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Education 5.0: The development of the Ukrainian educational system in the conditions of artificial intelligence

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Abstract: The article presents conceptual research on the trends, vectors, perspectives, and challenges of introducing AI technologies into education system. Both worldwide trends and Ukrainian specifics are considered. One of the core findings of research is a claim that while there is transition already from Education 4.0 to Education 5.0, and rapid growth of AI solutions for education is observed, motivation of teachers themselves, their continuous advancement in these technologies based on their own interest is crucial factor.

Keywords: *Adaptive learning, Artificial intelligence, Education 4.0, Education 5.0.*

1. Introduction

The sphere of education today remains one of the most constructive areas of human activity. The success of countries that claim a serious position in the global high-tech market depends on the implementation of new pedagogical solutions in the education system (Kryshtanovych et al., 2022; Kryshtanovych et al., 2023a). Progress in digital education has been amazingly rapid, and the global pandemic has greatly accelerated this transformation. With the advent of Education 4.0, we have firmly entered an era of innovative and immersive learning based on digital tools and methods that improve knowledge retention and practical application. Today's students, often referred to as digital natives, have grown up constantly interacting with digital technologies and have a deep understanding of how to effectively use these tools. Education 4.0 includes a variety of digital devices that enrich the learning process. Its main goal is to cultivate the 4Cs - communication, collaboration, critical thinking, and creativity - important skills for the 21st century (Kones and Ravishankar, 2021; Kryshtanovych et al., 2023b; Kryshtanovych et al., 2024; Prystupa et al., 2020).

At the World Economic Forum in Davos, the concept of "Education 4.0" for Industry 4.0 was discussed. Its core message is that education must become inclusive, focus on a broad range of skills to prepare students for the Fourth Industrial Revolution, and use technological and pedagogical innovation to put students at the center of learning.

Education 4.0 reimagines education as an inclusive, lifelong experience that places responsibility for skill development on the learner, with teachers and mentors serving as facilitators. The teacher's task is to create an atmosphere in which students can independently find ways to solve problems. Working alone or with others, they study the situation and ask questions to determine the root cause of the problem, brainstorm possible solutions together, experiment and test solutions, analyze the results of

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those tests, scale up, search for the best solution, and continue to explore it in the project to ensure that it is indeed correct (Auer and Centea, 2021).

Continuing informatization sets the direction for the transition to post-industrial type of education, which is project-based in nature; it is aimed at developing new competencies using modern teaching methods. There is a paradigm shift from knowledge to competencies; the textbook and the teacher are losing their positions as the main sources of knowledge; information, the amount of which is growing rapidly, is presented in multimedia interactive forms; Classic libraries are being replaced by knowledge bases in media formats. (Pandey et al., 2023). Changing technologies and professions are forcing universities to embrace these processes at an accelerated pace: twenty years ago, universities replaced the five-year specialty with a four-year bachelor's degree, in Europe the bachelor's degree became a three-year one, and now experiments are underway to reduce the bachelor's degree to two years. Obviously, such training will be enough for a graduate to last for the next few years, and, for the above reasons, he is "doomed" to constant, continuous retraining (in a master's degree, MBA, advanced training courses, etc.).

In Ukraine, the Ministry of Education and Science is planning a real educational breakthrough until 2032 - the major transformation program "Education 4.0: Ukrainian Dawn" (presented in 2022). One of the important steps on this path is entering the pan-European space of qualifications, forming joint institutions and using joint tools, ensuring educational and labor mobility. New formats of education will also be introduced: online courses, short-term programs, recognition of their results and implementation of micro-qualifications based on them. Support for the development of qualification centers where the development of skills as a result of non-formal and informal learning is checked. This means that the emphasis will finally be on the presence of a certain competence, and not on the method of obtaining it and documents about it (certificates, diplomas).

The program defines the main competencies of Education 4.0:

- Digital and technological skills,
- Cooperation and self-management,
- Innovation and creativity,
- Global citizenship and civic responsibility.

Priority directions and approaches to building education 4.0 are also determined. In particular, it is about High Tech - High Touch (HTHT) - this is an approach to learning aimed at using technology while preserving personally oriented learning. It is about technology combined with a personal touch, because implementing technology for technology's sake does not improve learning. Therefore, the path to the future of education through personalized learning in combination with high technologies has been determined.

The term High Touch (individual touch) emphasizes the need to maintain a "human connection" and indicates the importance of personal contact in the learning process. After all, the current model of teaching in the classroom, where teachers provide standardized content in a unified mass way, is not able to adapt to the individual needs of students.

Therefore, a breakthrough into the future is planned by combining two unique strengths: the teacher (High Touch) and the capabilities of technology (High Tech), in particular, artificial intelligence.

2. Literature Review

Modern approaches using elements of artificial intelligence are disrupting traditional approaches to learning and shaping the future of technology in the industry. Artificial intelligence solutions for education analyze large amounts of data using sophisticated algorithms to provide personalized and adaptable learning experiences. Students receive personalized learning, instant feedback and access to immersive technologies such as augmented and virtual reality in education. Common examples of the use of AI in education include the following (Kent, 2022).

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1. Personalized learning. All people have different abilities and inclinations and are differently able to master new educational material. For online learning through the use of AI, personalized learning can be implemented for everyone. There is no such concept in the traditional education system. In addition, thanks to the capabilities of machine learning, it is possible to teach an educational platform to evaluate a student's actions. With such capabilities, the system adapts to the personal learning process.

2. Automation of tasks. Along with providing personalized learning, AI can review self-study assignments, grade tests, organize research papers, keep reports, take presentations and notes, and manage other administrative tasks (Google Scholar). By automating everyday activities, AI makes the learning environment more informative and productive (Google Classroom, Coursera, Appinventiv).

3. Creation of "smart" content. Artificial intelligence and machine learning in education are also helping educators create innovative content to enhance presentation and learning. Examples of creating intelligent content using AI include visualization of the processes being studied, generation of educational material in bit format (Gurushala online learning platform), and frequent content updates. AI in education is used to complement traditional and virtual learning and is capable of supporting experts by improvising the learning process of individuals.

4. Adaptable access. Most educational organizations today rely on developing educational applications with advanced tools and features based on artificial intelligence and machine learning. Features such as multi-language support help translate information into different languages, making teaching and learning convenient for every native speaker (Google Translate).

5. Individual feedback based on the collected data. Feedback is a critical component, especially when it comes to learning practical skills. The fundamental difference between effective teaching and simple delivery of information is that effective teaching constantly uses feedback. Feedback is generated in accordance with the performance of each user. At the same time, AI analyzes the results of feedback and generates performance reports based on daily observations. The feedback system helps to increase trainee satisfaction, eliminates bias in training and helps to understand in which area the practical skills have not been sufficiently acquired.

AI chatbots for education are very advanced technologies. Virtual tutors offer quick help, promoting independent learning. Using natural language processing and machine learning algorithms, chatbots provide instant and personalized support to learners, answering their questions and guiding them through the learning process. Creating an interactive and engaging learning experience allows students to grasp concepts more easily and retain information better.

Artificial intelligence software systems can be actively used in remote examinations and interviews, identifying suspicious behavior of the examinee. Artificial intelligence programs evaluate human behavior through webcams, microphones, web browsers, and keyboard keystroke analysis.

According to the forecast of the Agency for Strategic Initiatives (USA), further development will move towards the division of education into mass, economical, individual education, known as "educational fast food", using the latest technological solutions, including the personalization of educational paths, remote technologies and simulators, as well as an information educational environment. On the other hand, expensive, high-intensity "live" education will be based on individual interaction with qualified teachers and collective creative work, as well as on the formation and development of teams, including training in specialized educational communities (Mukul and Büyüközkan, 2023).

Global AI in education market size, although is quite uneven in regional plane, still impresses with its rates of growth (see Figure 1).

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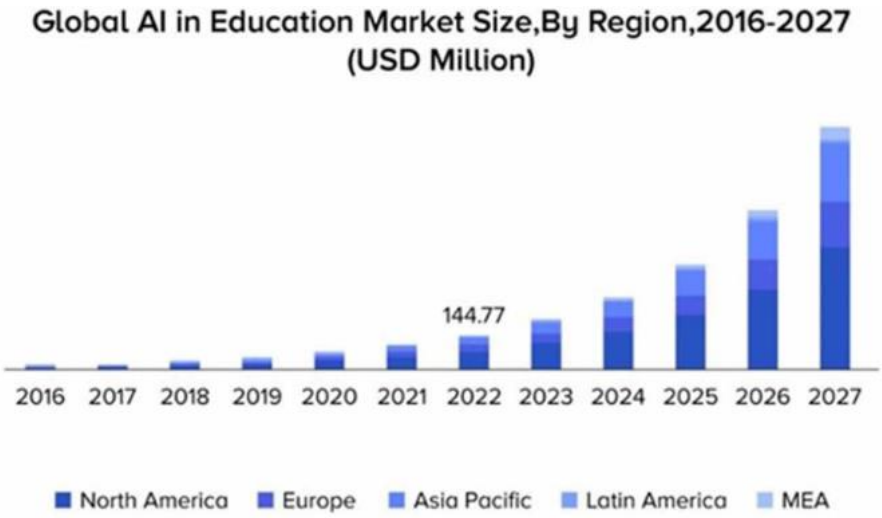

Figure 1.
Global AI in education market size (by region) from 2016-2027.
Source: (Polas et al., 2023).

Over the past few years, a whole body of research has appeared in the pedagogical and methodological literature, in which the authors revealed the didactic and methodological potential of many software products and ICTs created on the basis of AI. Systematic reviews and meta-analysis allow identifying five main vectors of using artificial intelligence in the pedagogical process: 1) educational management; 2) individualization of training; 3) optimization of the process of preparing a teacher for classes; 4) organization of the educational process; 5) optimization of the learning process in specific disciplines (Miranda et al., 2021).

However, an analysis of teachers' responses in independent empirical studies in Ukraine shows that, in general, higher education teachers do not have a systematic understanding of the organizational, didactic and methodological potential of AI tools. Many teachers have segmental knowledge, largely related directly to their professional activities in teaching specific disciplines, which are not able to create a holistic picture of the capabilities of AI in education. It is logical to assume that the situation is hardly better in secondary school.

Meanwhile, respondents usually agree with the opinion that AI technologies will create favorable conditions for students to build an individual educational trajectory. At the same time, there is a significant gap between the awareness and readiness of teachers to use AI technologies in the learning process, on the one hand, and their actual use, on the other.

Such data can be explained by the fact that AI technologies are just beginning to penetrate into education in Ukraine. Most teachers have already developed their course programs, teaching and testing materials and do not feel the need to change them, including with the help of AI tools. Large-scale analytical work by a teacher that requires the use of AI technologies also seems to be more the exception than the general rule.

3. Results

In addition to subject knowledge, Education 4.0 requires skills that enable students to continuously learn, develop their understanding, and expand their skill set: knowing how to search for additional knowledge, how to ask the right questions, how to check information. This new approach to teaching and learning requires students to learn to think critically, analyze information, and develop innovative solutions in environments that are collaborative, interactive, and diverse.

The following characteristics of Education 4.0 are identified (Kent, 2022):

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1. Personalization of learning. Thanks to artificial intelligence and cloud computing, many tools are available that customize the entire learning process according to the individual needs of the student, teachers on their part will be able to easily identify the strengths and weaknesses of students and provide instant feedback, in addition, students will be able to independently choose the curriculum.

2. Expanding distance learning opportunities. Learning needs to be accessible anywhere and anytime through a suite of e-learning tools, and the concept of blended learning (ABL), where students actively participate in learning outside of the classroom, is increasingly playing a role.

3. Lots of educational tools. Students can choose the tools and methods with which they want to gain knowledge (these include artificial intelligence technologies, BYOD technologies, virtual and augmented reality, etc.).

4. Project-based learning. The project-based approach encourages students to learn the time management, organizational, and collaboration skills they need for the future of work.

5. Simple and accurate assessment. Since students' actual knowledge can be measured through learning, the application of their knowledge is best tested while they are working on projects in a specific field.

6. Availability of analytical data. In Education 4.0, data analytics and reporting provide greater insight into student learning. Statistical analysis allows the instructor to understand where students are in the course and guide them accordingly.

7. Field experience. Utilize field experience in teaching through such means as internships, industrial projects and mentoring.

8. Mentoring. Teachers and specialists work more like mentors and coaches.

A very important skill that a student must master as part of Education 4.0 is collaboration.

Collaboration involves the student's ability to work in a team, both as a participant and as a leader. This skill of flexible team interaction is an integral part of the competency for working in an Agile environment. With this skill, students can inspire other team members and demonstrate effective persuasion, but at the same time be willing to change their minds when confronted with evidence that contradicts their initial beliefs. Thus, future employees will be able to establish themselves in the team and cope with work of any complexity.

A few years ago, the British publisher Pearson Education, together with the Partnership for 21st Century Learning (P21) initiative, analyzed the key elements in teaching students to work together. According to the report, three types of collaboration need to be incorporated into students' daily activities - interpersonal communication, conflict resolution, and task management. The study authors also recommend grouping students into many different groups to complete a variety of tasks and projects, and rotating roles among students so that all students have the opportunity to immerse themselves in different roles and situations. At the same time, it is important to teach students to evaluate the work of colleagues and give honest, constructive feedback (Pandey et al., 2023). Artificial intelligence technologies make learning such skills much easier.

It should be noted that, in fact, the latest developments in the field of artificial intelligence are used in the educational field through adaptive learning. This is a unique teaching method based on interactive mechanisms and taking into account the individual needs of each student. Adaptive learning is used, for example, in the following systems:

- Adaptive hypermedia - the most appropriate materials are offered based on the knowledge, goals, and preferences of students;
- Intelligent learning system - as a rule, such systems do not require the participation of a teacher and are based on the interaction of a student and a computer system;
- Computer adaptive testing - the system adapts to the level of the student.
- It is interesting to note the following solutions:
- Little Dragon is a startup that combines artificial intelligence and education and tries to create a smart application, with the ability to analyze the emotional reaction of users and adapt the user

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interface according to the reaction. The creators claim that their development can establish cooperation between the user and the program. Along with this, they create apps with educational games for children, where they also use the method of reading emotions.'

- Netex Learning - allows educators to develop and integrate curriculum across a variety of digital platforms and devices. The easy-to-use platform is available to create customized content for students that can be published on any digital platform. Teachers also gain tools for video conferencing, digital discussions, personalized assignments, and learning analytics that show visual representations of each student's personal growth.

The experience of leading countries in the educational space, such as the UK, USA, Germany, France, China, Japan, allows stating the effectiveness of using ERP systems in the management of educational processes (Shrivastava, 2023). This is a specialized assistant program in the "smart" category, which can be adapted to the specifics of educational organizations at various levels. To securely store an "individual" ERP system, many foreign educational institutions use one of the materialized forms of AI – the IBM Watson "supercomputer". For example, at Deakin University (Australia), the use of Watson makes it possible to effectively store educational and methodological information and advice students around the clock.

It is also interesting that at the end of 2017, the EU launched the "Digital Opportunity" program, within which the goal was to train education subjects in skills and competencies in areas such as cybersecurity, data analytics, programming, and AI. It is assumed that "digital schools" will not be burdened with "physical attributes" (premises, etc.), and the educational process will be implemented completely remotely.

As a successful example of the implementation of AI technologies in the educational space, experts cite the development of the British company Century Tech, which in 2019 signed a corresponding agreement with the government of Flanders (a province of Belgium). The Century system is a computer program containing tests to assess the knowledge and interests of students, the results of which are available to teachers and can significantly optimize the educational process. Since 2018, similar projects have been implemented in Australia and China.

In Ukraine, the Ministry of Digital Transformation, together with the Ministry of Education and Science and teachers, have developed a draft of recommendations for teachers on how to integrate and use artificial intelligence in schools. It provides practical advice on how to train teachers and transfer this knowledge to students. In addition, the document provided 'life hacks' on how to write a request to AI systems, lists of tools for work, and ideas for using AI in lessons.

Ukraine has very ambitious goals regarding artificial intelligence. Deputy Prime Minister for Innovation, Development of Education, Science and Technology, Minister of Digital Transformation Mikhail Fedorov recently stated: Ukraine should lead the AI trend in the world (Tanasiychuk, 2024).

Now in Ukraine many scientists are working on artificial intelligence in different areas. There are several dozen companies registered that develop AI models in Ukraine. In addition, science parks are appearing in the country, in particular Academ.City on the basis of the National Academy of Sciences of Ukraine.

The development of AI military in Ukraine is now a fairly successful trend. For example, computer vision technology is used in drones to recognize enemy equipment. AI is very actively and successfully used in design, marketing and PR, and engineering developments.

However, it is important to understand that some of the critical factors are the motivation and professionalism of the AI user. While in defense, science, and business both of these factors are present, in education it is not so clear cut. As noted above, there is a significant gap between the awareness and willingness of teachers to use AI technologies in the learning process, on the one hand, and their actual use, on the other. Thus, when developing AI in education, it is advisable to go from the opposite direction - to work primarily with teachers, increasing their motivation and digital competence, otherwise even the most advanced developments will not be useful. For truly successful development of AI technologies in education, the teacher himself, without any external coercion, must continuously

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increase his awareness of the latest AI developments suitable for use in the educational process, look for opportunities for self-learning, and actively experiment.

4. Discussion

AI-powered customized learning encourages student engagement by providing them with information that is relevant and meaningful to their needs and areas of interest. This approach has the potential to increase students' motivation and enhance their learning outcomes by strengthening their connection to the material they are studying (Alam, 2021; Sanusi et al., 2022). By tailoring the learning process to each student's learning preferences, learning styles, and areas for growth, AI-powered customized learning can increase retention rates.

Ciolacu et al. (2018) suggested an adaptive learning environment based on Auto Tutor by N. A. Crowder theory with adaptive self-assessment feedback, and an Early Recognition System outfitted with actual data recorded in a blended learning course with a tailored exam at the start of the semester. It's said that emphasizing students' experiences and achievements benefits both the administration and instructors in addition to students.

Experts are already discussing Education 5.0, which emphasizes adaptive learning and goes beyond current AI integration in education (Rane et al., 2023). AI in Education 5.0 strongly emphasizes customized and adaptable learning experiences, whereas AI in Education 4.0 is thought to be critical in supporting lifelong learning and upskilling activities (Spector, 2023; Yang et al., 2021). (Miranda et al., 2021). The fundamental elements of Education 4.0 and 5.0, which use Artificial Intelligence (AI) for customized and adaptive learning, are schematically illustrated by Rane et al. (2023) (see Figure 2).

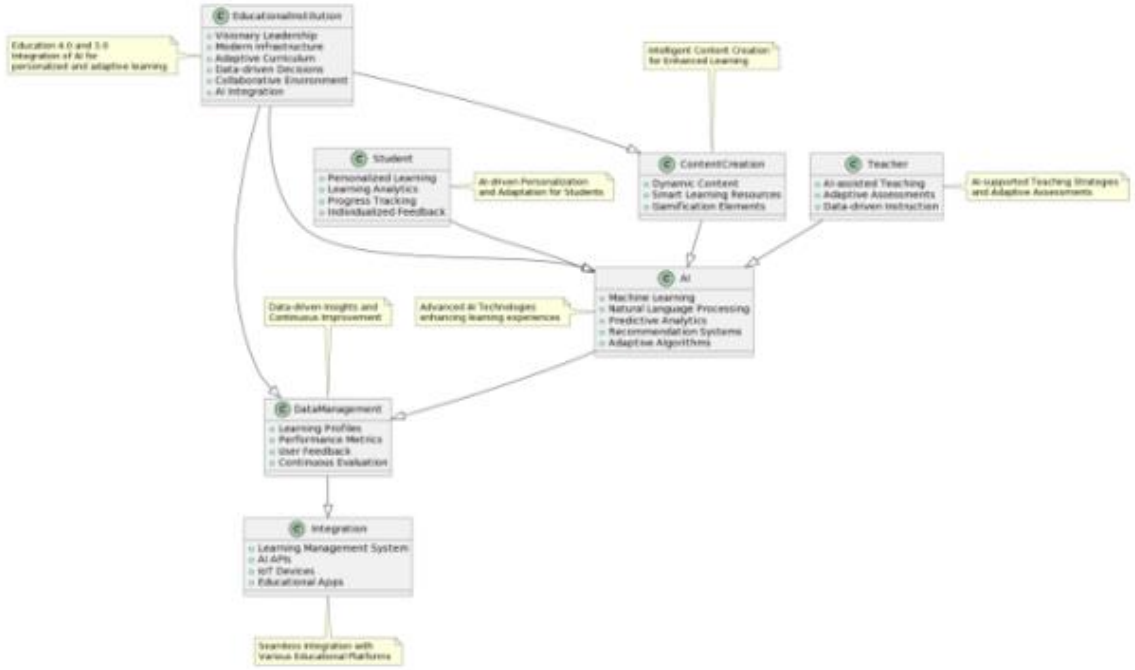

Figure 2.
Education 4.0 and 5.0 that integrate artificial intelligence (AI) for personalized and adaptive learning.
Source: (Rane et al., 2023).

To dynamically modify information, sophisticated AI algorithms examine each user's learning habits, preferences, and performance data (Rane, 2023). This guarantees that every student will receive a customized curriculum that fits their speed and learning preferences. Intelligent Learning Assistants (ILAs) are essential to the educational process, according to AI in Education 5.0. ILAs help students

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understand difficult ideas, respond to questions, and give immediate response since they are powered by machine learning and natural language processing (Younis et al., 2023). They serve as online tutors, which improves the educational process as a whole. Additionally, AI in Education 5.0 uses virtual reality (VR) and augmented reality (AR) to provide immersive learning environments. By letting students to interact with instructional information in three-dimensional areas, these technologies surpass traditional approaches and improve engagement while expanding comprehension of complicated subjects.

However, there are some concerns. Excessive "digitization" of educational activities can lead to certain threats and challenges and "... leads to the risk of destruction, the rupture of multi-subject relationships "teacher-student". A teacher who has a complex of integral personal characteristics (direction, competence, flexibility) and a high level of self-awareness is capable of creating a dialogue with students for the purpose of spiritual mutual enrichment and harmonization of the value system, which makes it possible to create a multi-subject community" (Costa, 2023).

It is obvious that the introduction of AI into the modern educational space as a whole carries certain risks for the effectiveness of educational processes and the well-being of all subjects of education, including:

- "Digital divide", which implies unequal access of educational subjects to AI technologies;
- Inconsistency of ethical aspects of the use of AI in the educational space (confidentiality, protection and use of data of educational subjects, lack of transparency and control over the use of AI, etc.);
- A high degree of dependence on technology, a decrease in the cognitive and creative abilities of many subjects of education;
- The requirement for continuous improvement of technical competencies of participants in educational and pedagogical processes, regardless of material and technical conditions;
- The inability (today) of AI supercomputers to perceive a wide range of socio-psychological interactions and states of educational subjects (joy, surprise, irritation, excitement, etc.), the superficiality of AI conclusions in the emotional and psychological field;
- Unification of skills and competencies within the main scientific and educational disciplines, formalization of professional knowledge, reduction in the labor productivity of graduates;
- Lack of "live communication", which affects the effectiveness of the activities of most educational subjects.

At the same time, the new opportunities and prospects of AI in the educational space are quite obvious, in particular in the formats of adaptive and personalized learning.

Adaptive educational AI technologies make it possible to timely monitor academic performance and select the "order of demonstrating educational material" to the interests and needs of educational subjects. However, experimental practices for the introduction of adaptive technologies into the educational space are mainly carried out in the commercial divisions of HR projects such as Competentum, Ispring, E-MBA, etc. (Kones and Ravishankar, 2021). Adaptive learning is inextricably linked with the theory and practice of personalized educational methods, the importance of which is recognized by about 80% of educational professionals (Kent, 2022). Personalized learning is an effective tool for the involvement and communication of all participants in educational processes, helping to increase the effectiveness of their activities. These formats make it possible to maximally optimize and differentiate the goals and pace of learning, teaching methods and approaches, depending on the needs, abilities and competencies of specific subjects of education.

An adaptive-personalized learning format based on AI technologies contributes to the formation and development of cognitive independence skills of educational subjects, which imply their intellectual abilities and the ability to independently isolate essential and secondary features of objects, phenomena and processes by abstracting and generalizing to reveal the essence of new concepts (Alieksieienko et al., 2022; Kryshtanovych et al., 2021a; Kryshtanovych et al., 2021b; Kryshtanovych et al., 2021c; Kryshtanovych et al., 2021d). In this perspective, the main components of cognitive independence

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include: the ability of the subject of education to independently obtain, master, and analyze new knowledge, skills, and abilities using various methods of independent learning (from "memorization" to "scientific discoveries"); the ability to competently and effectively apply these skills for self-education in the future; readiness to apply them in practical educational and work activities.

5. Conclusions

The adoption of Artificial Intelligence (AI) in education marks a significant shift away from traditional pedagogical approaches and toward Education 4.0 and 5.0. Education 4.0 represents a significant shift from traditional methods by utilizing cutting-edge technology to create settings that are more flexible, interactive, and learner-centered. Educators are now able to customize information and delivery to each student's unique learning style, preference, and pace thanks to the inclusion of AI in this phase. One of the main components of Education 4.0 is personalized learning, which guarantees that students have unique learning experiences and improves engagement and understanding. Adaptive learning systems powered by artificial intelligence (AI) automatically modify activities and information according to each learner's progress, promoting a more successful and efficient learning process. The effects of Education 4.0 are felt throughout the whole educational environment, not only in the classroom. By removing geographical obstacles and meeting a variety of learning demands, the integration of AI democratizes access to high-quality education through smart classrooms and online platforms. The groundwork for a fairer and more inclusive educational environment is laid during this phase. Education 5.0, which builds on the accomplishments of Education 4.0, aims to bring artificial and human intelligence together in a comprehensive and harmonious way. Simultaneously, the key to integrating AI into the educational system is teacher motivation and ongoing professional development, which is vital in Ukraine and requires extensive labor.

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