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ANALYSIS OF ARTIFICIAL INTELLIGENCE TECHNOLOGIES TO OPTIMISE INCLUSIVE PRACTICES IN HIGHER EDUCATION

Abstract. The article analyzes the potential of artificial intelligence (AI) technologies to optimize inclusive practices in higher education. Artificial intelligence opens up new opportunities for adapting the educational process to the individual characteristics of each student, which is especially important for people with special educational needs. The article discusses key aspects of the use of modern AI technologies in the educational process, including adaptive learning systems, voice assistants and text analyzers, and face and gesture recognition technologies. Both global trends and Ukraine's specific experience in implementing AI to support inclusiveness in education are analyzed. In particular, the article focuses on how AI technologies can help develop an educational environment for people with visual and hearing impairments, autism spectrum disorders, ADHD, and other disabilities. In conclusion, the article emphasizes the need for further research and development of innovative approaches to the implementation of artificial intelligence technologies in the educational process to create an inclusive, accessible and effective educational environment. The article contributes to the formation of a new view of the possibilities of integrating inclusive practices and artificial intelligence in the context of higher education.
Key words: Artificial intelligence, inclusive education, higher education, adaptive learning, voice assistants, facial recognition, text analyzers, augmented reality technologies, intelligent systems.

АНАЛІЗ ТЕХНОЛОГІЙ ШТУЧНОГО ІНТЕЛЕКТУ ЩОДО ОПТИМІЗАЦІЇ ІНКЛЮЗИВНИХ ПРАКТИК У ВИЩІЙ ОСВІТІ

Анотація. Стаття присвячена аналізу потенціалу технологій штучного інтелекту (ШІ) щодо оптимізації інклюзивних практик у вищій освіті. Штучний інтелект відкриває нові можливості для адаптації навчального процесу до індивідуальних особливостей кожного студента, що є особливо важливим для осіб з особливими освітніми потребами.
У статті розглядаються ключові аспекти використання сучасних технологій ШІ в освітньому процесі, включаючи системи адаптивного навчання, голосові асистенти та текстові аналізатори, технології розпізнавання

обличчя та жестів. Проаналізовано як глобальні тенденції, так і конкретний досвід України в імплементації ШІ для підтримки інклюзивності в освіті.

Зокрема, акцентується увага на тому, як технології ШІ можуть допомогти в розвитку освітнього середовища для осіб із порушеннями зору, слуху, розладами аутистичного спектру, СДУГ та іншими особливостями.

У підсумку, стаття наголошує на необхідності подальшого дослідження та розвитку інноваційних підходів до впровадження технологій штучного інтелекту в освітній процес з метою створення інклюзивного, доступного та ефективного освітнього середовища. Стаття сприяє формуванню нового погляду на можливості інтеграції інклюзивних практик та штучного інтелекту в контексті вищої освіти.

Ключові слова: *штучний інтелект, інклюзивна освіта, вища освіта, адаптивне навчання, голосові асистенти, розпізнавання обличчя, текстові аналізатори, технології доповненої реальності, інтелектуальні системи.*

Introduction. In today's world, inclusiveness is not new, but it is gaining importance as it is one of the main principles of many democratic societies. This is reflected not only in the political but also in the educational field in many countries, including Ukraine. Thus, human rights in education are reflected in several legal documents of both national and international importance: Article 24 of the Constitution of Ukraine enshrines the principle of equality of all citizens before the law; Article 6 of the Law of Ukraine "On Education" (2017) defines inclusive education as one of the directions of state policy in the field of education; the Strategy of National Policy on Education Development in Ukraine until 2021 calls for the introduction of inclusive education in all educational institutions of the country; Article 26 of the Universal Declaration of Human Rights (1948) defines The Strategy for the Development of Inclusive Education envisages creating conditions for all students, regardless of their characteristics, to have full access to the educational process.

It is in the interest of society to find ways to optimize inclusive practices to integrate a wide range of individuals into higher education institutions. Modern artificial intelligence technologies open up unlimited possibilities for realizing this task, as they can ensure that the educational process is adapted to the needs of each student.

The analysis of artificial intelligence technologies in the context of optimizing inclusive practices in higher education reveals the potential of modern innovations to solve this significant social problem. Possible areas of AI implementation include adaptive learning systems, voice assistants, face recognition technologies, etc. Artificial intelligence technologies help to solve the issues of accessibility of education for people with disabilities, improving the quality of education and promoting their social inclusion.

Thus, the analysis of modern technologies and the study of their potential for optimizing inclusive practices in higher education is a promising area of research that can contribute to the development of effective strategies for integrating all categories of students into the educational process.

Purpose. The goal of this study is to analyze modern artificial intelligence technologies and identify ways to use them effectively to optimize inclusive practices in higher education, to improve the accessibility and quality of the educational process for students with special educational needs.

The subject of the study is a set of artificial intelligence technologies (such as adaptive learning systems, voice assistants, face recognition systems, etc.) and their potential to solve the problems of optimizing inclusive education in higher education institutions.

The object of the study is the process of inclusive education in higher education institutions, including educational programs, teaching methods, tools and technologies used to ensure inclusiveness.

Literature review. A number of domestic and foreign scholars study the issue of inclusive education in general and in higher education institutions in particular: Gokul Yenduri [1], Vasiliki Ioannidi [2], Junaidi, Ahsan [3], Palamarchuk E.A. [4], Bortun K.O. and others. Many scientists study the digitalization of the educational process, in particular, focusing on the use of artificial intelligence in education: Ushakova O.I. [5], Michurin M. [6], Sharov S.V. [7], Barna O.V. [8], Somenko D.V. [9], Mupaikwa E. [10] and others. It should be noted that the issue of using artificial intelligence to organize inclusive education in higher education institutions is not sufficiently covered.

Inclusive education and artificial intelligence are fairly new areas of research. Given that this field of study has just begun to develop quite dynamically, many scientists and researchers are still formulating basic concepts and theories. The analysis of information sources confirmed the hypothesis that the use of artificial intelligence to organize inclusive education in higher education institutions is not sufficiently described.

Results. Inclusive education has its roots in the global civil rights movement, which emphasized equal rights for all individuals, regardless of their physical, mental or social differences. Starting in the 1990s, inclusive education was gradually introduced into the curricula of many countries around the world, with special attention paid to individualizing the learning process. Today, inclusive education continues to develop and adapt to modern realities. In Ukraine, as well as in other countries, there are numerous programs and initiatives aimed at implementing inclusive practices in the educational process. In this context, artificial intelligence opens up new perspectives, allowing for the creation of adaptive learning systems that can take into account the individual characteristics of each student.

The global context is characterized by a trend towards the democratization of education, using artificial intelligence technologies to expand access to educational resources and create more personalized learning experiences.

Inclusive education has its roots in the global civil rights movement, which emphasized equal rights for all individuals, regardless of their physical, mental or social differences. Starting in the 1990s, inclusive education was gradually introduced into the curricula of many countries around the globe, with particular attention paid to individualizing the learning process. Today, inclusive education continues to develop and adapt to modern realities. In Ukraine, as in other countries, many programs and initiatives exist to implement inclusive practices in the educational process.

The global context is characterized by a trend towards democratization of education, using artificial intelligence technologies to expand access to educational resources and create more personalized learning experiences.

Inclusive education has its own peculiarities that should be taken into account to enhance the processes of inclusion of all citizens in social relations, regardless of their physical, intellectual, cultural, linguistic, national, and other characteristics. The principle of inclusion is based on the realization of the value of human diversity and differences between people. It excludes any discrimination and reflects one of the main features of a democratic society. It applies to all citizens, regardless of age. However, it should be borne in mind that most people studying in educational institutions belong to the age category of children and youth. Unfortunately, it is traditionally believed that the concept of inclusion is associated only with people who have a "disability", a measure of health loss due to illness, injury (its consequences), or congenital defects, which, in turn, in interaction with the external environment, can lead to restrictions on a person's life. Mainstream education applies to all citizens with special educational needs (SEN) [4].

According to the UNESCO classification [11], persons with SEN include those who have the following developmental disabilities: emotional and behavioural; physical/neuromotor; speech and communication; learning difficulties; hearing vision; delayed/limited intellectual development.

This list is supplemented by children who grew up in unfavourable conditions, children from ethnic minorities, street children and children with HIV/AIDS.

According to the source [12], the structure of inclusive perfection has five dimensions: intrapersonal awareness; interpersonal awareness; transformation of the curriculum; inclusive pedagogy; and inclusive learning environments.

The difficulties of forming an electronic inclusive educational environment lie in the need to identify electronic tools for people with disabilities and their integration into the learning management system. Some tools require the implementation of projects for their development and implementation. In this study, we will use the general requirements for electronic resources in accordance with the features of inclusion, which are described in Table 1 of source [4].

The use of artificial intelligence in education is growing rapidly, and with it, the potential to create a more accessible and inclusive learning environment. AI-based technologies can be used to customize learning experiences for students with different needs, abilities, and backgrounds [13].

The term 'artificial intelligence' is relatively new, so it requires additional justification. Artificial intelligence is a toolkit of a system or service that can be used to collect and adapt user data (or data posted in open repositories) and generate new solutions or conclusions based on them, according to the user's request [14].

Artificial Intelligence can be divided in various types, there are mainly two types of main categorization which are based on capabilities and based on functionally of AI. Following is flow diagram which explain the types of AI (see Fig. 1) [15].
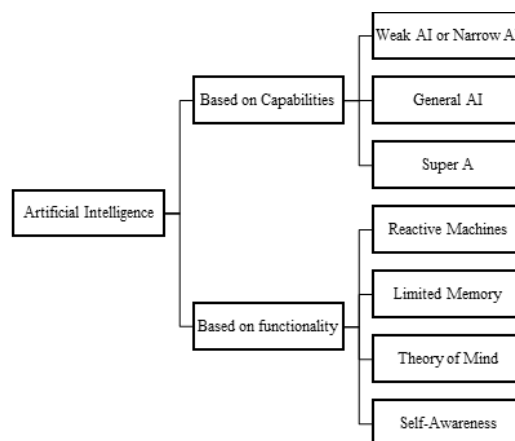

Fig. 1. Types of Artificial Intelligence

Based on Capabilities:

1. Weak AI or Narrow AI:

• Narrow AI is a type of AI which is able to perform a dedicated task with intelligence.The most common and currently available AI is Narrow AI in the world of Artificial Intelligence.

• Narrow AI cannot perform beyond its field or limitations, as it is only trained for one specific task. Hence it is also termed as weak AI. Narrow AI can fail in unpredictable ways if it goes beyond its limits.

• Apple Siriis a good example of Narrow AI, but it operates with a limited pre-defined range of functions.

• IBM's Watson supercomputer also comes under Narrow AI, as it uses an Expert system approach combined with Machine learning and natural language processing.

• Some Examples of Narrow AI are playing chess, purchasing suggestions on e-commerce site, self-driving cars, speech recognition, and image recognition.

2. General AI:

• General AI is a type of intelligence which could perform any intellectual task with efficiency like a human.

• The idea behind the general AI to make such a system which could be smarter and think like a human by its own.

• Currently, there is no such system exist which could come under general AI and can perform any task as perfect as a human.

• The worldwide researchers are now focused on developing machines with General AI.

• As systems with general AI are still under research, and it will take lots of efforts and time to develop such systems.

3. Super AI:

• Super AI is a level of Intelligence of Systems at which machines could surpass human intelligence, and can perform any task better than human with cognitive properties. It is an outcome of general AI.

• Some key characteristics of strong AI include capability include the ability to think, to reason,solve the puzzle, make judgments, plan, learn, and communicate by its own.

• Super AI is still a hypothetical concept of Artificial Intelligence. Development of such systems in real is still world changing task.

Based on functionality:

1. Reactive Machines:

• Purely reactive machines are the most basic types of Artificial Intelligence.

• Such AI systems do not store memories or past experiences for future actions.

• These machines only focus on current scenarios and react on it as per possible best action.

• IBM's Deep Blue system is an example of reactive machines.

• Google's AlphaGo is also an example of reactive machines.

2. Limited Memory:

• Limited memory machines can store past experiences or some data for a short period of time.

• These machines can use stored data for a limited time period only.

• Self-driving cars are one of the best examples of Limited Memory systems. These cars can store recent speed of nearby cars, the distance of other cars, speed limit, and other information to navigate the road.

3. Theory of Mind:

• Theory of Mind AI should understand the human emotions, people, beliefs, and be able to interact socially like humans.

• This type of AI machines are still not developed, but researchers are making lots of efforts and improvement for developing such AI machines.

4. Self-Awareness:

• Self-awareness AI is the future of Artificial Intelligence. These machines will be super intelligent, and will have their own consciousness, sentiments, and self-awareness.

• These machines will be smarter than human mind.

• Self-Awareness AI does not exist in reality still and it is a hypothetical concept [15].

In the 1970s, AIED has occurred as a specialist area to cover new technology to teaching & learning, specifically for higher education. The main aim of AIED is to facilitate the learners with flexible, personalized, and engaging learning along with the basic automated task. Some popular trends in AIED include Intelligent tutor systems, smart classroom technologies, adaptive learning, and pedagogical agents. Below diagram shows the relationship between all these trends.

In the 1970s, a specialized discipline known as the Automated Intelligent Educational Environment (AIED) emerged in higher education, aimed at introducing the latest technologies into the learning and teaching processes. The main goal of AIED is to create conditions for flexible, individualized learning, which is complemented by the automation of basic tasks.

Among the significant trends in AIED are the creation of intelligent tutoring systems, technologies for smart classrooms, adaptive learning, and pedagogical agents. The figure below demonstrates the relationship between all these areas (see Fig. 2).
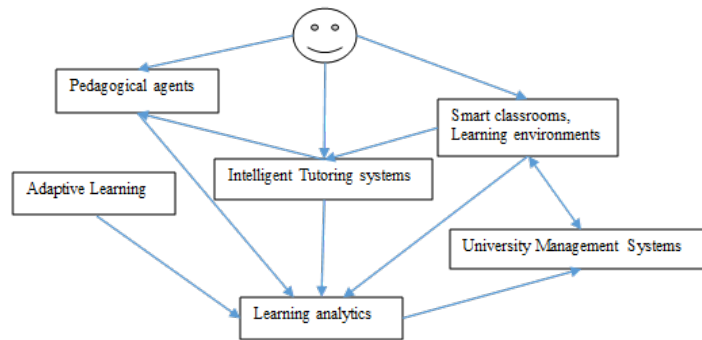
Fig. 2. Interconnection of artificial intelligence elements in higher education

The following ways of applying artificial intelligence in higher education institutions can be identified:
1. Automation of the same type of actions to assess students' knowledge.
2. Use of tutor programs to study basic material.
3. Provide instant feedback.
4. Provide personalized learning.
5. Create smart content using artificial intelligence.
6. Providing access to education for students with special needs:
• Adaptive learning systems use artificial intelligence algorithms to create individualized learning plans and monitor student progress. This helps optimize the learning process, making it more efficient and helping students with special needs find their way to success. Technologies analyze the dynamics of student learning and automatically adapt materials to their current level of knowledge and skills.
• Voice assistants and text analyzers can be extremely useful tools in inclusive education. They can help organize the learning process, convert text to speech, and support students with special needs through voice feedback and textual information analysis. This makes it possible to create a more accessible and inclusive learning environment where each student can work with the material in the most suitable format for them.
• Face and gesture recognition technologies open up new horizons for inclusive education. They can help analyze the emotional state and reaction of students to learning material, as well as adapt the learning process to the peculiarities of each student's perception.
To ensure an inclusive educational environment for students with SEN, it is advisable to use appropriate artificial intelligence systems:
1. Adaptive learning systems:
• Squirrel AI: is an adaptive learning system that uses artificial intelligence algorithms to personalize each student, analyzing their strengths and weaknesses and offering the most optimal learning path.
• DreamBox Learning: a math learning platform that adapts tasks and instructions in real time to the student's learning pace.
• ALEKS (Assessment and Learning in Knowledge Spaces) is an adaptive learning platform that provides individualized learning materials in math, chemistry, statistics, etc.
• Knewton is a system that uses big data to adapt learning materials to the needs of each student.
• Maple Learn is an interactive math learning tool that adapts the material to each student's level of proficiency.
2. Voice assistants and text analyzers:
• Google Assistant and Amazon Alexa: these assistants can help students organize their learning process, provide quick answers to questions, and help them solve various tasks.
• Grammarly: This tool uses AI to analyze text and detect grammatical, stylistic, and spelling errors, helping students improve their writing skills.
• Twinword Text Analysis: An API for text analysis that can detect sentiment, categorize text, and perform other tasks related to natural language processing.
3. Face and gesture recognition to adapt learning material:
• BrainCo: The company has developed a physical headband that can measure students' attention levels through brainwave analysis, allowing teachers to adapt their approach on the fly.
• Microsoft's Immersive Reader: This tool uses artificial intelligence technology to make reading and comprehension easier for students with special needs, including features such as reading text aloud, breaking words into syllables, and helping to translate text.
• Control other smart devices (lights, locks, thermostats, vacuum cleaners, switches) [16].
• Kinect (Microsoft) - Although initially developed for gaming, Kinect can be used for education for developing applications that respond to the user's physical actions.
Thus, we can summarize the correlation between the type of inclusion and the artificial intelligence system [4, 17-20], which should be used (Table 1).

Table 1

Available artificial intelligence systems depending on student inclusion

Disorders in Students with SEN	Features	Artificial intelligence systems	Examples
Partial visual impairment	Partial visual impairment, ability to work at a computer for some time	Text and image enlargement systems. Adaptive lighting and contrast.	Windows Magnifier: A magnification tool built into Windows operating systems. ZoomText: An application that provides powerful screen magnification and reading tools. Adaptive lighting and contrast: f.lux: a program that automatically adjusts the colour of your computer screen according to the time of day.
Visual impairment is complete	Lack of vision	Screen readers: Programs such as JAWS or NVDA can read the text displayed on the screen out loud to help the visually impaired. Voice Assistants: Voice assistants such as Google Assistant, Siri, or Alexa can help students find information or complete tasks without a screen. Text-to-Speech (TTS): TTS technologies can turn text documents into audio files, which can help visually impaired people listen to text instead of reading. Optical Character Recognition (OCR): Programs that use OCR technology can convert scanned documents or photos of text into editable text files, allowing students to use other technologies, such as TTS, to access the material.	JAWS (Job Access With Speech): one of the most popular screen reader programs. NVDA (NonVisual Desktop Access): A free and open-source screen reader. Voice assistants: Google Assistant, Siri, Alexa. Text-to-Speech (TTS): NaturalReader: a program that allows you to convert text to audio; Kurzweil 3000: an educational tool that provides various tools to support learning, including TTS. Optical Character Recognition (OCR): Adobe Acrobat: can use OCR technology to convert scanned documents into editable text files; ABBYY FineReader: a program that uses OCR technology to recognize text in scanned documents. Specialized keyboards and mice.
Hearing impairment	It is possible to listen by amplifying the sound level Ability to hear only with the help of special devices Non-perception of auditory information	For people with partial hearing loss, specialized artificial intelligence systems can be used to facilitate communication and learning. Here are some examples of such systems: Automatic speech recognition (ASR) and sign language translation systems. Systems for transcribing sound into text. Video and audio analyzers. Edutainment platforms with integrated subtitles and sign languages. Specialized software for teaching sign language. Adaptive learning platforms.	AVA: A mobile app that converts speech to text in real-time, helping deaf and hard-of-hearing people communicate more effectively. Google Live Transcribe: provides real-time transcription, helping people with hearing impairments to "read" what is being said around them. Kapwing: an online tool for automatically creating video subtitles. Coursera, edX: many online courses on these platforms have integrated subtitles and the ability to watch videos at a slower pace to make it easier to understand the material. Blackboard: a learning platform that includes tools for creating accessible content, including audio descriptions and subtitles.

Disorders in Students with SEN	Features	Artificial intelligence systems	Examples
Diseases of the musculoskeletal system	Cerebral palsy and other diseases	For people with musculoskeletal disorders, artificial intelligence systems can help create a more comfortable and accessible learning environment. Distance learning tools. Robotics for assistance.	Microsoft Teams: Allows students with physical disabilities to study remotely, avoiding the hassle of physical travel. Robot assistants, such as Robear or Toyota's Human Support Robot (HSR): help people with physical disabilities in everyday life and education.
ASD (autism spectrum disorder)	One of the disorders of psychological development. Symptoms manifested in the following disorders: understanding and expressiveness of speech; development of attachment; social contacts; functional or symbolic play. ASD may be accompanied by intellectual disabilities, problems with concentration, sensory over/under sensitivity, and reduced motivation to interact.	Adaptive learning systems. Social robots and assistants. Voice assistants. Technologies to improve concentration and focus. Visual and audio tools. Apps to improve communication skills. Specialized training software.	DreamBox Learning, ALEKS: These systems adapt to the individual needs of the student, allowing them to learn at a comfortable pace. Robots like Milo: specially designed to interact with children with ASD, helping them learn to recognize emotions and improve socialization skills. Amazon Alexa, Google Assistant: can facilitate learning by answering questions and helping to organize the learning process. Apps like Brili: help children with ASD structure their day by maintaining consistency and routine, which is often necessary for children with ASD. Visual schedules, Audio books: can facilitate the learning process by providing visual or audio cues. Proloquo2Go, Avaz: help improve communication skills by using icons and other visual tools to communicate.

Conclusions. Thus, based on the study of the role of artificial intelligence technologies in optimizing inclusive practices in higher education, we can conclude that AI plays a key role in the modern educational process. Adaptive learning systems, which allow individualized learning for a particular student, have proven to be particularly effective in this context.

Additionally, the use of voice assistants and text analyzers opens up new perspectives for people with visual and hearing impairments, making it easier for them to access educational materials and providing them with the opportunity to immerse themselves in the learning process.

In addition, facial and gesture recognition technologies can serve as tools to create a more personalized and adaptive learning experience, taking into account the individual characteristics of each student.

Thus, further study and implementation of artificial intelligence technologies in higher education is an important step towards creating a more inclusive and accessible educational environment. This will ensure quality education for all students, regardless of their characteristics and needs.

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