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MAIN TRENDS OF TECHNICAL SPECIALISTS TRAINING IN GERMANY

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The article provides a comprehensive analysis of current trends in the development of higher technical education in Germany in the context of its integration into a single European educational space. The relevance of the study is determined by the growing importance of technical education for innovative economic development, the formation of competitive human capital, and the need to adapt national higher education systems to common European standards. Based on the analysis of scientific publications, regulatory and policy documents, educational development strategies, and analytical materials of European and national educational institutions, three leading trends in the development of higher technical education in Germany are identified. These include: increasing openness of universities to cooperation with key stakeholders, such as employers, research institutions, and local communities; the introduction of innovative educational models, particularly dual education, along with the active use of modern digital and information and communication technologies in the organization of the educational process; and the internationalization of educational programs combined with the accreditation procedures improvement for training technical specialists in accordance with international quality standards. It is substantiated that these trends are systemic in nature and reflect the interaction of external socio-economic and socio-cultural factors with internal organizational and pedagogical mechanisms of the higher education institutions functioning in Germany. The study proves that orientation toward dual learning models, digitalization of the educational environment, and adherence to international quality standards contribute to increasing professional mobility and competitiveness of graduates of technical specialties in the European and global labor markets. The materials of the article can be used in comparative pedagogical research and in the modernization process of higher technical education systems in other countries.

Keywords: *higher technical education, trends in educational development, Germany, internationalization of education, dual education, digitalization of the educational process.*

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ПРОВІДНІ ТЕНДЕНЦІЇ ПІДГОТОВКИ ФАХІВЦІВ ТЕХНІЧНОГО ПРОФІЛЮ В НІМЕЧЧИНІ

Н. А. Сейко, А. В. Динович

У статті здійснено комплексний аналіз сучасних тенденцій розвитку вищої технічної освіти в Німеччині в умовах її інтеграції до єдиного європейського освітнього простору. Актуальність дослідження зумовлена зростанням ролі технічної освіти у забезпеченні інноваційного розвитку економіки, формуванні конкурентоспроможного людського капіталу та необхідністю адаптації національних освітніх систем до загальноєвропейських стандартів. На основі аналізу наукових джерел, нормативно-правових документів, стратегій розвитку освіти та аналітичних матеріалів європейських і національних освітніх інституцій виокремлено три провідні тенденції розвитку вищої технічної освіти в Німеччині. До них належать: зростання відкритості університетів до взаємодії з ключовими стейкхолдерами, зокрема роботодавцями, науково-дослідними установами та місцевими громадами; упровадження інноваційних освітніх моделей, зокрема дуальної освіти, а також активне використання сучасних цифрових та інформаційно-комунікаційних технологій в організації освітнього процесу; інтернаціоналізація освітніх програм і вдосконалення акредитаційних процедур підготовки фахівців технічного профілю відповідно до міжнародних стандартів якості. Обґрунтовано, що зазначені тенденції мають системний характер і відображають взаємодію зовнішніх соціально-економічних та соціокультурних чинників із внутрішніми організаційно-педагогічними механізмами функціонування закладів вищої освіти Німеччини. Доведено, що орієнтація на дуальні моделі навчання, цифровізація освітнього середовища та дотримання міжнародних стандартів якості сприяють підвищенню професійної мобільності й конкурентоспроможності випускників технічних спеціальностей на європейському та глобальному ринках праці. Матеріали статті можуть бути використані в компаративних педагогічних дослідженнях, а також у процесі модернізації системи вищої технічної освіти в інших країнах.

Ключові слова: *вища технічна освіта, тенденції розвитку освіти, Німеччина, інтернаціоналізація освіти, дуальна освіта, цифровізація освітнього процесу.*

Introduction of the issue. Determining trends is one of the most methodologically complex modern scientific and pedagogical research problems. They reflect the specifics of educational processes and phenomena. The formulated trends perform not only a descriptive, but also a prognostic function, since they serve as a basis for the promising methods of scientific analysis application, as well as for leading directions, models and trajectories of the individual branches of education development outlining. Their interpretation is carried out taking into account the complex action of interrelated factors, in particular socio-economic, socio-political and educational that together determine the dynamics, content and results of educational transformations.

Current state of the issue. In modern dictionary and reference literature, the concept of «trend» is interpreted as a stable direction of a certain phenomenon, process or system development. It can be interpreted as an internal aspiration or orientation inherent in the object or subject of activity. Such an understanding is given, in particular, in *the Explanatory Dictionary of the Ukrainian Language*, where a trend is defined as *"the direction of something development; aspiration, intention, inherent in someone or something"* [3]. In *the Great Ukrainian Encyclopedia*, a trend is defined as a path or direction of an idea development or idea, reflecting the dynamics of change and the evolution logic of the corresponding phenomenon [4].

Analysis of the scientific research devoted to the problems of content, organization and models of modern technical education, testifies to the presence of numerous attempts to outline the trends of its development. Certain aspects of this issue are reflected in the works of Y. Brytsyna [1], who focuses on the trends of secondary and vocational

education development; V. Burdun [2] analyzes transformational processes in the field of vocational training; T. Kapeliushna [5] investigates the trends of technological education development in general secondary education institutions; L. Sergeieva [6] considers modern trends of vocational education in the context of European integration, and other scientists.

Among foreign authors who have made a significant contribution to the study of the German higher education system, it is worth highlighting Jürgen Baumert [9] and Sigrid Metz-Göckel [10]. Jürgen Baumert [9] is known as a German teacher and researcher, focusing on the educational quality problems and its comparative analysis in national and international contexts that creates theoretical foundations for the results evaluating of educational reforms and improving educational programs at technical universities. Sigrid Metz-Göckel [10] specializes in higher education didactics and curriculum development that contributes to the formation of content structures and educational modules, in particular in technical and applied disciplines, taking into account the requirements of the modern labor market and the competence-based orientation of education.

Mats Vernholz [12] makes a significant contribution to understanding current trends of the technical education development in Germany, focusing on the human dimension of educational processes and the conscious professional self-development importance of future specialists.

Ulrich Teichler's research interests [11] focus on a wide range of issues related to higher education as a social system. He examines the relationship between higher education and the labor market, compares higher education systems in different countries, focuses on the problems of education internationalization and mobility of students and researchers, and pays detailed attention to trends of the higher technical education development.

The **aim** of the article is to analyze and summarize key trends in the higher technical education development in Germany, caused by the influence of globalization processes, digitalization, and innovative development of European educational policy, as well as to clarify their role in the modern models of technical training formation in higher education institutions.

Results and discussion. The development of higher technical education in Germany is taking place due to dynamic socio-economic and technological changes associated with the production digitalization, the "Industry 4.0" concept implementation, the economy innovation orientation and the requirements growth strengthening for technical specialists. In this context, the system of higher technical education responds to external challenges by constantly updating the content, forms and methods of training that leads to the emergence of sustainable change directions that should be considered as leading trends in its development [8].

Analysis of trends in the higher technical education development allows us to identify natural and relatively stable directions of transformations that reflect not isolated reforms or local innovations, but systemic changes that are formed under the influence of a complex of factors – educational, social, economic and political. In scientific and pedagogical research, trends are considered as an analytical tool that provides the opportunity not only to describe the current state of educational processes, but also to form well-founded conclusions regarding the prospects for the further higher technical education development [6].

Germany is one of the leading industrialized countries in Europe with a powerful system of technical training, demonstrating a specific model of higher technical education development, combining academic traditions of university education with practical skills and close interaction with the industrial sector. That is why the study of its development trends acquires special

scientific significance, as it allows to identify effective approaches to the modernization of technical education that can be used in a broader European and national educational context.

Based on the German experience analysis and its comparison with the general European educational processes, it can be concluded that the higher technical education development in Germany occurs in several key areas that have the character of trends in a comparative pedagogical sense. Their isolation is based on the identification of sustainable changes that are systematically reproduced in the practice of higher education institutions of a technical profile [11].

1. The trend towards increasing openness of universities to key stakeholders (students, employers and scientific and pedagogical workers) occupies a leading place among the trends in the higher technical education development in Germany that we have identified. Its essence lies in the formation of a flexible, multi-vector educational environment that ensures the active participation of various subjects of the educational process in the design, implementation and assessment of learning outcomes. This trend is characterized by the individual choice possibility of educational trajectories in accordance with their own academic interests and professional plans for students; by direct involvement in the future specialists training, in particular through the active implementation of various dual education models for employers; by expanding academic mobility practices for teachers.

The leading nature of this trend is due to a number of objective factors, among which German geographical location in the center of Europe and its immediate neighborhood with nine countries occupy an important place. Such a position contributes to the openness of the higher technical education national system to interstate educational cooperation, taking into account the regional needs of the labor market and adapting educational programs to the demands of not only the domestic, but also cross-border educational space. As a result, when developing and implementing technical personnel training programs, the possibilities of students' academic mobility and the attractiveness of specialties for education seekers from neighboring countries are taken into account [11].

A significant factor in increasing the openness of higher technical education is the functioning of an extensive dual education system that includes a number of models, in particular the dual education, cooperative, work-oriented and correspondence models. Within the framework of these models, close integration of theoretical training with professional activities is ensured that meets the modern requirements of the labor market. In recent decades, the German higher technical education system has demonstrated a clear orientation towards practical learning outcomes, within which the formed skills and abilities acquire priority over isolated theoretical knowledge. The combination of training with paid professional activities within the framework of the dual model creates additional socio-economic opportunities for students, in particular in terms of financial autonomy and covering the costs of training [11].

The open nature of educational programs for technical specialists training at German universities is confirmed by the active participation of employers in planning, organizing and evaluating the results of industrial practices and internships. Representatives of industrial enterprises and the business sector are involved in determining the expected learning outcomes, assessing the professional competencies of education seekers and adjusting the content of educational programs that contributes to increasing their relevance and applied orientation.

2. The trend towards the innovative educational models introduction and modern information and the educational process technological support is one of the key characteristics of the higher technical education

development in Germany at the present stage. The study found that the blended learning model that involves a traditional classroom forms combination of educational activity with the use of digital educational technologies and online resources, is actively spreading in the technical universities of this country. The most widely used are the rotational model, the "flipped classroom" model and the flexible model that allow adapting the educational process to the individual needs and students' capabilities.

The blended learning use in the system of higher technical education demonstrates positive results, as it contributes to independent mastery of educational material at an individual pace, concentration of attention on complex topics and an increase in the educational autonomy level of education seekers. Alternating and combining different learning forms ensures the flexibility of the educational process and increases its resilience to external challenges, in particular in distance learning conditions during quarantine restrictions or other crisis situations. At the same time, the effectiveness of the blended learning models implementation is determined by the material and technical support level of universities, the readiness of teachers and students to use digital technologies, as well as compliance with relevant regulatory and methodological requirements [10].

The innovative educational models actualization in higher technical education is closely related to the fourth industrial revolution (Industry 4.0) challenges, which entails significant changes in the requirements for technical specialists' professional training. In this context, the formation of digital, technological and analytical competencies necessary for working with automated, robotic and cyber-physical systems is of particular importance. The key competencies of technical specialists in accordance with the requirements of Industry 4.0 include digital literacy and data management, programming and software development skills, understanding of the principles of cyber-physical systems functioning and the Internet of Things, the ability to work with automated production processes, as well as the ability to critical thinking and operational decision-making [10].

The information technologies integration into the educational process of technical universities contributes to the creation of a dynamic, interactive and practice-oriented educational environment. The use of computer simulations, virtual laboratories and specialized software makes it possible to model real technical processes, conduct experiments in safe conditions and ensure a close connection between theoretical training and practical activities. As evidenced by the results of modern pedagogical research, it is the practical orientation and application of digital technologies that are an important condition for the professional competence formation of future technical specialists.

3. The trend towards educational programs internationalization and accreditation procedures for technical specialists training.

Germany holds leading positions in the higher technical education development that is due to a long tradition of innovative educational models implementing, a high level of technological support and a systematic approach to ensuring the specialist's training quality. The experience of German technical universities is actively borrowed by other countries, and the higher education institutions themselves are attractive to students from different regions of the world. In this regard, it is advisable to conduct a comprehensive analysis of the structural and procedural aspects of the German higher technical education system functioning in the context of its integration into the European and global educational space.

The higher technical education system in Germany is characterized by a complex and multi-level structure, the features of which may vary depending on the federal state. At the same time, it is distinguished by a high accessibility and quality level: the entrance exams absence for a number of educational programs, wide

opportunities for academic disciplines individual choice, the combination of study with professional activities, as well as the academic mobility programs implementation without the educational process interrupting. An important component of internationalization is a developed system of social and financial benefits for national and foreign students, which, combined with the diplomas recognition in the countries of the European Union, significantly increases the level of graduates' competitiveness in the international labor market [9].

The accreditation system for technical education programs in Germany operates at three interconnected levels. At the Conference of Education and Culture Ministers of the Federal States level, general requirements for the country's higher education system are determined. The Accreditation of Educational Programs in Germany Foundation accredits accreditation agencies and develops uniform criteria for the quality of education assessing. Direct accreditation of educational programs is entrusted to independent accreditation agencies, among which, along with German ones, agencies from Austria and Switzerland are also involved that further strengthens the international nature of the quality assessment procedure [10].

However, the conceptual and legal status of accreditation in Germany remains debatable. Accreditation agencies do not have the status of state bodies, although they operate within the framework of regulatory requirements established by the state. At the same time, the regulatory and legal acts regulating their activities are not always mandatory that leads to the accreditation interpretation as an administrative procedure aimed at confirming the compliance of educational programs with established quality standards without clearly defined legal guarantees.

In Germany, two main accreditation models are implemented: programmatic and systemic. Programmatic accreditation involves a multi-stage expert assessment of individual educational programs, while systemic accreditation is aimed at confirming the university's ability to provide stable mechanisms for internal quality control of educational activities. Within the framework of systemic accreditation, regular evaluation of educational programs and areas of training is carried out with the internal and external leaders, academic experts, employers and graduates representatives involvement. A positive result of such a procedure confirms the qualification goals achievement and educational programs compliance with established standards that gives the university the systemically accredited status [12].

Along with this, alternative accreditation models are used in the practice of German higher technical education, in particular procedures that, if successfully completed, grant universities the right to self-accredit educational programs, which indicates a high level of institutional autonomy and trust in internal quality assurance systems [12].

We can summarize the trends in the higher technical education development in Table 1:

Table 1

Main trends in the higher technical education development in Germany

	Trend Name	**Content Description**	**Main Manifestations in the Educational Process**
1.	The trend towards increasing openness of universities to key stakeholders.	The focus of universities on taking into account the interests of all educational process participants.	Students' individual educational trajectories; active dual education implementation; employers' involvement in organizing internships and learning outcomes assessing; participation of leading

			scientists and practitioners in teaching.
2.	The trend towards the innovative educational models introduction and modern information and the educational process technological support.	Integration of modern information and communication technologies and innovative learning models to improve the professional training quality.	Blended learning introduction (rotational model, flipped classroom, flexible model); digital platforms, virtual laboratories and simulations use; digital competencies in accordance with the requirements of Industry 4.0 development.
3.	The trend towards educational programs internationalization and accreditation procedures for technical specialists training.	German higher technical education integration into the European and global educational space.	Academic mobility of students and teachers; implementation of joint educational programs; involvement of international accreditation agencies; program, system and alternative accreditation of educational programs.

[Source: developed by the author based on Teichler, U. (2017). Higher Education System Differentiation, Horizontal and Vertical. In: Shin, J., Teixeira, P. (eds.). Encyclopedia of International Higher Education Systems and Institutions. Springer, Dordrecht. DOI: https://doi.org/10.1007/978-94-017-9553-1_36-1]

Conclusions and research perspectives. The three leading trends in the higher technical education development in Germany identified in the study reflect, on the one hand, the general socio-economic, socio-political and socio-cultural conditions for the educational system functioning, and on the other hand, the internal organizational and pedagogical mechanisms of the activities of higher technical profile education institutions in the integration context into a single European educational space.

The above trends demonstrate the German universities desire to combine national educational traditions with innovative European approaches to the educational process organizing and its effectiveness ensuring. The conclusions obtained create a basis for further comparative analysis and can be used when considering the possibilities of German experience individual elements adapting in the higher technical education system of other countries.

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