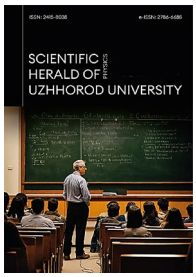
Scientific Herald of Uzhhorod University
Series "Physics"
Journal homepage: https://physics.uz.ua/en
Issue 56, 2006–2014
Received: 29.02.2024. Revised: 07.06.2024. Accepted: 02.07.2024




DOI: 10.54919/physics/56.2024.200yg6

# Actual problems of modern education in technical university

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**Abstract**

**Relevance.** This research review focuses on the critical issues within technical education, emphasizing the need for new educational strategies and techniques to enhance learning outcomes.

**Purpose.** The primary goal of this review is to investigate the factors influencing vocational education, particularly in the context of technical universities, and to evaluate the impact of current educational practices.

**Methodology.** An analytical review of existing scientific publications on technical education was conducted to gather data on the effectiveness of traditional teaching methods and the integration of information and communication technologies (ICT) in education.

**Results.** The review revealed significant challenges, including the low motivation of students and the inadequate competence of lecturers who prefer traditional teaching methods. These issues have persisted in technical education for many years. Additionally, the study highlighted the deficiencies in the modern educational process at technical universities, particularly during the COVID-19 pandemic, which necessitated the development of adaptive distance education systems.

**Conclusions.** The authors discuss the theoretical approaches to organizing the educational process in modern higher education institutions and propose practical recommendations for the administration of these institutions. These recommendations aim to improve teaching methods, including the implementation of adaptive learning in higher education, to address the identified shortcomings and enhance the quality of technical education.

**Keywords:** technical education; vocational training; institute of technology; engineering.

**Suggested Citation:**
Ismakova B, Bakina Y, Chaussova T, Udartseva T, Udartseva S. Actual problems of modern education in technical university. *Sci Herald Uzhhorod Univ Ser Phys.* 2024;(56):2006-2014. DOI: 10.54919/physics/56.2024.200yg6

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## Introduction

Modern conditions of globalisation require revision of specialists' training, and preparation for a variety of creative activities: professional, research and socio-cultural. Vocational training is at the crossroads between a person's abilities and aspirations and a huge number of ways to implement these characteristics in the labour market. While working to make vocational training more meaningful for students and more acceptable for employers, it is necessary to focus on students' professional development, and not on future specialists training. Particular attention should be paid to acquiring several skills for a workflow dominated by information technology (IT) [1]. This review study is an attempt to identify the problems of technical education, including an analysis of the effectiveness of the introduction of innovative teaching methods in higher education institutions; exploring the opportunities that information technology opens up to improve the quality of future specialists' training. The article explores possible prospects for the educational system in the innovative teaching and learning methods implementation.

Socio-cultural conditions have predetermined new parameters of structure, content and nature of the professional culture of university graduates. It should be noted that in current conditions, the employer pays special attention to such qualities of a specialist as professional competence, readiness for research activities, high level of general cultural and psychological preparedness, ability to creatively and effectively use in practice knowledge and skills acquired in the process of studying at university. In the modern labour market, such technical specialities as equipment design; technical support; software development; system architecture and design; IT security and management; system and network administration; technology management, etc. are considered the most demanded [2].

Education will be relevant, focused not on relaying the past, but on constructing a progressive future, on nature and cultural development of all spheres of human activity. Considering the problems and inability of existing education system to meet international requirements, Kazakhstan has adopted a curriculum that relies on the best practices and restructures education system to meet the needs of modern society. Today, all Kazakh universities are accredited by national or international organisations, the purpose of which is to confirm the level of education [3]. Globalisation has had a positive impact on education development in Kazakhstan, as it has caused several reforms to provide quality education in the country. One of the strategic directions of educational the modernisation of the Republic of Kazakhstan is the transition from the reproductive method of teaching to a new educational paradigm that will ensure the independence of students' thinking and cognitive activity. A natural heuristic feature of modern global changes in education is the change of the principle of "education-teaching" to the principle of "education-creation". The purpose of such education is to ensure that each student enters society as an adequate and active member of it. Thus, education turns into the transmission of cultural and historical values, norms and traditions to individuals, transferring to the content and forms of education that are preferred by state institutions. The question of specialists' culture development, which combines high professionalism, intelligence, social maturity and creative activity, is being actualised.

The State Program of Industrial and Innovative Development of the Republic of Kazakhstan for 2020-2025 [4] notes that Industry 4.0 requires appropriate training of personnel, primarily technical profile. In other words, graduates of technical and vocational educational organisations and technical higher educational institutions should have relevant professional competencies in such areas as digital technology, artificial intelligence, new materials and energy, bioengineering, etc. [5]. The basis of modern production in the framework of Industry 4.0 is based on such factors as Product Lifecycle Management, Big Data, Smart Factories, Cyber-physical systems, etc. Industry 4.0 is changing the perception of the modern education system. These changes concern not only teaching methods but also the very concept of education development requires changes. Adaptation and updating concern almost all components of the educational system, starting with curricula development and teaching staff professional development, ending with the latest technologies introduction into the educational process [6].

The purpose of this review study is to study issues that have an impact on vocational education.

## Materials and Methods

To identify the problems of vocational training, a search and review of literature available on the Internet containing information from the studies conducted explaining the need for fundamental changes to existing educational programme was carried out. In this paper, the main method is the descriptive research method. The theoretical and methodological approach provided an opportunity for a detailed study of modern teaching and learning methods. The regularities of teaching and learning in technical universities around the world are considered, and the experience of universities of other countries is studied using the method of induction and deduction. A comparative analysis of various innovative methods influence in implementation of such in educational process of technical universities is carried out. To study and generalise the results obtained, method of analysis and synthesis was used, including expert evaluation of pedagogical experiments. Each selected article was carefully studied and analysed, and research on innovative methods of teaching students of technical specialties were highlighted and classified separately. Critical analysis was used to study experts' opinions on the problems of technical education. Thus, this review study was conducted in several stages. In the first stage, to search for publications and collect necessary information according to the chosen topic, a short plan was drawn up, consisting of the following points:

– selection of terms for search queries;

– search for publications by titles containing words and phrases of selected terms;

– study of abstracts of found articles and selected studies;

– a thorough study of selected publications and texts directly related to the topic of this study;

– viewing and studying references and recommended sources;

– detailed analysis of collected and studied materials.

The next step, following the plan, was to search for the selected search queries. The search for the necessary information was carried out in the Google search engine in the Scopus and Google Scholar databases mainly in English (in some cases in Russian). The search queries contained the following terms: technical education; higher education; features of higher education; technical university; problems of modern education; higher education in European countries; quality of educational programmes of technical universities; engineering education; problems of education of technical universities; technical education of the 21st century; Industry 4.0 in the educational system; innovative technologies in higher education, etc. Thus, 32 studies were found that correspond to the topic of this review.

At the next stage, when studying abstracts of selected research articles, irrelevant articles were identified and excluded from the study, in particular those containing data from studies conducted more than five years ago. Publications without access to the full text were also not considered. For this review, research materials were selected that were conducted in the period from 2017 to the present. Special attention was paid to those studies that studied and analysed the problems of technical educational processes. At the stage of studying the references, two more studies corresponding to the given topic were found and included in this review. The final stage was the analysis and systematisation of collected data, summing up and formulating theoretical conclusions. The theoretical basis for this review study was the scientific work of scientists who paid attention to study the problems of the modern educational system within the context of engineering specialties and highlighted the issues of innovative training programmes introduction in the educational process of technical universities.

## Results and Discussion

The modern education system is not much different from the general education system of the last century. A high level of education is considered a prerequisite for achieving a stable social position. Designed to help graduates to create their own secure future, the education system as a whole does not cope with this task. In the 21st century, the "age of computer technology", the implementation of cardinal reforms in the field of education is required to solve the existing problems of modern society. Almost all areas of education need these reforms, from the content and structure of educational processes to ways and methods of teaching. In this context, improving the quality of education can be achieved using innovative technologies in the educational process. One of the main tasks of republican higher educational institutions (universities) teaching staff is to ensure quality control of the educational process. The current knowledge assessment system does not motivate students to strive to carry out individual educational activities, improve, analyse and evaluate their achievements. The reform of education system taking place in Kazakhstan to enter the world educational space is accompanied by serious changes both in the theory of pedagogy and in the practice of the educational process [7].

The number of currently existing studies studying the problems of higher education effectiveness, including its impact on the economic and social development of society, emphasise the relevance of the topic under consideration. The importance of radical changes in general education culture through the introduction of innovative teaching methods is primarily explained by the need to improve the quality of education in a market economy, considering globalisation. The increase in the number of commercial universities in the Republic of Kazakhstan has led to a decrease in the quality of knowledge acquired by students (paying for university tuition, students are deluded about the impossibility of their expulsion) and, as a result, to a reduction in employment opportunities conditioned upon a decrease in employers' confidence in the diploma [8; 9]. In the context of higher education in general, it is worth paying attention to the fact that there is a fairly widespread trend in the world among employers to choose employees based on an educational institution's reputation. So, after analysing the role of universities in Bolivia (in particular, the main cities of La Paz, Cochabamba and Santa Cruz) [10], the researchers concluded that the university's reputation plays a significant role for employers. According to the study, applicants from a highly rated university were more likely to receive a positive response from an applicant compared to applicants from less prestigious universities.

Among the most common problems that students face when studying engineering, researchers note the following: lack of proper training conditioned upon following old teaching patterns; insufficient qualifications of teaching staff; not paying due attention to the importance of practical skills; lack of modern teaching materials; weak feedback from teacher or its complete absence [11]. The most urgent problem is technical university graduates' employment. Despite various activities aimed at ensuring that graduates of technical specialities have the practical skills necessary in the labour market and presentations about the benefits of technical education, the technical university does not attract young people, since most graduates of technical specialities cannot find a job corresponding to their field of education. A large number of graduates of technical universities, who are mostly teenagers, remain unemployed [12; 13]. According to the researchers, universities should develop partnerships with industrial enterprises and create opportunities for internships and industrial excursions so that students can acquire sufficient practical skills before graduation.

Since socio-economic and technological integration directly depends on innovative technologies introduction in all spheres of modern society, trends of training new generation specialists require serious improvement. This is explained by the change of priorities and social values: strategies and tactics of training specialists in higher educational institutions are radically changing; the process of education is being updated, and its effectiveness completely depends on students' cognitive activity. When training future specialists in higher education institutions, it is important to use pedagogical technologies and techniques necessary for modern students and to study and analyse trends in industry development in which educational services are provided. Given the favourable trend towards training specialists, universities can develop

their own strategies for curricula development, which will have a positive impact on the number of students and the quality of their acquired knowledge. Within the framework of larger institutions and processes, the training of highly qualified specialists will be smoothly integrated into the national and European education sector, meeting the social and personal needs of modern youth [14].

The governments of almost all countries of the modern world direct their efforts to technical and vocational education development, believing that the development of skills increases labour productivity and supports the competitiveness of the world economy. One of the most important features of technical education is its focus on work skills acquisition. Technical universities can be considered as a category of polytechnic universities of a separate type, "rooted" in the Industrial Revolution of the 18th century, that achieved the greatest popularity in the second half of the 19th century. Educational institutions called technical universities or technological institutes, as a rule, are focused on engineering education, which is based on academic activity in close cooperation with industrial organisations.

In their study, L. Geschwind and A. Broström [15] characterise the "technical university" as a type of specialisation that differs significantly horizontally from competing less specialised categories, vertically – from institutes of vocational education. Based on the analysis of four Swedish universities, the researchers concluded that those aspects that at one time were determined attractive from the standpoint of designating the university as technical weakened after a while. Despite the variety of disciplines provided by modern technical universities, they all train engineers. Over time, as a result of technological development, the disciplinary scope expands, which creates a certain kind of complexity, one of which is the contradiction between fundamental and applied subjects. A common issue requiring the search for compromise solutions remains the balance between theory and practice.

On the one hand, engineering education is recognised and respected by the public. On the other hand, such structural transformations as the introduction of large-scale technological processes faced by industry require a new level of engineering graduates' education, which indicates the weak effectiveness of traditional teaching methods and providing higher education. In their review, the researchers note that the advanced academic education organisation, and methods of practical training remain controversial and differ significantly in different countries and regions. In many cases, institutional boundaries have been recognised in the form of two-component systems with a lower level of teaching in polytechnic institutes and technical colleges. Over time, these boundaries may change, both in the form of re-regulation from top to bottom, and by the method of upward institutional changes and consolidation.

Technical disciplines and engineering have a significant impact on solving many problems of our time. According to critics, technical education in the context of rational and technical approaches needs a paradigm shift. The researchers analysed an interdisciplinary innovative merger of three higher education institutions in the Ampere City region [16; 17]. Their research has shown that interdisciplinary structures do not increase technical education accountability to interested parties. Therefore, the expected increase in social impact and the university's ability to contribute to solving current problems is questionable. In the course of the conducted research, the main aspects most often mentioned in the comments on the proposal to create a new interdisciplinary university were identified, and the respondents' opinions on the expected reaction of interested parties to the proposed changes were analysed. Based on the idea of creating a new interdisciplinary university, where various disciplines will interact productively within the organisational structure, it can be saw a way to increase the social significance of all areas of education, including technical education. This is especially true since technical education is criticised for its inability to solve the so-called pressing problems of our time with the help of a disciplinary approach.

An analysis of respondents' answers to the proposal to create interdisciplinary faculty structures designed to increase the university's influence on society identified their concern that if traditional organisational structures are changed, interested parties may not recognise or properly evaluate technical education. Respondents supported the old structure and disciplinary sector, expressing the opinion that the recognition and acceptance of education in technical universities or individual technical sectors will remain high, given that the traditional disciplinary approach is organisationally understandable and meets the needs of interested parties. Based on this, the researchers believe that the leadership of higher education institutions, and the national policy of higher education aimed at supporting and implementing an interdisciplinary structure, will face resistance from teachers of most disciplines.

It can be assumed that they will argue their protest by saying that increasing the social significance of technical education conditioned upon the intersection of multiple disciplinary views can change the significance of technical education in the eyes of interested parties, questioning its identity. Many technically oriented universities look to the future with confidence and pride, relying on their historical past and support of a significant part of society in which technology as a field of knowledge is as widely recognised as possible. However, the technological development of modern industry does not guarantee that the education of existing technical universities meets the needs of tomorrow. Researchers claim that traditional educational methods and organisational patterns left over from previous industrial and technical revolutions require a radical update [18; 19].

In recent years, there has been an increase in activity to rethink borders and organise technological universities. The heritage and traditions of technical universities should not be regarded as mandatory. The categories of technical university identity are associated with values and ideas that are highly significant in higher education and academic research. When creating and reviving academic institutions, values such as engineering thinking can be mobilised. Universities applying a problem-based approach to engineering practice are likely to play an important role in the academic environment of the future, developing innovative research and educational solutions, focusing on opportunities and risks associated with new technologies, and demonstrating genuine interest in them. New technologies represent organisational principles by

which universities that call themselves technical will be able to build and improve successful strategies. This will also determine the public recognition of new technological solutions, and technological changes that affect users' daily lives, industries and society as a whole.

Technical universities as educational institution engaged in engineering sciences, but do not recognise future needs of modern society, may miss a valuable opportunity for the development of the next generation of technical universities. Another problem is that the more volatile concept of technical university organisation affects the understanding of future needs for key engineering skills, as they are discussed inside and outside the organisational boundaries of what are today called technical universities. The current process of technological education has been repeatedly criticised. University engineering faculties should prepare graduates not only with theoretical technical knowledge, but also with a wider range of applicable professional skills, an understanding of social context of engineering and, in particular, an understanding of what these skills can bring to production processes.

University engineering courses should provide students with broad knowledge and innovative problem-solving skills for effective work in the future, motivating students to become engineers after graduation. Engineering is much more than just knowledge, and even more so it is not just the ability to solve equations. There is creativity in it that needs to be developed through experience. The literature review confirms the existence of different methods and models of teaching engineering specialties. Modern social conditions impose special requirements on specialists' professional activity and their qualifications in general, which indicates the need to develop a training model considering the complex content of students' professional training at technical universities.

According to researchers, an important component of teaching and learning processes is assessment [20]. The assessment motivates students to study the subject, helps them correctly identify their strengths and weaknesses, overcome difficulties, get an idea of what should be given more attention, etc. In the context of engineering education, the assessment of students' knowledge is more significant. To become professional engineers, students of technical specialities need to develop certain skills: analytical, communicative, problem-solving, teamwork skills, etc. These abilities cannot be adequately assessed by traditional assessment methods. Accordingly, there is a need to develop an effective method for assessing engineering knowledge. In engineering education, providing high-quality feedback to students regarding their assimilation of course content is the teacher's very important task. Most teachers of engineering faculties around the world do not have sufficient experience in adequately assessing students' academic performance and providing unambiguous feedback to understand the quality of their assimilation of the course content [21; 22]. Feedback involves helping students use evaluation comments to redirect their thinking to improve. The researchers claim that students' assimilation of course content in engineering education can be improved with the help of assessment and feedback methods.

The Fourth Industrial Revolution (Industry 4.0) is characterised by a powerful development of automation based on the mass introduction of information technologies and cybertechnical systems into production [23]. In this context, the reform of higher education is an essential component of the digital transformation of Industry 4.0. The main goal of modern education is to increase students' motivation to acquire knowledge and to improve their learning outcomes. Digital technologies are changing lives, and IT skills are becoming more and more necessary and in demand in the modern world. To meet the requirements of a changing technological society, it is necessary to innovate in the process and methods of training. Education 4.0, providing easy access to educational resources, provides more effective and efficient training for these important skills acquisition than conventional traditional methods [24; 25]. Digital media resources open access to digital learning. The 4.0 curriculum is preferable for students since the training is often individual: students have the opportunity to study at any time, using materials and methods according to individual abilities.

Researchers of the School of Engineering and Sciences (Tecnologico de Monterrey, Mexico City) [26], illustrating the concept and vision of education 4.0. using the example of three case studies, concluded that the components of education 4.0 can be applied to different levels of education and informal educational environment. The introduction of "Education 4.0" concept enables both teachers and students to use modern infrastructure and the latest technologies to improve educational process in higher education. Education 4.0 promotes teaching based on humanistic and constructivist principles. An interesting fact is that two years earlier, the results of the implementation of an integrated Research-based learning programme (RBL) for undergraduate students of computing technologies at the same Tecnologico de Monterrey were studied and analysed [27; 28]. It is noted that during the semester, students acquired skills to collect and process valuable information; learned how to analyse data using statistical methods; and developed a research project. In the process of teamwork, most students have significantly improved their research skills.

It should be noted that the 2019 pandemic brought about drastic changes and restructuring of the university education system. Distance learning has put university teachers in front of the need to urgently rebuild their work and master computer learning technology. New problems have emerged, the main one of which is the lack of "live" communication with students, which deprives the teacher of direct control over the audience, high-quality feedback, lively discussion, etc. On the other hand, this phenomenon has had a positive impact on educational methods, giving universities the opportunity to focus on blended learning, combining independent computer training, online communication and students' face-to-face training. The use of rapidly developing computer learning technology has become the most common in multinational universities. Due to this educational practice, powerful informal networks (study groups) have been created, which students effectively use to exchange information and strengthen ties. Online education provides universities with a range of opportunities for integration and diversity, providing securing education for students of different

nationalities, including for students with disabilities or limited physical activity [29; 30].

Among many technological innovations in the educational system, the adaptive learning introduction should also be noted. Adaptive learning seems to be a promising approach with great potential to meet the diverse needs of students, including providing access to education to low-income groups in poor areas and improving access through large-scale individual training; to improve the quality of education. Despite the potential benefits, implementing adaptive learning is not an easy task. The researchers note that adaptive learning introduction requires time and considerable monetary investments. Resources are needed to develop staff, improve learning strategies, develop training materials, and conduct research for continuous improvement.

Since the method of adaptive learning is based on data, analytics is necessary to improve the quality of education, including continuous feedback between teacher and student [31]. The main advantage of adaptive computer technology introduction is the ability for students to choose the most preferred learning style themselves, which significantly increases the likelihood of more active involvement in the learning process [32; 33]. As practice shows, non-traditional teaching methods contribute to the development of collective interaction and communication skills among future specialists, teach them to formulate their thoughts in a professional language, improve speech skills, ability to hear, listen, understand and respect the opinions of others, conduct polemics correctly and argumentatively, analyse, generalise, think critically. Teachers note that such classes form the subject and social qualities of a professional specialist, develop students' creative independence.

Modern effective models of education distinguish three groups of conditions for personality traits and qualities development: universal, civil and professional. In the model of education, the conditions for the development of professional values and universal, general cultural values among students should be balanced. Along with professional knowledge and skills, attention should be paid to professional personality qualities development: communicative, organisational, and socio-cultural, paying serious attention to work on improving the level of development of the general and professional culture of future specialist's personality. The solution to these tasks is connected with a special atmosphere creation of spirituality at the university, pedagogically educating environment as the most important factor in the establishment of the professional orientation of the student's personality, the development of professional skills of the future specialist, his passion for the chosen profession [34; 35]. In any professional activity, its connection with culture is significant. Conditioned upon different interpretations, professional culture can be considered in various aspects. Often, representatives of a particular professional environment understand "professional culture" as a certain level of socio-cultural norms mastery. Culture in this case is considered as a certain level of spiritual and material values assimilation. Professional culture can also be considered as a component of general concept of professionalism. Then it integrates qualitative and "power" characteristics of culture in understanding it as a professional sphere, as a systemic element of culture. Professionalisation is the process of teaching a student at university, which should be accompanied by professional culture establishment, and his development as a professionally fit person. Professional culture is considered to be a set of special theoretical knowledge and practical skills related to a specific type of activity.

## Conclusions

Thus, during the study and analysis of selected literature, it was identified that the problems of technical universities' educational system are quite complex and in most cases cannot be solved quickly. This research work explains the weak effectiveness of existing educational teaching methods used in technical universities. The studied and analysed conclusions of the studies corresponding to the topic of this review allowed the conclusion that new technologies' introduction into the educational process faces resistance and many obstacles. The level of modern world economic development requires continuous growth of competitiveness of technological goods of domestic production, which entails the need to reform technical education and requirements for young professionals. This determines the need to attract students' increased attention to research activities, which allows young people to form the skills necessary for the development and implementation of relevant technological solutions and products. Analysis of research in the field of modern higher technical education suggests that its structural reform, redefinition of its goals and effective programmes to achieve them can be implemented using the theory and methods of a competence-based approach that allows the fullest integration of theory and practice with the most effective interaction of higher education institutions and employers.

The interaction of the competence approach with the traditional ones – axiological, synergetic, value-motivational, integrative, contextual, and activity – fundamentally changes the learning process, strengthening the priority of practice-oriented and instrumental orientation of engineering education, maximally optimises the field of development of students' research skills. Such principles as continuity, integration, orientation to practice and creativity, unity of the educational space, intensification of learning, and reflexivity crystallise the foundations of the competence approach and become the methodological basis for the construction of the concept. The implementation of such an approach, its methodology and principles implies a rethinking of goals, directions and methods of teaching students of technical universities, which implies management system transformation of educational institutions, aimed primarily at managing education quality, with the main goal of developing students' research skills. Educational models need to be reformed: integration of new teaching methods to develop students' critical and creative thinking; a clear definition of competencies common to all university graduates; more relevant teaching and learning that considers the needs and unique qualities of students; active introduction of information and communication technologies. Reform in social responsibility and knowledge transfer: the knowledge and skills that students acquire in higher

education institutions should be understandable and relevant, anticipating the social needs of modern society.

**Acknowledgements**
None.

**Conflict of Interest**
None.

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# Актуальні проблеми сучасної освіти в технічному університеті

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**Анотація**

**Актуальність.** Цей огляд досліджень фокусується на критичних питаннях технічної освіти, підкреслюючи потребу в нових освітніх стратегіях і методах для покращення результатів навчання.

**Мета.** Основна мета цього огляду - дослідити фактори, що впливають на професійну освіту, зокрема в контексті технічних університетів, та оцінити вплив поточних освітніх практик.

**Методологія.** Проведено аналітичний огляд існуючих наукових публікацій з питань технічної освіти для збору даних щодо ефективності традиційних методів навчання та інтеграції інформаційно-комунікаційних технологій (ІКТ) в освіту.

**Результати.** Огляд виявив значні проблеми, серед яких низька мотивація студентів та недостатня компетентність викладачів, які надають перевагу традиційним методам викладання. Ці проблеми зберігаються в технічній освіті протягом багатьох років. Крім того, дослідження висвітлило недоліки сучасного освітнього процесу в технічних університетах, особливо під час пандемії COVID-19, що зумовило необхідність розробки адаптивних систем дистанційної освіти.

**Висновки.** Автори розглянули теоретичні підходи до організації освітнього процесу в сучасних закладах вищої освіти та запропонували практичні рекомендації для адміністрації цих закладів. Ці рекомендації спрямовані на вдосконалення методів викладання, в тому числі впровадження адаптивного навчання у вищій школі, усунення виявлених недоліків та підвищення якості технічної освіти.

**Ключові слова:** технічна освіта; професійна підготовка; технологічний інститут; інженерія.