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Models and Mechanisms for Implementing an Inclusive Approach in Engineering Education Based on Artificial Intelligence

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Abstract: The article analyzes the models and mechanisms for implementing inclusive education in engineering education using artificial intelligence (AI) technologies. Modern digital tools that facilitate the adaptation of the educational process for students with different educational needs are analyzed. The principles of personalized learning, controlled knowledge control and intelligent decision support systems are described. Recommendations for the implementation of AI in the educational process with increased accessibility of the engineering educational process are given.

Keywords: Inclusive approach, engineering education, artificial intelligence, equal opportunities, educational technologies, adaptive learning, accessibility.

Introduction: Modern trends in the development of higher education require the active implementation of innovative technologies to ensure the accessibility and quality of education. In particular, inclusive education in engineering specialties requires the creation of adaptive mechanisms that take into account the individual needs of students, including people with disabilities. Artificial intelligence (AI) opens up new prospects in this area, providing personalized learning, intellectual support for teachers and students, as well as automated knowledge control [1]. The use of AI in engineering education can not only increase the accessibility of educational programs, but also improve the quality of training specialists, adapting the content of courses to the level of knowledge and needs of each student. This article is devoted to the study of models and mechanisms for implementing an inclusive approach in engineering education using AI, as well as an analysis of the prospects for their implementation. The development of artificial intelligence (AI) technologies allows us to form new approaches to inclusive engineering education, ensuring the accessibility of education for students with different educational needs. Let us consider the main models and mechanisms that contribute to the effective implementation of inclusion in engineering education using AI [2].

METHODS

The educational policy of foreign countries has contributed to the formation of various approaches to the education and upbringing of children with disabilities. The main models include segregation, mainstreaming, integration and inclusion. Models based on data analysis and AI can adapt educational content and tasks to the individual needs of students, taking into account their abilities and the pace of learning. Using digital technologies and online platforms allows you to create accessible educational materials that can be adapted for students with different needs, including people with disabilities [3,4].

Models of inclusive education are successfully used in various European countries, and their implementation depends on many factors, including the socio-economic conditions and educational traditions of each country.

In the UK, researchers R. Bond and E. Castagner emphasize that the successful integration of children with disabilities into the general education system requires the use of specialized technologies and support from teachers. They note that not only tutoring support from teachers plays an important role, but also the active participation of peers without disabilities. This approach is called "class-wide peer tutoring"

(CWPT) or "cross-age tutoring" [5].

In South Korea, various strategies for inclusive education have been developed based on American research. Their effectiveness depends on a number of conditions:

• assignment of a specially trained teacher to support children with disabilities during the learning process;

• creation of an individual educational space, where children move from one teacher to another when studying various disciplines;

• group learning, within the framework of which the teacher develops a unique work strategy for each group of students, taking into account their developmental characteristics;

• organization of classes in small groups, which ensures more intensive attention from the teacher to each student;

• rotation of teachers, when specialists working individually are periodically replaced by other teachers.

In Sweden, Greece and France, inclusive education is based on temporary pedagogical interaction. These countries provide for the participation of highly qualified specialists who work outside educational institutions and provide support to teachers interacting with children with disabilities in preschool organizations [7,8]. We analyzed the mechanisms and models for the implementation of inclusive education in technical universities (Table 1):

TABLE 1

MODELS	KEY ASPECTS	EXAMPLES
Adaptive Learning Model - Using AI allows for personalization of the educational process, adjusting materials and teaching methods to the individual characteristics of students	Analyzing students' knowledge levels and their learning needs using intelligent systems. Dynamically changing the difficulty of tasks based on the student's progress. Using machine learning systems to predict the difficulties a student may encounter.	AI-based platforms, such as Smart Learning Systems, that tailor the course to the student's level of knowledge. Recommender systems that help the student choose the most appropriate format for studying the material (video, text, interactive tasks).
Model of intelligent support for students - **AI can act as a personal assistant that accompanies the student in the learning process, helping him to overcome educational barriers**	Implementation of chatbots and voice assistants to answer students' questions. Use of intelligent help systems integrated into educational platforms. Support for students with disabilities through voice interfaces and machine translation systems.	Virtual assistants, such as IBM Watson Tutor, that analyze students' questions and offer personalized explanations. Programs that automatically translate text into audio or support sign language for students with hearing impairments
The model of automated knowledge control - AI can significantly improve the objectivity and accessibility of the process of assessing students' knowledge, reducing the influence of subjective factors	Automatic checking of assignments using machine learning algorithms. Intelligent systems for assessing answers that take into account not only the correctness, but also the logic of the student's reasoning. Online proctoring with AI analysis of student behavior to ensure the fairness of exams	Automated testing systems such as AI-Graded Exams that grade students' answers without the teacher's involvement. Analysis of written and spoken answers using NLP (Natural Language Processing) to identify knowledge gaps

RESULTS

In the course of our research, we studied in detail the mechanisms for implementing inclusive education in technical universities, analyzing the best global practices and modern technologies that contribute to the creation of an accessible educational environment. An analysis of existing approaches to teaching students with special educational needs was conducted, digital tools and methods that ensure their successful integration into engineering education were considered. Based on the data obtained, we developed a model for implementing the inclusive potential in technical education based on the use of artificial intelligence technologies, adaptive learning and intelligent educational platforms. This model includes mechanisms for personalizing the educational process, automated knowledge control, virtual mentoring and the use of AR / VR technologies to increase the accessibility of engineering disciplines. The proposed model is aimed at creating equal opportunities for all students, regardless of their physical, cognitive or sensory characteristics, and can significantly increase the effectiveness of inclusive education in technical universities (Fig. 1).

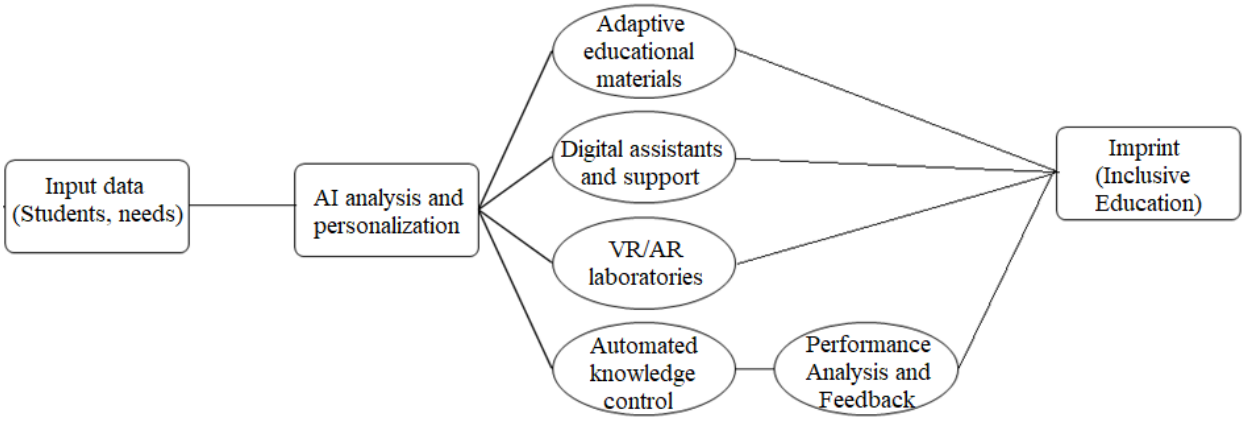

Figure 1. Model for the implementation of inclusive potential in technical education

The developed model of inclusive education is aimed at creating an adaptive educational environment in technical universities that ensures the availability of engineering education for students with special educational needs (SEN). The model is based on artificial intelligence (AI) technologies, automated systems for adapting the educational process, digital student support tools, and innovative knowledge assessment methods.

1. Model structure

The model includes three key components:

- Adaptive educational environment - using AI to personalize learning, adjust materials and formats for presenting information
- Digital support tools - integration of voice assistants, automated tutors, and VR/AR technologies for students with disabilities.
- Intelligent assessment and feedback mechanisms - automated testing systems, performance analytics, and forecasting student needs.

2. Key implementation mechanisms

2.1. Adaptive learning using AI

- AI algorithms analyze the student's knowledge level and offer personalized learning paths.
- Functionality:

• Automatic adjustment of the complexity of materials and tasks.

• Selection of an individual learning pace.

• Use of multimodal content (audio, video, text, interactive models).

2.2. Intelligent educational assistants

- AI bots and voice assistants help students with disabilities adapt to the educational environment and receive the necessary support.
- Functionality:

• Answers to questions on the curriculum.

• Automated recommendations of educational materials.

• Text voicing, conversion of lectures into audio format.

2.3. Virtual and augmented laboratories (VR/AR)

The creation of digital labs allows students with disabilities to participate in hands-on learning without being physically present in the lab.

- Functionality:

• Conducting engineering experiments in a virtual environment.

- Visualization of complex technical processes.
- Interactive simulations of engineering problems.

2.4. Automated knowledge control and online proctoring

AI systems analyze students' answers and evaluate them not only for correctness, but also for the logic of their reasoning.

- Functionality:
- Automatic checking of written and oral answers.
- Analysis of academic performance and identification of knowledge gaps.
- Online proctoring with AI control during exams.

2.5. Digital platforms for inclusive learning

Educational platforms combine adaptive learning, AI assistant support and virtual labs into a single ecosystem.

- Functionality:
- Flexible curriculum.
- Availability of educational materials in various formats.
- Integration with AR/VR, automated tutors and analytical systems.

3. Advantages of the model

- Personalization of learning – each student receives an individual development trajectory.

- Accessibility of education – learning becomes inclusive, eliminating physical and cognitive barriers.

- Automation and support – digital tools provide continuous assistance to students with disabilities.

- Interactivity and engagement – the use of VR/AR, simulators and chatbots makes learning interesting.

- Objectivity of assessment – AI reduces the influence of the human factor in knowledge testing.

The developed model of inclusive technical education based on AI technologies allows creating an accessible, personalized and effective educational environment for all students, including those with special educational needs. The integration of adaptive platforms, digital assistants, virtual laboratories and intelligent knowledge assessment systems helps to remove barriers and improve the quality of engineering education in technical universities. It includes the following main components: analysis and personalization through AI, adaptive materials, digital assistants, VR/AR laboratories, automated knowledge control and a feedback system. All these elements are combined to create an effective inclusive educational environment. The conclusion summarizes the results of the study, noting that the introduction of inclusive models in engineering education using AI technologies is a promising direction that helps improve the accessibility and quality of education.

CONCLUSION

In this research shows that further research and development in this area can lead to the creation of innovative solutions that will make engineering education more inclusive and adaptive. The use of artificial intelligence technologies in engineering education opens up new opportunities for increasing its inclusiveness. The developed models of adaptive learning, intelligent support and automated knowledge control allow taking into account the individual needs of students and creating equal conditions for everyone. The introduction of intelligent educational platforms, VR/AR technologies and automated mechanisms for adapting educational materials contributes to the formation of an accessible educational environment, which is especially important in the training of future engineering personnel. For the further development of inclusive engineering education, additional research and pilot projects are needed to test and improve the proposed models and mechanisms.

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