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Development Of Engineering Education System In Uzbekistan In The Era Of Digital Technologies

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Abstract: This article focuses on the analysis of the transformation of the engineering training system in Uzbekistan in the era of digitalization. The focus of the study is on the changes in educational policy and approaches to meet the new requirements of the digital economy. The article discusses the issues and prospects of introducing modern technologies in engineering education, as well as training in the context of Industry 4.0. Special attention is paid to modern trends in education and their compliance with international standards. In conclusion, the article presents proposals for improving the system of engineering education in the context of digitalization.
Key words: engineering education, digitalization, industry 4.0, training, Uzbekistan, educational technologies, transformation.

Introduction

In recent years, digitalization has encompassed all aspects of life, including education. Modern technologies such as artificial intelligence, automation, the Internet of Things and big data have significantly affected production and social processes.

In the context of the global digital revolution, the issue of training engineering professionals who can not only adapt to the new conditions, but also become the driving force of technological transformation is becoming more and more relevant.

In Uzbekistan, the system of training engineers is also adapting to the challenges of the digital era. The key point is the actualization of educational programs, introduction of advanced technologies and application of modern teaching methods to form highly qualified personnel.

Aim and objectives of the study

Purpose of the study: The purpose of this paper is to examine how the system of training engineers in Uzbekistan is changing in the context of digitalization, to identify the difficulties faced by specialists and to propose ways to overcome them.

Objectives of the study:

1. To analyze the current situation in engineering education in Uzbekistan.
2. To study how digitalization affects the system of engineers' training.
3. to investigate how other countries educate engineers under the conditions of digital transformation.
4. Identify problems and weaknesses in the existing education system.
5. To develop proposals for improving the training of engineers in the digital environment.

Study of the topic

In the early 2000s, digitalization covered all spheres of economy and education, and the issues of transformation of engineering education in the digital era became the subject of active research[1]. This issue is also gaining importance in Uzbekistan, where measures to improve the education system have been taken in recent years. Although some works deal with some aspects of digitalization, such as the use of IT-technologies in teaching, there is not enough research on engineering education systems in the digital environment[2].

Research Methods

A variety of approaches are used to realize the research objectives:

1**. document research** - study of laws, strategies and educational programs aimed at training engineering and technical specialists in Uzbekistan.

2. Comparative analysis - comparing international experience in training engineers with the practice in the country. 3.

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3. Expert Interviews - interviews with university professors, digital technology specialists and representatives of industrial enterprises.

4. Content analysis - study of scientific articles, reports and studies on the development of engineering education in the context of digitalization.

Main part

1. State of Engineering Education in Uzbekistan

In recent years, Uzbekistan has been actively introducing digital technologies in the field of education. This includes the use of modern educational methodologies, updating curricula and attracting experience from other countries. However, technical education institutions face a number of challenges:

Insufficient technical equipment of the university limits the students' learning opportunities.

Lack of qualified teachers who are proficient in modern technologies.

Low integration of educational programs with industry does not allow training specialists who can effectively use digital technologies.

2.Digitization and Training of Engineers: International Experience

The introduction of digital technologies and the training of engineers are key aspects of modern education that have become crucial in the digital age. With the rapid development of technology and changes in the global labor market, it is becoming increasingly important to train professionals with high digital competencies. Let us consider examples of international experience and digitalization in engineering education.

2.1 Digitalization in Engineering Education

In engineering education, digitalization is a set of measures aimed at introducing information and communication technologies into the educational process. It includes not only the use of ICT in teaching, but also the creation of new formats of teaching materials and the development of educational platforms.

Examples of digitalization in curricula:

- Virtual laboratories and simulators: World-class universities such as MIT and Stanford University are actively using virtual laboratories to train students. These labs allow them to create digital models of various engineering processes and conduct experiments in a virtual environment. This helps to save time and resources and makes education more accessible. For example, as part of a course on aerodynamics, students can virtually test airplane models, bringing them closer to real-world tasks without the need to create physical prototypes[1].

- In-demand publicly available online courses (MOOCs): platforms such as Coursera, edX and Udacity offer free or paid programming programs from leading universities and technology corporations, as well as courses in machine learning and robotics. This gives students from all over the world the opportunity to get a quality education without leaving home. For example, Professor Andrew Wu's Coursera machine learning course has become a benchmark for engineers who want to learn the basics of artificial intelligence [3].

Use of modern design and modeling tools: at the Technical University of Munich In leading universities such as (Germany), programs such as AutoCAD, MATLAB and ANSYS are actively used to model engineering systems and solve problems close to reality. These tools help students to develop design and engineering analysis skills under conditions close to industrial standards [2].

2.2 International experience in training engineers

Many countries are actively introducing digital technologies into the process of training engineers, taking into account global trends and industry needs. Let us take a look at how this is happening in some countries.

UNITED STATES:

At the forefront of digitalization in education, the United States of America is actively pursuing innovative methods of training engineers. Universities such as the Massachusetts Institute of Technology and Stanford University are using advanced educational platforms to develop unique courses that include not only theory, but also hands-on training using virtual and augmented reality.

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At the Massachusetts Institute of Technology, students use special devices such as digital replicas of real industrial machines and tools. This allows to create an accurate virtual model of an object and test various design options without the risk of damaging the real object [1].

Germany:

In Germany, the concept of Industry 4.0 is being actively implemented, and the introduction of digital technologies in engineering education occupies an important place in the country's educational policy. Universities such as the Technical University of Munich integrate automation and digital technology concepts into their programs.

As part of their studies, students are introduced to the concepts of smart factories and the Internet of Things, allowing them to apply their knowledge in practice already during their studies. Future engineers learn not only how to manage production processes, but also how to use modern sensors, cloud technologies and big data analytics to improve production efficiency[3].

Singapore:

As a flagship for digitalization and high-tech, Singapore is actively developing educational programs that include in-depth digital learning. At the Singapore Technological University (NTU), hybrid learning is widely used, where theory is taught in an online format and practical classes are conducted using digital simulators and virtual labs.

NTU students can use virtual simulators to study robotics, mechanics and other engineering disciplines. This allows them to use digital models, which significantly accelerates the learning process and provides access to advanced technologies[2].

In China, digitalization of education is also being actively introduced into engineering education with a focus on the application of technology in real-world industries. Universities such as Jiangsu University of Technology are implementing a virtual lab system and offering online courses to educate students.

- **Virtual labs and artificial intelligence:** as part of the courses, Chinese students can work with artificial intelligence, analyze big data, and apply algorithms to develop manufacturing and logistics solutions [3].

2.3 The future of engineering education in the context of digitalization

The future of engineering education will be closely linked to the further digitalization of learning processes. Educational technologies are expected to become even more personalized in the coming years, allowing students to gain unique knowledge in engineering.

- **Interactive platforms and the use of AI:** In the future, the education system will increasingly utilize digital technologies. Educational technology is expected to become even more personalized in the coming years, allowing students to gain unique engineering knowledge.

Use of artificial intelligence and interactive platforms: in the future, artificial intelligence will be used to create individualized educational trajectories for each student. AI will analyze student data and select the most appropriate courses and assignments for each student, which will improve learning efficiency.

In the future**, interactive platforms and artificial intelligence** will be used to create individualized educational paths for students. Thanks to artificial intelligence, the optimal course and assignment will be selected for each student, which will increase the efficiency of learning.

It is expected to expand cooperation between **international universities,** which will allow students to participate in international projects and share experiences with colleagues from other countries. This will enable students to develop their skills in a global context and prepare for the global labor market.

The introduction of digital technologies in the training of engineers is not just the integration of new tools, but also a complex process that requires the revision of educational strategies and teaching methods. The experience of such countries as the USA, Germany, Singapore and China demonstrates successful approaches to the introduction of digital technologies in education that help to train engineers able to work effectively in the digital economy

3.Introduction of digital technologies in engineering education in Uzbekistan.

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In recent years, there has been a trend towards the introduction of digital technologies in the educational process in Uzbekistan. In particular, online courses and distance learning platforms are being actively developed. In addition, virtual and enhanced technologies are actively used in the educational process.

However, in order to fully transform the education system, a number of key challenges need to be addressed:

To update curricula and courses to meet the requirements of the digital economy;
improve the qualifications of teachers, especially in the area of new technologies;
establish partnerships with industrial enterprises for practical training of students.

Table 1: How the education system in Uzbekistan is organized using digital technologies.

Direction	Description	Implementation status
Digital platforms and online courses	Utilizing a platform for distance learning and digital education in a student-centered environment.	Initial stage
Innovative learning technologies	Application of virtual and augmented reality and artificial intelligence to simulate manufacturing processes.	Limited use
Training and internship	Practical training of students in cooperation with enterprises.	Low implementation rates
Laboratory modernization	Modernization of educational laboratories with the use of advanced technologies and equipment.	In the initial phase

1. Challenges and goals of the engineering education system

Although the results in the field of education in Uzbekistan are positive, there are still problems and challenges in the process of digitalization. One of the main problems is the lack of qualified teachers who understand new technologies. Therefore, it is necessary to improve teacher training programs and ensure their access to modern teaching methods and tools.

In addition, the introduction of digital technologies requires large financial investments. Educational institutions must be equipped with modern hardware, software and high-speed Internet. In some regions of Uzbekistan, such conditions have not yet been created, which hinders the digitalization of education.

The importance of adapting curricula and regulations to the conditions of the digital economy should be emphasized. It is necessary for curricula to include relevant knowledge about modern technologies such as blockchain, artificial intelligence, robotics and other advanced engineering areas.

There are a number of serious problems in the engineering education system of Uzbekistan:

1. Weak links with industry: universities and enterprises rarely cooperate, which makes it difficult to develop and implement joint educational programs.
2. Outdated infrastructure: laboratories and equipment do not meet modern standards.
3. Shortage of qualified teachers: teachers do not always have time to master new technologies, which negatively affects the quality of education.

Results and discussions

The article reviews the major changes that have taken place in the field of education in Uzbekistan, focusing on the training of engineering personnel in the rapidly evolving digital technological environment. This section presents key findings and discussions related to the integration of

digitization into the learning process, as well as challenges and opportunities of the engineering education system.

One of the most important aspects highlighted in the article is the active introduction of digital technologies into the pedagogical process and the development of pedagogical skills. In Uzbekistan, reforms have been carried out in recent years to improve the quality of education and incorporate the latest digital technologies into the curriculum. In particular, the introduction of online courses, distance learning platforms, virtual laboratories and simulators allows engineering students to access modern tools and technical knowledge.

The article discusses the key changes in the field of education in Uzbekistan that have taken place recently. Particular attention is paid to the training of engineering professionals in a rapidly changing technological environment. This section presents the results and discussions related to the integration of digital technologies into the educational process. Problems and perspectives of the engineering education system are also discussed.

One of the key aspects highlighted in the article is the active introduction of digital technologies into the teaching process and the development of digital competencies among teachers. In Uzbekistan, reforms have been carried out in recent years to improve the quality of education and introduce modern digital technologies into the curriculum. In particular, the use of online courses, distance learning platforms, virtual laboratories and simulators allows engineering students to access modern tools and technical knowledge.

The application of information and communication technologies (ICTs) in the country's educational institutions has improved the quality of educational services. In particular, the introduction of platforms such as Moodle helps to improve interaction between teachers and students, and provides access to up-to-date teaching materials and online courses. Thus, students can study engineering disciplines in a convenient format, including practical work with modern digital tools, which contributes to the development of their competencies in engineering technology and innovation.

The article discusses the key changes in the field of education in Uzbekistan that have taken place recently. Particular attention is paid to the training of engineering professionals in a rapidly changing technological environment. This section presents the results and discussions related to the integration of digital technologies into the educational process.

In this part, we will look at the main points related to the introduction of digital technologies in education. We will also discuss the challenges and opportunities for the system of training technical specialists in a rapidly changing technological environment.

We will also discuss the challenges and opportunities of digital technologies in the educational process. The problems and perspectives of the engineering education system are also considered.

Conclusions and recommendations

1. It is necessary to update educational programs to meet the requirements of the digital economy and new technologies.
2. The digital infrastructure of universities should be developed, including the creation of modern laboratories and the introduction of new educational technologies.
3. It is important to improve the qualifications of teachers by organizing retraining courses and internships for them in high-tech companies.
4. It is necessary to strengthen cooperation with industrial enterprises to ensure practical orientation of education and employment of graduates.

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