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Engineering Pedagogy as the Theoretical Basis of Training Engineers

Pedagogika inżynierska jako podstawa teoretyczna kształcenia inżynierów

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ABSTRACT

The origin and development of engineering pedagogy as a subdiscipline of pedagogy in Ukraine and in foreign countries is analyzed. The outstanding role of the founder of IGIP Professor Adolf Melecinek in the processes of formation of an international scientific school of engineering pedagogy and creation of conditions for professional-pedagogical and psychological training of teachers of technical disciplines as a factor in training competitive engineers is discussed. The essence, content and structure of professional training of future engineers with the aim of forming professional competences are highlighted. The features of the cognitive and practical activities of future engineers are revealed. The components and conditions for increasing the efficiency of the formation of the engineer's professional competence and his readiness have been determined. Particular attention is given to the quality of academic teaching is decisively determined by the qualifications and competencies of the teaching staff, which also include university pedagogical capabilities. Therefore, it has been substantiated that with the growing environment and consciousness of "outcome-based education", the importance of engineering pedagogy has increased manifold.

Keywords: engineering education; engineering pedagogy; International society for engineering pedagogy (IGIP); IGIP accreditation criteria; professional competences

The modern world of domestic higher technical education is what it is, thanks to everything that preceded this moment. A lot preceded it: digital overwhelm, rapid globalization, the activated Bologna process, the start of large-scale modernization of education. The current socio-political situation in the country

necessitated, firstly, a drastic increase in the role of technical universities as generators of innovative activity in the formative economy of knowledge, and secondly, systemic transformations in higher education pedagogy. Higher technical education in today's conditions is a catalyst for progress and a powerful factor in the development of intellectual and productive forces of society, ensuring the sustainable development of the state and improving human well-being. It is about subordinating the goals of economic, cultural and social development, growth and dissemination of knowledge and skills. The competence of future engineers is considered as a result and product of the activities of a higher technical school, as a competitive product on the labor market, as a significant component of forming the reputation of a certain university. Changing the paradigm of higher education based on the competence approach aims to shift the emphasis from the organization of the professional training process to its final quality result (Yermakova, 2014).

Rapid globalization, hypercompetition, a complex demographic situation, on the one hand, modern scientific achievements, an increase in the share of multidisciplinary research, the relentless development and complication of science-intensive technologies, on the other hand, have a serious impact on the changing role of an engineer in high-tech industry and society.

Issues of the content of engineering education in a higher technical educational institution are in the focus of research attention as foreign scientists (P. Darvall, A. Melecinek, Zh. Martin, A. Maiorov, Z. Pudlovskyi, L. Sakharchuk, A. Sotov, A. Subetto) as well as domestic scientists (V. Britan, A. Velychko, V. Ivanenko, O. Kyrylenko, L. Klymashevskyi, O. Potap, A. Rozhkov, A. Yasev, etc.), where the scientific understanding of the continuous university training of a future engineer is highlighted production industry within the subsystems "specialist – master's student – graduate student". The problem of training future specialists of a technical profile is the subject of research by domestic and foreign scientists. In particular, they investigate: theoretical provisions of the professional activity of an engineer and the peculiarities of his training (S. Artiukh, N. Briukhanova, O. Kovalenko, A. Nizovtsev, E. Zeyer); pedagogical aspects of teaching engineering disciplines (S. Artiukh, V. Belikova, O. Belova, G. Iziumska, O. Kovalenko); modern pedagogical technologies in professional training of future technical professionals (O. Padalka, S. Sysoyeva); teaching methods of technical disciplines (N. Briukhanova, V. Bohdanov, K. Gomoyunov); methods of teaching special disciplines (N. Udalov); organization of independent work and its role in the training of technical specialists (I. Bendera, N. Holub, V. Tiurina); application of professional knowledge by future engineers under production conditions (B. Arpentiev, T. Dmytrenko, M. Lazarev).

The article aims to reveal the problem of engineering pedagogy as a theoretical training of engineers and outline the key factors and principles of the development of engineering pedagogy based on modern world trends.

The engineering profession includes a large number of specialists from various fields. The circle of modern engineers is so wide that it is possible to mistakenly think of everyone related to engineering as capable of making sound technical decisions, designing and personally troubleshooting. Undoubtedly, this profession involves excellent abilities in exact sciences and is associated with inventions, new trends and directions. A person with an engineering profession implements in practice the brilliant ideas that come to his mind. An engineering career outlines that an essential part of a person's life will be mental activity, ideas and their dissemination. One aspect of the engineering profession is the ability to perform practical work, for instance, such as debugging and repairing equipment, assembling and disassembling any technical product, and also bringing work to a logical conclusion. In practice, this person is an extremely literate and skilled specialist. According to Baranets (2012), a good engineer can become a person who is able to make this world better thanks to his talents and desire; the one who always has a lot of practical ideas and the ability to do something with his own hands; one who has the right outlet for spontaneity and originality. As the established concept states, an engineer is a specialist who performs well-defined "highly specialized" functions. Nowadays, especially in small high-tech companies, in addition to the fact that an engineer is the "main generator of innovation", he is required to be a researcher, an organizer of the work of a "team" (manager), and a leader at the same time.

Due to its communicative and interdisciplinary essence, the engineering profession combines interdisciplinary knowledge, innovative ideas and features of the environment with its own possibilities of synthesis of various information to create a new objective reality. A professionally trained engineer ought to: design and construct; use the means of production, management-practical, constructive-technological, research activity; organize the production process; ensure the implementation of achievements of science and production; develop scientific and technical documentation; use normative reference, scientific and technical, production information; develop technical and technological projects, plans, regulations; regulate and manage production work; develop and implement measures to improve production efficiency (Pazynych, 2009). Engineering activity demands a holistic view of the design object, forming "multi-screen" thinking, knowledge of the language of formulas, drawings and schemes, a combination of scientific and artistic thinking styles, reasoned courage and the gift of foresight.

Modern training of an engineer entails the integration of fundamental scientific and technical knowledge with the ability to carry out specific developments and ensure their rapid implementation in real life. Engineering pedagogy contributes significantly to the development of innovative approaches to the problem of organizing the education of engineers under modern conditions of high information saturation of the educational process.

In accordance with Professor Nychkalo's (2010) viewpoint, the theoretically grounded provisions of integration and at the same time specialization in pedagogical sciences, as well as globalization in pedagogy and education, are extremely crucial. Scientific problems, analysis of the genesis and modern categories of specialization and integration require special attention. The interdependence of these concepts, which, at first glance, are contradictory and even contradict each other (Nychkalo, 2010) is undeniable. Under these conditions, the primary task is to address the current problems of the modern philosophy of education, to unite the efforts of representatives of various branches of scientific knowledge in order to conduct theoretical and methodological research.

We consider a significant scientific achievement of Austrian scientists to be the theoretical and methodological justification of engineering pedagogy, a sub-discipline which in the 1970s entered the global pedagogical science. Its founder is Professor Adolf Melecinek, known in Europe as the president of the International Society of Engineering Pedagogy – "Internationale Gesellschaft für Ingenieurpädagogik" (IGIP), a teacher-researcher, a brilliant lecturer and a talented organizer of engineering-pedagogical activities on an international scale. In 1957, after obtaining an engineering education, A. Melecinek became a qualified engineer – a specialist in the field of electronics. Subsequently, he began teaching at a technical university, while not having special pedagogical training. Almost all engineers who start teaching activities in the absence of special psychological-pedagogical and professional-pedagogical competencies are familiar with the same situation. Some of them, having gone through a long path of pedagogical trials and errors, become excellent lecturers, and some continue to experience serious difficulties throughout their activities in the system of higher technical education. The existence of this problem is obvious to all teachers of engineering disciplines. A. Melecinek decided to adapt the courses of pedagogy and psychology for the training engineers and formulated the idea of the need to introduce planned and systematic pedagogical training of engineers who start teaching. It was this Austrian scientist who in 1977 created the world's first textbook on engineering pedagogy (Melecinek, 2000), which gradually won its place at higher technical educational institutions and later became a desk book for teachers of technical disciplines and at Ukrainian technical universities. This and other works of the outstanding scientist became the scientific foundation of engineering pedagogy as a science, which constitutes a pedagogical theory that allows to substantiate the development of the system of training engineering personnel and teachers of higher education as a major subsystem in the inseparable triad "science – education – production". In the context of A. Melecinek's reasoning, engineering pedagogy is something aimed at improving the teaching of technical disciplines, as well as something related to the activation of their goals, content and forms of learning. At the same time, the scientist took into account the following features

of engineering activity: manufacturability and purposefulness, algorithmization, scientific justification, systematicity. The main principles of the engineering pedagogy course are: integral character, scientificity, systematicity, connection of theory with practice (Kovalenko, 2003).

Consequently, at the end of the seventies of the last century, thanks to the efforts and achievements of A. Melecinek, it was possible to teach technical disciplines on a scientific and pedagogical basis, saving effort and time. In addition, the teaching process, organized in compliance with the principles of engineering pedagogy, became much more efficient, effective and exciting for students. Engineering pedagogy, having established a connection between technology, technical disciplines and didactics, created an opportunity for many teachers at technical universities to master pedagogical skills.

Engineering pedagogy is closely related to many scientific disciplines, in particular, with psychology, anthropology, economics, political sciences, philosophy, ergonomics, and management. It is also related to general pedagogy, special pedagogy, andragogy, higher school pedagogy, culture pedagogy, labor pedagogy, free time pedagogy, etc. The methodology of engineering pedagogy and the methodology of engineering-pedagogical research is a strategy of scientific research activity that determines the prospects for the development of this sub-discipline, the systematicity, consistency and expediency of conducting theoretical and experimental actions based on their application in a certain set and interdependence of methods, methods and techniques.

Therefore, the theoretical part of the science "engineering pedagogy" is, first of all, the identification and formulation of laws and regularities that express the essential relationships between education, science and production and their influence on the dynamics of the development of both the entire system and its individual elements; secondly, the development of conceptual foundations for training engineers for innovative activities, which are carried out under rapidly changing external conditions. The practical part of engineering pedagogy is the development, implementation and optimization of pedagogical systems of training and self-training of teachers and students of engineering and technical universities for innovative professional activity, taking into account theoretical concepts and empirical experience of the development of integration processes in the system "education – science – production", their impact on the effectiveness of training engineers to solve various problems in the field of engineering.

It should be emphasized that in modern conditions, engineering pedagogy is the core of the formation of the content of training engineers for innovative activities within the framework of mega-projects that integrate the creative activity of numerous teams of scientists, engineers, economists, ecologists, businessmen and other specialists. The basis of the activity of engineers participating in large interdisciplinary projects, as before, remains the engineering and technical core

(Beynon, 2014). However, the system of requirements for the personal and socio-professional competencies of engineers – participants in mega- and multi-projects – is significantly expanding and includes new components that, integrating with traditional ones, should form a new essence of a creative engineer working in a multicultural environment.

The combination of fundamental and applied knowledge, modern technologies, and, most primarily, their effective use for practical purposes becomes the main task of an engineer in his innovative activities. In this way, a new approach to engineering education is being developed. In the 21st century, theoreticians and practitioners of innovative engineering education talk about the need for a specialist in the field (engineering and technology) to develop not only certain knowledge, abilities and skills, but also special "competencies" focused on the ability to apply them in practice, in a real case, in the process creation of new competitive products in the shortest possible time. Therefore, competences constitute "knowledge in action" (Kovalenko, 2003). The curricula are adapting accordingly. Already in the first year of study, students are shown the connection of the proposed educational material with their future engineering activities, perspectives of scientific and technical, technological, economic and social development of society. Such a pedagogical method allows students to develop the necessary motivation for learning, great receptivity to theory when learning it through practice.

The object of engineering pedagogy is the pedagogical system of training engineering personnel, its goals, principles, forms of organization, methods and means of training, and the subject is the design of the content of education, the training process and the formation of the personality of a future specialist. Engineering pedagogy reveals the theory and methodology of design, constructive, communicative, managerial and other functions; theory and methodology of teaching technical and technological knowledge, abilities, skills, formation of specific methods of engineering activity. Engineering pedagogy deals with the principles, methods, and procedures of designing the content of education at the level of the system (curriculum, specialties) and subject, selection and structuring of educational material. The main methodological principle of designing the content of education is orientation to the prospects for the development of science, technology, production, and culture (Pazynych, 2009). The International Society for Engineering Pedagogy (IGIP) is one of the authoritative organizations in the field of higher technical education. The initiator of the creation of IGIP and its constant president during 1972–2002 was Professor A. Melecinek. The goal of IGIP is to promote scientific methods of teaching technical disciplines, i.e. pedagogy and methodology (Melecinek, 2000). To carry out the assigned tasks, the IGIP board approves an international committee of experts – the International Monitoring Committee (IMC IGIP), as well as groups of experts in individual

countries – national monitoring committees (NMC IGIP). A pertinent component of IGIP activity is the organization and holding of annual international symposia on engineering pedagogy. The first organized symposium was held in Klagenfurt in May 1972, attended by delegates from five countries. Nowadays, teachers of technical disciplines from more than 80 countries of the world are members of IGIP.

Through the efforts of IGIP, the general principles and philosophy of engineering education were formulated, a special document was developed and adopted – the "ING-PAED IGIP" (international engineer-pedagogue) register, which defines the qualification requirements for teachers of a higher technical school. These requirements are specified in accordance with significant external changes in the education system.

The main tasks of improving the quality of engineering and technical education in accordance with the prospective requirements of science-intensive production, society, as well as the needs of graduates of technical universities cannot be solved separately from the implementation of a whole set of tasks related to improving the quality of teacher training for innovative professional and pedagogical activities.

On September 12, 1999, at a meeting of the European Monitoring Committee (EMC) in Istanbul, a decision was made to establish the National Monitoring Committee of Ukraine (NMCU). Currently, there are two Centers of Engineering Pedagogy in Ukraine – since 1999 in Kharkiv at the Ukrainian Engineering and Pedagogical Academy, and since 2009 in Dnipropetrovsk at the National Mining University. These Centers for retraining and professional development of teachers of higher technical educational institutions were created with the aim of training teaching staff to obtain the title "International Engineer-Pedagogue" (ING PAED IGIP). At the same time, the introduction of Centers in Ukrainian technical universities is a significant step in the development of engineering education in our country. The active implementation of engineering pedagogy in the educational process of domestic technical universities will contribute to increasing the level of training of engineers on the basis of the compliance of engineering and pedagogical personnel with the global requirements of technical education (Nykytiuk, 2012).

The necessary qualification conditions for inclusion in the "International engineer-pedagogue (ING-PAED IGIP)" register are based on: 1) thorough technical knowledge of the teacher of technical disciplines. Therefore, a higher technical education and experience in practical work are necessary; 2) engineering and pedagogical knowledge. Appropriate training corresponds to one semester of a university (minimum 240 hours) (Pazynych, 2009). Content-wise, engineering-pedagogical training should be based on the engineering-pedagogical model and the cycle of disciplines, be obtained in an educational institution certified by the

IGIP; 3) engineering and pedagogical practice, for instance, in the position of associate professor, mentor. Practical experience should be at least one year.

The words belong to Bernard Shaw: "The only way to knowledge is activity". The joint activity of international centers of engineering pedagogy contributes to the formation of a single engineering-pedagogical educational space, and provides an opportunity to acquire new international knowledge. The list of organizations (Zafoschnig, 2012) which IGIP interacts most actively include: European Society for Engineering Education (SEFI), Educational Society of Electrical and Electronic Engineers (IEEE), American Society for Engineering Education (ASEE).

The engineering industry has a special, strategic importance for the development of the national economy and Ukrainian society as a whole. Therefore, the state of professional training of petroleum engineers, the prospects for its improvement and development are considered as one of the critical assignments of educational policy.

In the "Energy Strategy of Ukraine for the period until 2030" it is stated that the efficiency of the work of the components of the Fuel and Energy Complex (FEC) is determined by the "intellectual level of the personnel" and at the same time it is recognized that the system of training and retraining of engineering and technical workers and specialists of leading professions is lost in the complex, the connection is lost the connection between generations in production", "that "the leading role of science in almost all sectors of FE has been lost", that the costs of science "per worker are 50–80 times lower than in the leading countries of the world". This situation in the field of training and providing the industry with professional human resources reflects an obvious shortage of professional workers, engineering and technical, managerial and scientific personnel. The training of specialists in engineering professions needs significant improvement.

The global labor market, the unified information space and other integration processes in the economy make special demands on the specialist in any industry. In addition to increasing the scope and depth of professional knowledge, an engineer today needs to have non-standard thinking, develop professionally key qualities, possess communication skills, implement a creative approach to solving not only technological and technical, but also socio-economic, environmental, scientific and research problems, at the same time using a broad synthesis of interdisciplinary knowledge.

To gain a system engineering education means, at least, to find out the purpose of various types of engineering activity in the relevant subject area, to see the entire arsenal of means of activity, to know how and to be able to use the main ones, to own its basic technologies and to understand what is at the entrance, and what is desirable to obtain at the output (Tymkiv, 2020). The process of forming the readiness of future engineers is based on the pedagogical principles of systematicity and integrity, professional orientation, interdisciplinary integration,

problem solving and creative orientation, self-realization and self-actualization and is carried out under the condition of the introduction of an information and communication complex of specialized disciplines.

It should be emphasized that the professional activity of a modern engineer is related to work in a constantly changing environment, therefore, the professional competence of a specialist in the engineering industry has a three-component structure (general cultural, subject-professional and personal components) (Tymkiv, 2020b).

Theoretical-methodological approaches to engineering pedagogy, substantiated propositions that were introduced into scientific circulation by A. Melecinek in the 1970s, were of decisive importance for the formation and development of engineering pedagogy as a science. The scientist argued their content on the basis of a system of knowledge, the mastery of which ensured the formation of professional skills and abilities necessary for future engineering activities.

Contemporary conditions of differentiation of sciences, profiling of educational disciplines, multiplication of activity standards create difficulties that can be compared to the effect of "Babylonian pillar formation". In relation to ancient legends, the inhabitants of Babylon decided to forever glorify their magnificent city and dared to build a tower, the height of which was supposed to reach the top of the sky. The Lord, outraged by the audacity of the people, decided to punish them for their pride. He mixed the builders' languages so that they could no longer understand each other. The construction of the colossal tower had to be stopped, the builders could not implement a joint project (Koptilov, 1976). Since then, the search for a universal language of communication has become the main task of people's existence. Overcoming difficulties in the field of technical science and education is served by international societies, teachers and practitioners of engineering, aimed at forming uniform requirements for the activity of a teacher of technical disciplines. In "language creation", that is, in solving the task of building an environment of mutual understanding, A. Melecinek made a real breakthrough. Scientists have created a common language for everyone – the international language of engineering pedagogy, which allows teachers working in Higher Technical Educational Institutions of different countries, having behind them different traditions, different systems of engineering education, different conditions of survival within the framework of the Bologna process, to understand each other well. Thanks to the use of the intellectual and scientific potential of the world engineering-pedagogical community under the conditions of constantly developing interaction between scientists and practicing educators, the process of training engineers for creative activity under the conditions of a globalized world is being improved.

It should be noted that in engineering pedagogy effective teaching engineering depends on a number of variables, which form the foundation of Engineering

Pedagogy Science Didactical Pentagram designed by Rüütmann (2019), developed from Uljens (1997):

- instructional goals and learning results for higher level learning;
- students' psycho-structure (psychology, students' individual differences, learning styles, level of motivation, prior knowledge, self-regulation, feedback, ethics, etc.);
- instructors' competencies and roles (competencies in specialty and didactics, learning theories, motivation, self-analysis, reflection, life-long learning, feedback, rhetoric, ethics, classroom management skills, entrepreneurship, learning analytics, etc.);
- course content (learning materials, visual aids, literature, videos, etc.);
- socio-structure (learning environment, cooperation, teamwork, creativity, critical thinking, collaboration, communication; etc.);
- teaching technology, media, e-learning (blended learning, distant, remote and e-labs, robotics, flipped classroom and hybrid classroom, drones, virtual and augmented reality, simulations, etc.);
- teaching methodology, models and strategies (deductive and inductive teaching, active learning, case-analysis, studio learning, engineering design, lab methodology, interactive teaching, PBL, peer-instruction, etc.);
- assessment and feedback methodologies;
- analysis and reflection (strengths and weaknesses, analysis of students' feedback, compilation of teaching philosophy statement and teaching portfolio, peer-evaluation, coaching and mentoring, etc.).

As shown in Figure 1, commonly named "Classic didactic triangle" (*Educator – Students – Course content*), which formed on the grounds of didactics, provides the basis of Engineering Pedagogy Science Didactical Pentagram (Rüütmann, 2019). Appropriately, an educator will have to teach students the course content (considering students' individual differences and prerequisites) by explaining, supervision, questioning, integration, showing connections, using didactical fundamentals for supporting learning with deep understanding, etc. Furthermore, the following triangles support the described basic one in the didactical pentagram (Rüütmann, 2019):

- *Students – Independent learning – Classroom management*: for independent learning via e-learning it is essential to teach students to learn, teachers have to learn how to teach over internet, use learning analytics, take part in coaching and mentoring, learn classroom management and entrepreneurship;
- *Teacher – Independent learning – Course content:* for supporting classroom learning, individual learning or e-learning teachers use contemporary methodology, active learning structures, and integration, supporting communication, collaboration, creativity and critical thinking;

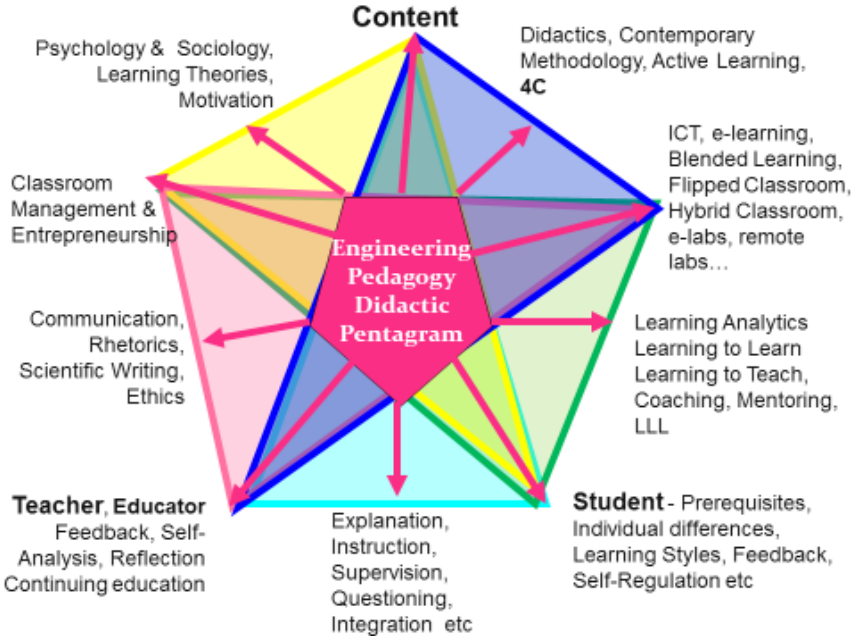

Figure 1. Didactical Pentagram of Engineering Pedagogy Science

Source: Rüütmann, 2019.

- *Classroom management – Course content – Students*: teachers have to master the basic principles of psychology and sociology, and know learning theories for supporting learning and motivation;
- *Teacher – Independent learning – Classroom management*: for supporting classroom and independent learning teachers have to master the basics of rhetoric, ethics, supportive communication and scientific writing for compilation of effective learning aids and materials.

The above-described Didactic Pentagram of Engineering Pedagogy Science (Figure 1) sets the ground of the pedagogical competencies of engineering faculty along with the specialty competencies, ensuring effective teaching and learning engineering.

Considering the research outcomes on engineering pedagogy, it is reasonable to justify the provisions pertaining psychological and pedagogical aspects of predicting employment demand at state and regional levels; consolidating the efforts of relevant ministries and agencies, employers, researchers and non-governmental organizations; the development of social partnership; strengthening the responsibility for quality training, retraining and advanced training of employees; legislative support for the training of employees competitive in the labor market.

Based on the findings, engineering pedagogy is a subdiscipline of pedagogy that has an integrated character and substantiates its theories taking into account the results of research from other fields of scientific knowledge. This is due to their system object – professional education, which covers all subject fields of knowledge, activities, formation and development of specialists in various industries. This makes it possible for professional pedagogy to generate new theories in accordance with integration processes, information and technological development of society. Summarizing a rather concise analysis of the outlined problem, we note that Ukrainian pedagogical science and practice need increased attention to the study of scientific problems of their own subdisciplines, and especially engineering pedagogy in the conditions of lifelong learning, as well as several changes in the application of knowledge and skills of an engineer during his active period of life.

Thus, the quality of engineering education essentially relies on the specialty and pedagogical competencies of engineering faculty. Pedagogical competencies are becoming more considerable in the quality assessment of higher technical education. The basis of pedagogical education of engineering faculty is engineering pedagogy, which offers appropriate and consistent didactical models for guarantee of effective teaching and significant learning.

REFERENCES

Baranets, O. (2012). Whom to be an engineer? *Dnipro*, 8, 138–141.

Beynon, J. (2014). Engineering education needs an international dimension. *FOCUS*, 184, 3–9.

Downey, G.L., & Lucena, J.C. (2004). Knowledge and professional identity in engineering: code-switching and the metrics of progress. *History and technology*, *20*(4), 393–420. **DOI: 10.1080/07341510400030435 8**

Flueckiger, F. (2007). Editorial: engineering education – pedagogic and didactic aspects in the context of the emerging knowledge society. *European Journal of Engineering Education*, *32*(4), 363–365. **DOI: 10.1080/03043790701336934**

Kovalenko, O. (2003). *Methodology of professional education. Manual for engineers-pedagogists, lecturers of special purpose disciplines for the system of professional and technical and higher education.* Kharkiv: ChP "Shtrikh".

Koptilov, V. (1996). *In the world of famous quotes*. Kyiv: Veselka.

Melecinek, A. (2000). *Engineering pedagogy. Practice of transmission of technical knowledge.* New York: Springer Wien.

Nykytiuk, N., Shabanova Y. (2012). The introduction of the world trends of engineering pedagogy in higher technical education of Ukraine. In: *Upravlinnia yakistiu pidhotovky kadriv z vyschoyu osvitoyu cherez udoskonalennia procedur litsenzuvannia, akredytatsii ta reitynhuvannia. Proceedings of the scientific and methodical conference, March 15−16, Dnipropetrovsk (2)* (pp. 105–107). Dnipropetrovsk: National mining university. Retrieved April 25, 2023, from: http://ir.mnu.org.ua/handle/123456789/3215.

Nychkalo, N. (2010). Professional pedagogics and pedagogics of labour: the problems of the interrelations in market environment economy environment. *Pedagogy and Psychology*, *2*, 33–45.

Pazynych, Y. (2009). The Role of Engineering Pedagogy in Modern Education. *Bulletin of National Technical University of Ukraine "Kyiv Polytechnic Institute". Philosophy. Psychology. Pedagogy: the Collection of Scientific Papers*, *3*(27), 165–167.

Rüütmann, T. (2019). Engineering Pedagogy Science as the Contemporary Basis for Effective Teaching of Science, Technology and Engineering. In: V. Lamanauskas (Ed.). *Science and Technology Education: Current challenges and possible solutions. Proceedings of the 3rd International Baltic Symposium on Science and Technology Education (BalticSTE2019)* (pp. 187–194). Šiauliai: Scientia Socialis Press. **DOI:10.33225/BalticSTE/2019.187**

Sheppard, S.D., Macatangay, K., Colby, A., & Sullivan, W.M. (2008). *Educating engineers, designing for the future of the field.* The Carnegie Foundation for the Advancement of Teaching.

Shields, D., Verga, F., & Blengini, G.A. (2014). Incorporating sustainability in engineering education. Adapting current practices to mining and petroleum engineering education. *International Journal of Sustainability in Higher Education, 15*(4), 390–403. **DOI: IJSHE-02-2013-0014**

Tymkiv, N. (2020a). *International professional communication of petroleum engineers: instructional guidelines.* Kyiv: Yurko Liubchenko Publishing House.

Tymkiv, N. (2020b). *Professional training of specialists for the oil and gas industry at technical universities of Ukraine.* Kyiv: M.P. Drahomanov NPU Publishing house.

Uljens, M. (ed). (1997). *Didaktik – teori, reflektion och praktik*. Lund: Studentlitteratur.

Zafoschnig, A. (2012). How IGIP, the International Society for Engineering Education, intends to tackle the New Pedagogic Challenges in Engineering Education. In: *Tenth LACCEI Latin American and Caribbean Conference (LACCEI'2012), Megaprojects: Building Infrastructure by fostering engineering collaboration, efficient and effective integration and innovative planning, July 23-27, Panama City, Panama.* Retrieved April 30, 2023, from: http://www.laccei.org/LACCEI2012-Panama/Refereed Papers/ RP173.pdf

Yermakova, S. (2014). Vektors of lean-education in Higher Educational Institutions in a transitive economy environment. *Newsletter of Ivan Franko Zhytomyr state university*, *1*, 58–62. Retrieved April 30, 2023, from: http://nbuv.gov.ua/UJRN/ VZhDU_2014_1_13.

ABSTRAKT

Artykuł dotyczy pochodzenia i rozwoju pedagogiki inżynierskiej w Ukrainie i w innych krajach. Omówiono wybitną rolę założyciela IGIP profesora Adolfa Melecinka w procesach kształtowania się międzynarodowej szkoły naukowej pedagogiki inżynierskiej oraz tworzenia warunków do profesjonalnego pedagogicznego i psychologicznego przygotowania nauczycieli dyscyplin technicznych jako czynnika kształcenia konkurencyjnego inżyniera. Zwrócono uwagę na istotę, treść i strukturę szkolenia zawodowego przyszłych inżynierów w celu kształtowania kompetencji zawodowych. Ujawniono cechy poznawczej i praktycznej działalności przyszłych inżynierów. Określono składowe i warunki zwiększenia efektywności kształtowania kompetencji zawodowych inżyniera oraz jego gotowości. Szczególną uwagę przywiązuje się do jakości nauczania akademickiego, która w decydującym stopniu determinowana jest kwalifikacjami i kompetencjami kadry dydaktycznej, do których zalicza się również uniwersyteckie możliwości pedagogiczne. Zaznaczono, że wraz z rosnącym środowiskiem i świadomością „edukacji opartej na wynikach" znaczenie pedagogiki inżynierskiej wzrosło wielokrotnie.

Słowa kluczowe: edukacja inżynierska; pedagogika inżynierska; Międzynarodowe Towarzystwo Pedagogiki Inżynierskiej (IGIP); kryteria akredytacji IGIP; kompetencje zawodowe