of teaching and learning.

Keywords: Information technology, higher education, e-learning, artificial intelligence

Introduction

Modern education is one of the sectors of the economy undergoing rapid change, driven by the development of information technology. Information technology is a term that encompasses all tools and technologies related to information processing. The traditional teaching model, based primarily on the teacher imparting knowledge through lectures and textbooks, is increasingly giving way to hybrid and remote models. Today, increasingly advanced information processing techniques are becoming the foundation of all educational activities. The widespread use of modern, technology-supported educational tools, such as mobile devices, interactive whiteboards, MOOCs, tablets, laptops, simulations, dynamic visualizations, and virtual laboratories, has significantly influenced the way education is conducted (Haleem et al., 2022). Technology not only enables access to educational resources from anywhere in the world, but also influences how knowledge is acquired, competencies are developed, and students are assessed.

Information technology tools also serve to disseminate shared knowledge. The Internet of Things (IoT) has emerged as one of the most important technologies of the 21st century, including in higher education. Through the use of affordable computing technologies, cloud computing, big data, analytics, and mobile technologies, the IoT serves as a robust mechanism for integrating a world-class educational experience for all (Dreimane et al.,

2022), (Keengwe and Bhargava, 2014). IoT in education has opened up new possibilities for personalization, interaction, and learning efficiency, creating smart classrooms and enabling remote learning. Companies operating in the edtech sector are constantly seeking innovative solutions that will increase access to education for those without access to appropriate educational institutions. Social media can also be a useful educational tool, offering opportunities for communication, access to educational resources, and collaboration in learning. An increasing number of teachers and students view it as an integral part of the remote learning experience, playing a key role in the exchange of information on important topics. In addition to enabling the rapid dissemination of content regardless of time and place, social media also serves as an excellent platform for networking, fostering social relationships and potential employment opportunities (Haleem et al., 2022), (Büyükbaykal: Communication technologies and education - Google Scholar).

According to OECD research (OECD Digital Education Outlook 2023, 2023), schools that have successfully implemented information technology have seen improved student performance and higher levels of engagement. The 2023 report on digital education found that online educational platforms are present in 26 of the 29 countries covered in the report. However, these countries have not yet adopted a system-wide approach to the digital transformation of education that would foster personalized, proactive learning and assessment and support better decision-making across the entire education system. The 2023 report indicates that 19 of the 29 countries have implemented systems that collect information on individual student outcomes, which are currently used for statistical purposes. Of these, 45% integrate individual student performance into standard national assessments, 31% provide dashboards or visualizations, and another 31% combine student and teacher data, which helps teachers tailor instruction to students' needs. Five countries use early warning systems to predict the risk of students dropping out and trigger early interventions. However, the most common digital educational resources remain static ones, created primarily by digitizing paper materials. Such resources are available in 26 of the 29 countries.

However, to harness the potential of digital educational technologies to improve learning outcomes, a system-wide approach is needed. Significant disparities in the availability and use of digital tools underscore the need for comprehensive professional development and upskilling of teachers and administrators. Although 60% of secondary school teachers received training in digital education in 2022, 20% still report a need for further training (OECD Digital Education Outlook 2023, 2023).

The digital transformation of education has the potential to significantly improve the quality of teaching and learning. According to the findings of the Survey on National Education Responses to COVID-19 School Closures published in November 2020 by UNESCO, UNICEF, and the World Bank, the COVID-19 pandemic provided a much-needed boost to digital education and accelerated the digital transformation of education on an unprecedented scale (unesdoc.unesco.org/ark:/48223/pf0000374702/PDF/374702eng.pdf.multi). Responses collected from the ministries of education of 118 countries in May and June and 149 countries in June and October revealed the extent of the losses caused by the pandemic in education. According to estimates conducted in 108 countries, students lost approximately 47 days of schooling in the first half of 2020. In response to this threat, the vast majority of the countries surveyed introduced remote learning based on the use of online platforms, television, radio, as well as sets of tasks and assignments for students to complete. While in high-income countries (World Bank Country and Lending Groups – World Bank Data Help Desk) remote learning has become the new norm, in other countries it has not been fully implemented. Therefore, systemic approaches that ensure the coherence of tools, technologies, and other resources within the education system are essential to fully unlock the potential of digital technologies to improve learning outcomes (Raport dot. edukacji cyfrowej 2023 - Polska w OECD - Portal Gov.pl). The OECD Digital Education Outlook 2023 outlines proposed actions to accelerate the digital transformation of education systems across the OECD (OECD Digital Education Outlook 2023, 2023). The recommendations presented are based on an overview of situations and phenomena where digital solutions could help achieve specific goals. Furthermore, they emphasize the importance of increasing data interoperability across the entire education ecosystem and using public procurement to encourage educational technology providers to incorporate interoperability standards. In light of the rapid development and growing use of generative artificial intelligence, the report presents updated guidelines for its responsible implementation in the education sector, addressing key issues such as equal opportunities, privacy protection, mitigating bias, and ensuring transparency. The recommendations include, among other things, the need to ensure equal opportunities in access to high-quality connectivity infrastructure and digital educational resources, as well as the introduction of mechanisms for the ongoing monitoring and evaluation of digital education policies, enabling the continuous assessment of the impact of AI integration on the educational process.

In light of these changes and the growing importance of information technology in educational systems, a thorough analysis of these technologies in the context of contemporary educational processes is warranted. This study focuses on analyzing the role of information technology in the educational process at the higher education level. The impact of selected digital tools on the organization of the teaching process, the level of student engagement, and the possibilities for individualized instruction was analyzed. Changes in the functions and competencies of academic instructors in the context of the ongoing digitization of education were also considered. A review of the relevant literature was also conducted, and reference was made to teaching experiences, which allowed for the identification of both the potential and the limitations of using information technology in education. Selected examples of digital tools, including e-learning platforms and AI-based solutions, were analyzed, highlighting their significance in the context of contemporary educational challenges.

Key Changes in Education

A Shift in the Teaching Model

The rapid development of information technology in recent years has enabled a shift away from one-way knowledge transfer toward interactive, personalized, and project-based education focused on the active participation of learners. Information and communication technologies have made it possible to create environments in which students become co-creators of knowledge, rather than merely its recipients. E-learning platforms such as Moodle, Google Classroom, Microsoft Teams, Khan Academy, and Zoom have become essential tools for supporting both remote and in-person classes. They facilitate the sharing of instructional materials, task management, progress assessment, and maintaining constant communication between teachers and students. Thanks to these tools, it is possible to move away from traditional curricula toward personalized education by creating courses tailored to users' individual needs. The development of digital tools has also enabled the wider adoption of project-based and problem-based learning methods, which require students to think critically, seek information independently, and develop social skills.

Multimedia and interactive educational resources, such as videos, simulations, and virtual laboratories, are also gaining in importance. These resources make it possible to visualize phenomena that are difficult to understand and observe in a traditional lecture setting. Furthermore, they enable experimentation in a safe, controlled environment. Meanwhile, advanced analytical and statistical tools built into educational platforms allow teachers to monitor student activity and adjust the pace of learning to their abilities.

Social media and communication tools have also had a significant impact on the current shape of the teaching model. Their widespread use has led to the transfer of some educational interactions outside the formal framework of classes. Knowledge sharing and problem-solving have become easier thanks to various discussion groups, chats, and online forums. Furthermore, these platforms enable collaboration among students from different parts of the world. In this way, the learning process is no longer confined to the classroom or set class hours.

Information technology also supports the development of the concept of lifelong learning by providing access to online courses, webinars, and educational resources anytime and anywhere. With the goal of professional development and adapting to rapid technological changes, students can learn at their own pace, revisit difficult topics, and develop additional skills beyond the core curriculum.

However, attention must be paid to the challenges facing the education system in the face of the dynamic development and implementation of modern technologies. First among these is the risk of widening educational inequalities in situations where users have limited access to computer equipment or the internet. Additionally, significant issues related to data security, privacy, and information overload are emerging.

In summary, the shift in teaching models driven by technological advancements is systemic in nature and encompasses both educators' teaching methods and learners' experiences. The teaching process is becoming increasingly flexible, interactive, and tailored to individual needs. The accelerating pace of technological development requires constant reflection on how technology can support, rather than replace, the essence of the teaching process. The direction of these changes will be increasingly reinforced in the coming years by the use and development of artificial intelligence, which opens up new perspectives but also presents the education system with entirely new challenges.

The New Role of the Teacher

The rapid development of information technology in recent decades has had a significant impact on the functioning of modern education, including higher education. Advances in digital tools, information systems, and educational platforms are bringing about changes in how the teaching process is organized, how communication takes place, and how knowledge is accessed. As a result, universities are faced with the need to adapt their teaching methods to new technological conditions, and the role of the academic teacher is undergoing a gradual transformation.

The traditional teaching model, in which the teacher served primarily as a source of knowledge transmitted in a one-way manner, is gradually giving way to a more interactive model focused on learner activity. The development of the internet, digital databases, learning management systems (LMS), and online communication tools has made access to information widespread and virtually unlimited. In this context, the primary role of the academic teacher is no longer solely to impart knowledge, but above all to support students in its critical analysis, selection, and practical application. The modern academic teacher increasingly serves as a mentor, moderator, and guide in the educational process. Their task is to design an educational environment conducive to active learning, in which information technologies serve as tools to support the development of students' competencies. In practice, this means the need to employ a variety of teaching methods, such as blended learning, e-learning, the use of multimedia, and interactive educational platforms. These technologies enable a more flexible organization of classes, as well as the individualization of the learning process.

Despite the common direction of change in higher education, certain differences can be observed between the natural sciences and the humanities and social sciences, which concern both the nature of the knowledge being imparted and the way information technology is used in the teaching process. In the case of sciences, such as mathematics, computer science, physics, or chemistry, knowledge is typically more formal and algorithmic in nature. The teaching process often relies on solving problems, analyzing mathematical models, and performing calculations. In this context, information technologies support the educational process through the use of computer simulations, programming environments, and specialized computational software.

In the humanities and social sciences, greater emphasis is placed on interpretation, textual analysis, facilitating discussions, and developing argumentation skills. In this area, information technologies are primarily used as tools that provide access to digital databases, source materials, library resources, and platforms that support collaboration and communication among participants in the teaching process.

Regardless of the specific nature of a given discipline, the role of the academic instructor is evolving toward that of a mentor and guide who supports students in the learning process. In the sciences, the instructor more often serves as an expert who assists with problem-solving and the development of analytical skills. In the humanities and social sciences, on the other hand, greater emphasis is placed on moderating discussions, developing critical thinking, and interpreting phenomena from various perspectives.

The development of IT tools and rapid technological changes require instructors to adapt quickly to new educational realities. Above all, this shift in teaching models demands that teachers be proficient in using digital tools and modern technologies. It also requires new methodological skills. It has become essential to skillfully integrate technology with existing educational objectives and to employ strategies that support active learning. Therefore, it is essential to expand the academic instructor's skill set to include, among other things, the ability to prepare multimedia materials, use e-learning platforms, conduct remote classes, and utilize tools that support online collaboration. These competencies are becoming crucial in the context of rising expectations among students who operate in a digital environment on a daily basis. The development of information technology creates not only new opportunities but also challenges for academic instructors. Issues arise regarding the quality of education in a digital environment, the reliability of information sources, and the ethics of technology use. Consequently, the role of the instructor also includes fostering responsible attitudes toward the use of digital resources and developing critical thinking skills.

Personalized Learning

Personalized learning is one of the key trends in the development of modern higher education. In the context of dynamic social and technological changes, increasing importance is being placed on adapting the educational process to students' diverse needs, abilities, and learning styles. The traditional teaching model, based on a

uniform delivery of instructional content to the entire group, is gradually giving way to a more flexible approach that takes into account the individual pace of learning and the cognitive preferences of those participating in the educational process. The individualization of teaching primarily involves creating educational conditions that enable students to actively participate in the process of acquiring knowledge and developing their own interests and competencies. In practice, this means using a variety of teaching methods that allow for different learning styles, levels of subject-matter preparation, and student motivation. A contemporary academic instructor should therefore not only impart knowledge but also design the teaching process in a way that allows for its flexible adaptation to the needs of individual students.

An important aspect of personalized instruction is the use of active learning methods, such as group projects, case studies, and problem-based tasks. These methods foster the development of analytical and critical thinking skills, while also allowing students to choose topics or approaches to tasks that align with their interests and competencies. As a result, the teaching process becomes more engaging, and the knowledge gained is more practical and lasting.

Information technologies play a significant role in the implementation of individualized instruction. Digital tools, such as e-learning platforms, learning management systems, and interactive multimedia materials, enable the creation of diverse educational pathways and provide students with access to instructional materials at a time and pace convenient for them. This makes it possible to tailor the learning process to individual needs, as well as to foster students' independence and responsibility for their own educational development. Modern adaptive systems, which use information technology to tailor instructional content to the user's needs, have proven to be an important element in supporting the individualization of teaching.

Educational platforms based on data analysis and artificial intelligence, such as Khan Academy, ALEKS, Pearson, Coursera, and other e-learning systems that use machine learning algorithms, enable the difficulty level of the material to be automatically adjusted to the learner's current proficiency. Based on an analysis of task results, time spent, and the number of errors made, the system can suggest subsequent exercises that match the user's individual pace and learning style. The use of such solutions allows for more precise monitoring of learning progress and faster identification of areas of difficulty. By analyzing the collected data, the instructor can obtain detailed information regarding students' mastery of specific topics, which enables more effective planning of instructional activities. Adaptive systems can therefore support academic instructors in diagnosing students' educational needs and in tailoring content and teaching methods to their individual capabilities.

In Poland, these systems are used more frequently in elementary and secondary schools than in higher education. University professors also make use of them, though typically to a more limited extent. This is due to several factors: greater student independence, the specific nature of university studies, and the greater emphasis on project work and research. In higher education, adaptive technologies are mainly found:

- in online courses and MOOC platforms, e.g.:
 - NAVOICA – a Polish educational platform owned by the Ministry of Science and Higher Education, developed by the National Information Processing Institute (OPI PIB: Ośrodek Przetwarzania Informacji – Państwowy Instytut Badawczy). The platform's name comes from Nawojka, who, according to legend, was the first Polish female student (NAVOICA - polska platforma edukacyjna),
 - PARP Academy (Polska Agencja Rozwoju Przedsiębiorczości) – Polish Agency for Enterprise Development – a free e-learning platform offering online courses in entrepreneurship, marketing, law, and finance (Strona główna - PARP - Centrum Rozwoju MŚP),
 - The PFR Knowledge Zone is a free e-learning platform of the Polish Development Fund, offering courses, webinars, and educational materials for entrepreneurs, employees, and individuals seeking to improve their qualifications. It focuses on practical knowledge in the areas of digitalization, ESG (sustainable development), project management, AI, and law and finance (Bezpłatne kursy i szkolenia online | Strefy Wiedzy PFR),
 - Khan Academy – the Polish-language version of the non-profit educational platform, offering free teaching materials: videos, articles, and exercises in various fields, primarily mathematics and programming (Khan Academy | Darmowe kursy, lekcje i ćwiczenia online).
- in universities' own e-learning platforms used to monitor student progress.

The effective implementation of personalized instruction also presents certain challenges. It requires academic instructors not only to possess strong subject-matter expertise but also to be able to plan diverse learning activities and utilize modern technological tools. In addition, it is necessary to properly prepare the technical infrastructure and ensure that students have access to digital resources that support the learning process.

Examples of IT Applications in Education

Information technologies have become an integral part of modern education systems. Their importance has grown significantly in recent years, particularly due to the experience of remote learning during the COVID-19 pandemic, the development of AI-based tools, and the implementation of augmented and virtual reality solutions. It is emphasized that these technologies can increase access to education, support personalized learning, and boost learner engagement; however, their effectiveness is not automatic and depends on implementation conditions, the quality of infrastructure, teacher competencies, and alignment with educational objectives. UNESCO notes that technology in education should be viewed as a tool serving students and teachers, rather than as an end in itself (Global Education Monitoring Report 2023: Technology in Education: a Tool on Whose Terms? [EN/AR/PT/RU/SW/ZH] - World | ReliefWeb, 2023).

Remote Learning During the COVID-19 Pandemic

One of the most striking examples of the use of information technology in education was the widespread shift to remote learning during the COVID-19 pandemic. The closure of schools and universities forced the rapid implementation of digital solutions that enabled the educational process to continue. In this context, online education served as an intervention and safeguard for educational systems, mitigating the risk of a complete disruption of learning. The OECD's Digital Education Outlook 2023 report emphasized that the pandemic revealed both the potential of digital education and the need to build sustainable and coherent digital ecosystems in education. It also noted that in many countries, the digitization of education management tools has been only partial, while fully mature and coordinated systemic solutions are still lacking (OECD Digital Education Outlook 2023, 2023).

At the same time, experiences during the pandemic have shown that the effectiveness of remote learning varied significantly in terms of both social factors and infrastructure. UNESCO's findings indicate that online education played a significant role in maintaining educational continuity and reducing the risk of a complete disruption of the teaching process, but it did not ensure equitable access to education for all students. The Global Education Monitoring Report 2023 indicates that approximately 31% of students worldwide remained outside the effective reach of distance learning (Global Education Monitoring Report 2023: Technology in Education: a Tool on Whose Terms? [EN/AR/PT/RU/SW/ZH] - World | ReliefWeb, 2023). These data confirm that information technologies can be an important support tool in crisis situations; however, in conditions of limited access to connectivity, appropriate devices, and digital competencies, they can simultaneously contribute to the perpetuation or exacerbation of existing educational inequalities.

Based on an analysis of research findings on remote learning in higher education, as presented in the study (Fernández-Batanero et al., 2022), it was demonstrated that online education played a significant role in ensuring the continuity of the educational process during a crisis, but at the same time revealed a number of limitations related to the sudden implementation, methodological shortcomings, communication difficulties, and the insufficient level of preparation of some faculty members and students to function in a digital environment. It was also noted that the further development of higher education may, to some extent, be based on online and hybrid models, which requires an appropriate strengthening of technological infrastructure, the systematic development of teaching staff competencies, and the improvement of instructional design.

It should also be noted that a significant portion of the critical assessments of remote education made during the pandemic did not refer to a mature e-learning system designed in accordance with the principles of digital pedagogy, but rather to emergency remote teaching implemented under crisis conditions. The negative assessments of online education made in 2020–2021 largely concerned an improvised model introduced under the pressure of a sudden epidemiological emergency, rather than the very idea of technology-supported education. From a scientific perspective, therefore, the pandemic was not found to have undermined the validity of using information technology in education. Instead, it was shown that the effectiveness of digital solutions is closely linked to the level of organizational, pedagogical, and social preparedness (Fauzi, 2022). It has also been demonstrated that the effectiveness of remote learning was closely correlated with the quality of national digital

ecosystems, including internet access, the availability of educational platforms, the level of teachers' digital competencies, the efficiency of educational information management systems, and the degree of coordination of public policies. At the same time, the experiences of the pandemic period confirmed that the mere presence of technology is not a sufficient condition for the effective implementation of the educational process, as institutional readiness and the quality of organization and instructional design are considered of key importance (Fernández-Batanero et al., 2022), (Fauzi, 2022).

The Use of Artificial Intelligence in Education

The second significant area of application for information technology in education is the use of artificial intelligence. Modern AIED (Artificial Intelligence in Education) systems include, among other things, tools for personalized learning, intelligent tutoring systems, automated assessment, educational data analysis, and support for teachers in developing instructional materials. Current research on AIED (Artificial Intelligence in Education) covers a wide range of applications: from adaptive learning and personalized intelligent tutoring, through intelligent assessment and instructional management, to supporting teachers in developing instructional materials (Wang et al., 2024).

From an educational perspective, AI is particularly valuable when it enables the learning process to be tailored to the needs of individual students. Based on data regarding work pace, common mistakes, mastery of content, and activity patterns, AI-based systems can generate personalized recommendations, suggest additional exercises, adjust the difficulty level of the material, or recommend supplementary resources to support the learning process. The OECD notes that such tools can accelerate the personalization of teaching, support students with special educational needs, and help education systems identify the risk of dropping out. At the same time, the organization clearly states that promising applications of AI in education are still in the development stage in many areas and require careful implementation (OECD Digital Education Outlook 2023, 2023).

In recent years, generative AI tools have also gained significant momentum; these tools support the creation of outlines, summaries, quizzes, problem-based questions, remedial materials, and alternative versions of texts tailored to students' skill levels. However, in its guidelines on generative AI, UNESCO emphasizes that the implementation of these solutions should be human-centered, meaning that it should prioritize the overarching role of humans in defining educational goals, assessing content quality, and taking responsibility for the teaching process. The agency notes that many countries still lack adequate regulations regarding generative AI in education, which creates risks related to data privacy, a lack of transparency in how systems operate, and insufficient preparation of educational institutions to validate these tools (Guidance for generative AI in education and research | UNESCO).

The findings of available studies indicate that the use of AI may contribute to improved educational outcomes, although the extent and nature of this impact vary. Publications from 2025 on the relationship between AI use and student performance confirm the existence of a generally positive effect, while emphasizing the importance of moderating factors, including educational level, type of AI tool, duration of the intervention, teaching strategy, and subject area. In light of these findings, artificial intelligence should not be treated as a universal remedy for educational problems, but rather as a tool whose effectiveness depends on the specific characteristics of the implementation context (Dong, Tang and Wang, 2025).

The literature on the subject also highlights the risks associated with the use of AI in education. The most frequently identified risks include the reproduction of algorithmic biases, limited transparency of decision-making models, the risk of generating erroneous recommendations, threats to data privacy, and the potential for undermining students' cognitive autonomy in the context of uncontrolled use of generative tools. For this reason, the current trend in scholarly reflection does not boil down to determining whether AI is a beneficial solution, but rather to analyzing the conditions of its use, target groups, and the scope of pedagogical oversight within which it can effectively support learning (Vincent-Lancrin and Vlies, 2020).

Augmented and Virtual Reality in Education

Another key area of application for information technology in education involves solutions based on augmented reality (AR) and virtual reality (VR). These technologies enable the creation of educational environments characterized by a high level of interactivity and immersion, thereby supporting learning based on experience,

exploration, and simulation. In educational practice, AR and VR are used in fields such as biology, medicine, history, geography, as well as technical and engineering education. Among other things, they enable the observation of three-dimensional anatomical models, the exploration of historical reconstructions, the visualization of phenomena that are difficult to observe directly, and the conduct of practical exercises in controlled and safe conditions (Coban, Bolat and Goksu, 2022), (Augmented Reality in Higher Education: A Systematic Review and Meta-Analysis of the Literature from 2000 to 2023 | MDPI).

Available studies indicate that both virtual reality (VR) and augmented reality (AR) can have a positive impact on learning outcomes, although the strength of this impact varies and depends on the educational context. In the case of immersive virtual reality, a positive, moderate effect on learning has been observed, with its magnitude depending, among other things, on the type of instructional task, the degree of immersion, and the subject area (Coban, Bolat and Goksu, 2022). Similarly, research on AR indicates its positive impact on student responses, the development of knowledge and skills, and task performance, while emphasizing the importance of factors such as the duration of the intervention or the organization of the learning process (Chang et al., 2022). More recent analyses also confirm the particular potential of AR in higher education, where a high overall instructional effect has been observed, especially in situations requiring visualization, object manipulation, and active problem-solving (Augmented Reality in Higher Education: A Systematic Review and Meta-Analysis of the Literature from 2000 to 2023 | MDPI).

The high level of student engagement often observed in VR and AR settings does not necessarily lead to a corresponding increase in cognitive outcomes. Stimulus overload, poorly designed interaction, and an excessive focus on the technology's appeal can increase cognitive load and undermine concentration on core instructional objectives. For this reason, the need to design immersive environments in a way that is aligned with the logic of learning is emphasized. This conclusion remains particularly relevant from both the perspective of school practice and academic research (Coban, Bolat and Goksu, 2022), (Augmented Reality in Higher Education: A Systematic Review and Meta-Analysis of the Literature from 2000 to 2023 | MDPI).

An analysis of selected examples shows that information technologies play a significant role in education, both in organizing instruction and in supporting students' cognitive processes. Experiences with remote learning during the COVID-19 pandemic have demonstrated that these technologies can maintain educational continuity in crisis situations, while also revealing and exacerbating digital inequalities. Tools utilizing artificial intelligence offer opportunities for personalizing instruction, monitoring progress, and supporting teachers' work; however, their implementation requires responsibility, regulation, and an ethical framework. AR and VR technologies, on the other hand, can increase student engagement and support experiential learning, particularly where visualization and simulation play a significant role, although their effectiveness depends on the quality of instructional solutions. In light of the available findings, it must therefore be concluded that technology in and of itself does not improve education, but can only contribute to its development when used in a purposeful, pedagogically sound, and equitable manner (Coban, Bolat and Goksu, 2022), (Chang et al., 2022).

Challenges and Risks Associated with the Use of Information Technology in Higher Education

Despite the numerous benefits resulting from the development of information technology, its widespread use in education also entails a number of challenges and potential risks. Introducing digital tools into the teaching process requires not only appropriate technological infrastructure but also reflection on the social, organizational, and ethical consequences of their use. In the context of higher education and education more broadly, the significance of the following issues should be considered:

- Accessibility and the digital divide: disparities in access to information technology across regions and social groups exacerbate educational inequalities.

One of the key challenges remains the accessibility of information technology and the phenomenon of the digital divide. Despite the rapid development of IT infrastructure, significant disparities in access to modern digital tools persist. According to the Central Statistical Office's report **The Information Society in Poland in 2025**, 96.2% of households already have internet access; however, disparities in the use of digital technologies persist depending on the level of urbanization and the socioeconomic status of households (GUS, 2025), (NIK, 2024), (Wykluczeni w cyfrowym państwie – NIK o nierównościach w dostępie do środków publicznych - Najwyższa Izba Kontroli). Unequal access to

computer equipment, a stable internet connection, or specialized software can lead to a deepening of existing educational inequalities. As a result, some students may have limited opportunities to use educational resources available in the digital environment, which negatively impacts their educational achievements and opportunities to develop digital competencies.

In response to the growing challenges posed by the digital divide in Poland, numerous systemic initiatives are being undertaken to improve access to technology, enhance digital literacy, and reduce educational inequalities. In 2026, remedial measures are based on investments from the National Recovery and Resilience Plan (KPO - Krajowy Plan Odbudowy) and new educational and social programs. Initiatives in higher education focus on developing the digital skills of students and academic staff and modernizing universities' Information and Communication Technologies (ICT) infrastructure. The projects include training, access to modern digital tools and e-learning platforms, which is intended to support personalized learning and reduce digital exclusion (Ministerstwo Cyfryzacji - Portal Gov.pl), (Strona główna - Centrum Projektów Polska Cyfrowa - Portal Gov.pl).

- Data security and privacy: The growing number of digital tools carries the risk of misuse and unauthorized data processing.

Another important issue is data security and the protection of users' privacy in educational systems. As the number of e-learning platforms, educational apps, and data-driven tools increases, so does the amount of information collected about students' activities. This data may include learning outcomes, activity history on educational platforms, or information regarding the use of instructional materials. Improper management of this data or a lack of adequate safeguards can lead to unauthorized processing, misuse, or violations of user privacy. For this reason, it is essential to implement appropriate data protection procedures and raise awareness among both faculty and students regarding the secure use of digital tools. In Poland, issues related to personal data security and privacy protection in the educational environment are gaining increasing prominence in public discourse and institutional actions. In recent years, the Personal Data Protection Office (UODO - Urząd Ochrony Danych Osobowych) has noted an increase in reports of cyber threats in educational institutions, including cases of unauthorized access to teachers' accounts, phishing, and the accidental sharing of documents containing data on public websites, which highlights insufficient security measures and procedures in educational institutions (Strona główna - UODO).

In response to these challenges, educational and training initiatives are being undertaken to raise awareness about data protection and the safe use of digital tools. These programs emphasize the ethical aspects of using new technologies, the impact of artificial intelligence on privacy, and practical data protection skills in the school environment. Such initiatives also complement the existing legal framework, including the obligation to comply with the General Data Protection Regulation (RODO) and specific regulations regarding data processing in public systems, such as the Integrated Information System on Higher Education and Science (POL-on - Zintegrowany System Informacji o Szkolnictwie Wyższym i Nauce), which require universities to implement information security policies in accordance with current EU and national regulations (Pomoc, 2016).

- Information overload: an excess of content and technology can lead to a loss of focus and burnout among students and faculty.

Information overload is also becoming a significant challenge. The modern digital environment offers a vast amount of educational materials, multimedia resources, and tools to support the learning process. However, the excess of information and the need to use multiple platforms simultaneously can lead to distraction, reduced learning effectiveness, and increased stress levels among both students and teachers. In the long term, this can contribute to educational burnout and reduce motivation to actively participate in the learning process.

In summary, the development of information technology opens up new opportunities for modern education, but at the same time presents the education system with a number of significant challenges. The effective use of digital tools therefore requires not only their integration into the teaching process, but also the implementation of measures aimed at reducing the digital divide, ensuring data security, and the rational management of information resources in the educational environment.

Conclusions

Information technologies are playing an increasingly important role in the transformation of modern education, influencing both the organization of the educational process and the methods used to support learning. The development of e-learning platforms, analytical tools, systems utilizing artificial intelligence, and augmented and virtual reality technologies expands the possibilities for personalizing instruction, monitoring progress, and engaging learners. It can therefore be concluded that the future of education will be largely based on digital solutions; however, the effective use of these solutions remains contingent on maintaining a balance between technology and the direct teacher–student relationship.

The effectiveness of information technology is neither automatic nor universal. Its scope depends on the quality of the instructional design, the level of teacher preparation, infrastructure conditions, users' digital competencies, and the alignment of the solutions used with educational objectives. This means that technology is not an independent factor in improving the quality of education, but rather a tool whose value is only realized in a properly designed educational environment.

Experiences from the COVID-19 pandemic have shown that information technologies can effectively maintain the continuity of education in crisis situations, while also highlighting digital inequalities, infrastructure limitations, and competency gaps. This confirms the need for a systemic approach to the digital transformation of education, encompassing infrastructure development, organizational support, appropriate regulations, and the professional development of teaching staff.

The development of information technology is leading to significant changes in the functioning of higher education and in the way academic teaching is conducted. The role of the academic instructor is expanding. They are no longer merely lecturers; increasingly, they also serve as mentors and guides who support students in acquiring and applying knowledge in practice. Contemporary academic education therefore requires academic teachers not only to possess high subject-matter expertise but also the ability to effectively utilize information technology in the educational process.

In summary, the significance of information technology in academic education stems not only from its presence in the educational process, but above all from the manner in which it is implemented and utilized. Its potential is revealed only when it is integrated into the teaching process in a conscious, pedagogically sound, and ethical manner that upholds the principle of equal educational opportunities.

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