



SELF-REALIZATION IN ENTREPRENEURSHIP OF FUTURE ENGINEERING SPECIALISTS

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Abstract

Relevance: professional preparation of future specialists of engineering specialties takes place in technical establishments of higher education of Europe, mostly, after one of two strategies (specialized activity or administration) and directly does not envisage preparation of bread-winners of higher engineering education to self-realization in an enterprise; however under modern circumstances of civilization advancement a self enterprise can be the most effective and effective method of self-realization of specialists of engineering profession.

The *purpose* of the article was to characterize the features of stimulating the training of engineering graduates for self-realization and starting their own business based on the analysis of the entrepreneurial experience of engineers and educational programs for the professional training of future specialists in engineering specialties.

Methods: the research methodology is represented by the integrity of person-oriented, subject-activity, competence, synergistic, existential-phenomenological, environmental, and integrative approaches, which made it possible to maximally take into account the sectoral specificity of engineering, the peculiarities of the process of obtaining an engineering education, the complexity of integrating the professional and entrepreneurial activities of an engineer.

Results: the ideas regarding the training of future specialists in engineering specialties to open and successfully implement a business are substantiated.

Conclusions. A conclusion was made about the need to implement an entrepreneurial component in the professional training of future specialists in engineering specialties, which will contribute to the actualization and development of their individual and personal qualities for starting their own business and successfully promoting their own business. The obtained results can become the basis for further scientific substantiation of the content and innovative technologies of training students of engineering education for self-realization in innovative entrepreneurship, as well as the introduction of game methods, business accelerators, simulators, and simulators.

Keywords: *specialists in engineering specialties, self-realization of engineers, engineering education, innovative entrepreneurship, training of future engineers for entrepreneurship.*

Introduction. Engineering is a field that provides students with more skills than they need to perform engineering jobs. Engineering courses equip them with the skills they need to become successful

entrepreneurs. At the current stage of social progress, which is characterized by dynamic transformations in all spheres of economic activity, the content, forms, and methods of obtaining education,

work and human life are changing. The implementation of integration, informatization, technologization and diversification trends along with negative crisis globalization phenomena (climate changes, humanitarian, demographic and economic crises, pandemics, etc.) require human adaptation to the new realities of being in the system "society - man - nature" (Bazyl, Radkevych, Radkevych, & Orlov, 2020). Under such circumstances, a micro-society of active, proactive, effective, and stable individuals is formed, who strive to become economically independent, comprehensively self-realize, influencing civilizational challenges, and not passively adapt to the latest changes. Specialists in engineering specialties play a special role in the civilizational development of society in developed countries. Integrating interdisciplinary knowledge, interesting ideas, and innovative characteristics of the environment with their own ability to synthesize the received information for the formation of a separate subjective reality, graduates of technical institutions of professional education have direct access to commercial activity and can achieve not only financial and social independence, but also significant success in entrepreneurship. Independently analysing scientific sources, carrying out partial monitoring studies in a separate economic sector of the market and critically evaluating the received information, future engineers can design business plans, forecast the expected results of professional activity. Such actions have a positive effect on the development of their professional competence and entrepreneurial qualities, which helps to find alternative approaches to improving the goals and content of higher engineering education. Thus, the need to stimulate the training of future specialists in the field of engineering to start their own business and self-realization in entrepreneurship is appropriate and natural, as it will contribute to updating the target guidelines, improving the content and process of professional education by updating the entrepreneurial component and applying innovative pedagogical technologies, teaching and control methods, as well as methods of subject-subject interaction of teachers and students of engineering education.

Sources. The importance of training future specialists in engineering specialties for entrepreneurship is emphasized in the Strategy for the Development of Higher Education of Ukraine for 2021-

2031 the relevance of cooperation between technical universities with scientific institutions and the business sector for the formation of the professional and scientific and educational potential of the nation by ensuring professional and personal development is emphasized. development focused on the highest achievements in science and practice (Stratehiia rozvytku vyshchoi osvity v Ukraini na 2021–2031 roky), as well as the need to include an entrepreneurial component in the content of educational programs, considering the subject specifics of industries. In agreement with most scientists, we believe that supporting entrepreneurship contributes to the competitiveness of each state and in connection with technological changes and the intensification of global competition caused by globalization and economic liberalization is the most justified necessity (Grecu, & Calin, 2017).

In the modern scientific and educational discourse, the trending features of preparing young people for entrepreneurship are analysed and attention is focused on the importance of creating business incubators in technical universities (Nestorenko and other, 2021; Nestorenko and other, 2022); developed conceptual models, technologies and methods of such training for future specialists of various specialties, in particular, the most effective are "engineering-entrepreneurial workshop technology", case technologies and workshop technologies (Idris and other, 2021). Scientists have conducted numerous empirical studies to determine the intentions of students towards entrepreneurship and their impact on obtaining an engineering education (Thompson, 2009; Bae and other, 2014; Rodrigues, and other, 2012), features and mechanisms of diagnosing levels of entrepreneurial competence (Saeed, and other, 2014; Brokesova, Deck, & Peliova, 2016) according to the methodology of the international EntreComp framework (Czyżewska, & Koziół, 2020) and the main barriers to self-realization of future specialists in engineering specialties in entrepreneurship have been clarified (Gano, & Łuczka, 2020). Based on the analysis of scientific research on engineering education and the logical generalization of the conceptual ideas of the authors, it was found that the effectiveness of training future specialists in engineering specialties for self-realization in entrepreneurship is determined by several determinants. First, aware-

ness of modern professional training of future specialists in the technical field as a way of socialization and harmonization of man and society (Hudgraft, & Kolmos, 2020). Secondly, the understanding of professionalization as a process of acquisition by a specialist not only of professional competence, mastery of fundamental, applied knowledge, but also the development of professional culture. Thirdly, by positioning the engineer's self-realization as a person's personal and professional development and career growth, which involves the actualization and activation of entrepreneurial skills (Tîrziu, & Vrabie, 2016).

The literature review on engineering education made it possible to identify the directions of the educational process that enable the integration of engineering and entrepreneurial thinking, the preparation of future engineers to solve the problems of self-employment and further successful implementation of their own business:

- integration of the fundamental-theoretical component of professional training with the personal experience of the students of engineering education and their practical application of specialized knowledge to perform typical and non-standard production tasks enables the conscious assimilation of professional knowledge and the acquisition of sustainable professional skills, the development of value orientations, which requires the development of new types and personalized models educational programs based on students' development and documentation of their own learning and career trajectories as part of their lifelong learning strategy (Titova, Luzan, Sosnytska, Kulieshov, & Suprun, 2021);

- the humanitarianization of professional training contributes to the realization of the mechanisms of self-knowledge by the students of education about themselves as individuals, their confirmation of their place in the national and world cultural environment, which will contribute to the emergence and confirmation of new forms of human co-existence and social interaction; however, in such a context, according to modern studies, the technology of engineering education should be in completely new economic, political and social planes (Center for online education, 2023);

- technologization of professional training of a specialist in the technical field is aimed at master-

ing the principles, laws, models of the production industry and technologies for the production of competitive materials and products, and engineering education should be much more active and dynamic (Hernandez-de-Menendez, Morales-Menendez, 2019);

- the management and consulting component of professional training, which is focused on the formation of corporate culture and teamwork skills (Wach, 2015, p. 38), in particular, the formulation of strategic and tactical engineering and technological tasks, the ability to find constructive ways to resolve conflicting situations in the field of industrial production and business (Holzmann, Breiteneker, Soomro, & Schwarz, 2017), social organization of work, establishment of adequate market relations under conditions of competition of ideas, goods and services;

- informatization of the professional training of future engineers involves in-depth study of information technologies, as well as the latest means of searching, processing, storing and displaying data; it is the strong connection with information and communication technologies that is the main distinguishing feature of modern engineer-entrepreneurs, who represent the generation of millennials, people with a different style of thinking and high performance indicators of learning in the course of multi-sensory activities (Titova, Luzan, Davlatzoda, Mosia, & Kabyshev, 2023);

- the application of an entrepreneurial approach to the professional training of a future engineer enables the development of adaptive skills of professional activity in the conditions of a market economy, the formation of the financial and economic culture of a future specialist whose engineering decisions are based on economic expediency (Westlund, 2011); in this context, the legal culture of the students of engineering education is developed, which is specified by familiarity with state legal laws and rules in the "man-machine-environment" system, in-depth knowledge of the impact of technical systems and production technologies on human health and the environment, which has a positive effect on the level of development of environmental competence of students of engineering education.

Therefore, the actualization of individual and personal qualities of future specialists in engineering

specialties before starting their own business and successfully implementing their own business is considered promising. We predicted that the obtained results could become the basis for further scientific substantiation of innovative technologies and the content of the training of engineering students for entrepreneurship, as well as the implementation of game methods and business simulators, which are partially considered in the publications of modern scientists.

Methods. The research methodology is represented by the integrity of person-oriented, subject-activity, competence, synergistic, existential-phenomenological, environmental, and integrative approaches, which made it possible to maximally take into account the sectoral specificity of engineering, the peculiarities of the process of obtaining an engineering education, the complexity of integrating the professional and entrepreneurial activities of an engineer. The complex of these approaches is coordinated with the main areas of solving the problem of preparing future engineers for entrepreneurship. Synergistic and person-oriented methodological approaches made it possible to identify the dynamics of personality development from the positions of self-determination, self-development, joint creativity, freedom to choose one's own career trajectory due to self-organization, self-reflection and development, entrepreneurial thinking. The subject-activity approach helped to identify ways of stimulating students to develop entrepreneurship, awareness of the expediency of self-realization in entrepreneurship, and building a business career. Thus, the results of the analysis of the official website of the Vellore Institute of Technology indicate that businessmen with a world name had, first of all, an engineering education, and the famous projects Ola, Flipkart, Zomato, Housing.com, Quikr, Snapdeal and others were created by former students of engineering faculties. For example, Sachin Bansal and Binny Bansal, computer engineering graduates from the Indian Institute of Technology, Delhi, co-founded Flipkart, an online shopping portal that proved to be a pioneer in the Indian e-commerce industry. Flipkart started as a small startup in Bangalore and has gradually grown to become one of the most successful online shopping apps, currently characterized by its wide range of products and fast delivery. Vijay Shekhar Sharma is one of the most successful entrepreneurs

in India, having received an engineering education at the Delhi College of Engineering, he founded the One97 company. Bhavish Aggarwal and Ankit Bhati, with engineering degrees from IIT Bombay, created Ola cabs, a mobile app that simplifies the taxi booking process. Deepinder Goyal and Pankaj Chaddah are co-founders of the Zomato mobile application, which was opened to provide complete information about restaurants (type of cuisine, menu, maps, branches, reviews, approximate cost of service for two people, etc.), later improved by adding service services with food delivery. At the same time, the first of the mentioned co-founders has an integrated master's degree in mathematics and computer engineering, and the other one studied engineering at IIT Delhi (VIT, 2021, 5 august). It is noteworthy that Sergey Brin, Bill Gates, Elon Musk, Larry Page, and many other world-renowned businessmen also have an engineering education.

We got acquainted with the successful practice of professional training of engineers in construction specialties at technical universities of the Republic of Poland (Academy of Silesia – former University of Technology, Katowice), Slovakia (University of Economics in Bratislava), Ukraine (National Transport University, Kyiv). We analysed educational programs and experience of training specialists in the field of engineering. At the same time, there are reasons to assert that the stimulation of training of students of engineering education for self-realization in entrepreneurship and starting their own business needs further improvement.

Results and Discussion. As evidenced by the results of our research, as well as numerous foreign monitoring surveys and argued by social practice, it is graduates of technical universities who become successful entrepreneurs. At the current stage of the formation of startup culture, students of engineering education generate interesting ideas and show a persistent desire to start their own business and successfully manage their company. Among the important characteristics of successful businessmen is a persistent cognitive interest in mastering new knowledge and a desire for self-education, which is naturally found in students of engineering education. In addition, technical thinking and experience acquired because of tasks from several technological projects at the same time contribute to a quick and logically moderate solution of various problems of

entrepreneurial activity. Technical thinking is the advantage of an engineer's personality. In connection with the information and technological progress, the possession of technical knowledge is a mandatory condition for employment in most industries. Businesses are also becoming technologically advanced. Therefore, it is engineers who have the advantage to be better entrepreneurs due to the individual and personal characteristics and professionally important qualities that they possess.

One of the key skills of future engineers is innovative thinking. Having experience in the development and implementation of projects, engineers are convinced that planning is one of the most important elements of success in project implementation. By working simultaneously on several engineering projects, future professionals acquire the ability to plan clearly, adhere to a plan drawn up in advance, and be ready to implement alternative plans (if necessary). Such abilities are an integral quality of a successful businessman. In particular, the success of engineers' self-realization in entrepreneurship is facilitated by the ability to determine the available resources and opportunities as accurately as possible and use them as efficiently as possible. Future engineers, performing tasks within the framework of group design, even during professional training at a vocational education institution, acquire teamwork skills that are important for entrepreneurial activity, in particular, they become aware of the peculiarities of teamwork and form the belief that the implementation of the project requires the active work of all team members, each of which he convincingly argues his own position, is characterized by unique personal qualities and makes an appropriate contribution to the implementation of the project, which can be of decisive importance for its success as a whole. That is why specialists in engineering specialties can easily join a team and ensure the smooth implementation of the project. In addition, future engineering specialists, having acquired initial experience of working in a team, realize sensitivity to the emotions of their team members, and are convinced that trust is an integral part of the success of any team. Thanks to such character traits as truthfulness and frankness, engineers easily manage to establish business relationships with partners.

Students of engineering specialties are determined to combine the development of professional

and entrepreneurial competence, are distinguished by endurance, resistance to failure and possess the emotional strength to withstand any difficulties of professional or career growth.

The ability to objectively assess the scale and socio-practical effect of an idea and to rationally approach its implementation enables a clear and specific determination of the feasibility of each stage in the implementation of a business idea and an accurate calculation of costs for the performance of each individual task (from logistics to configuration) in creation and debugging own business. It is a rational, not an emotional approach that contributes to successful business.

The study of the experience of professional training of engineers of construction specialties in technical universities of the Republic of Poland, Slovakia, and Ukraine, long-term research into the peculiarities of the professional work of representatives of engineering specialties, as well as long-term personal experience testify to its uniqueness in terms of communicative and subject-specific originality and the nature of actions, since their professional activity is possible by conditions for the thoughtful integration of multifaceted knowledge, the application of the latest ideas and innovative achievements of science and technology, taking into account the specific characteristics of the relevant environment and the ability of specialists to skilfully combine interdisciplinary information to create a new or improve the existing reality.

The study and logical generalization of the content of professional standards and job-functional instructions of engineers shows that to successfully perform complex tasks within the scope of professional activity, such specialists need to acquire design and construction skills, learn to rationally use available resources, and means of industrial production, carry out design-technological, management and practical activities, as well as conducting scientific research. Therefore, an integral requirement for the professional work of an engineer is the development of the ability to ensure high-quality self-organization of professional activity in the integrity of fundamental-specialized, subject-practical, psychological-pedagogical, and methodical aspects.

In European educational institutions, special attention is focused on students' mastery of regula-

tory requirements applicable to construction activities in the European Union. It is noteworthy that the educational process is carried out in such a way that students could maximally demonstrate individual qualities during the learning process, namely: creative and artistic abilities, technological thinking, the desire for independent mastery of knowledge, artistic and aesthetic taste. For this purpose, heuristic and project-based learning technologies are introduced.

Therefore, the educational process of training bachelors in engineering in the field of construction is carried out in such a way as to equip students with basic and latest knowledge about building materials and their strength, measuring devices, principles of technical drawing, legislative and regulatory requirements for designing roads, bridges or buildings, types of materials and technologies used in construction; to form the skills and abilities of designing main objects and individual building elements, implementation of the latest production technologies, selection and effective use of building materials, organization of the construction process, including management of a team of workers and a construction company, as well as to develop a number of individual and personal qualities. The integrity of the specified professional and individual qualities ensure the competitiveness of technical university graduates with the high demands placed on modern engineering personnel.

For example, graduates of the Academy of Silesia – former Katowice School of Technology (Republic of Poland, Katowice) after graduation are characterized by a high level of possession of innovative theoretical knowledge, computer techniques and the latest technologies used in engineering practice in the field of housing, communal, industrial construction and information and communication design. Indicators of a high level of quality of professional training of engineers in technical universities of Poland are achieved by harmonizing target guidelines (Ostenda, Nestorenko, & Ostenda, 2018), content, and forms of training organization within two educational cycles (bachelor's and master's). Master's studies are aimed at forming a creative and professional personality of a Master of Engineering with full competencies and qualifications, which is the result of the development of basic knowledge and skills acquired during training. As a result of this

organization of obtaining higher technical education, there is a high level of preparedness of graduates for independent and consciously responsible design, organization, and management of the construction process of various types of buildings, as well as design of reinforced concrete, steel, and wooden products. It is noteworthy that during master's studies, students acquire theoretical and practical skills necessary for planning investments in construction and their implementation, as well as for carrying out repair work, modernization, and reconstruction of buildings with a special emphasis on the specifics of railway, road, and housing construction, and for carrying out creative and research works in the field of construction.

In the conditions of the formation of a creative economy, including creative (innovative) entrepreneurship, specialists in the IT industry are in high demand. Engineers of this field are distinguished by the development of technical imagination and abstract thinking, the formation of stable intentions to create the latest technologies and IT tools, they are fond of solving puzzles, creative abilities and can make alternative solutions to solve a specific problem. The rapid development of new technologies and modern devices, which require specialized software, pose new challenges to IT engineers. This creates favourable circumstances not only for their employment, but also for starting their own business, further professional development, and career growth in business. The experience of the Republic of Poland is of scientific and practical interest in this context. Thus, graduates of the Silesian Academy are able to create, program and implement models for biomedical purposes in order to conduct simulations and experiments "in silico"; develop systems and services that offer content on the Internet along with the creation of applications for mobile devices; successfully use existing IT solutions and adapt them to the needs of business analysis; critically analyse the risk of vulnerabilities in individual elements of the IT infrastructure and apply appropriate measures to protect the infrastructure in a timely manner.

The University of Economics in Bratislava has a specific position in the Slovak higher education system. Despite the social science character of most of the study programmes offered, students graduate with a diploma of an engineer. This has historical roots and is equally used in the territory of

former Czechoslovakia. Encouragement for entrepreneurship is thus strongly rooted in all study programmes. Graduates of technical disciplines at all three technical universities in Slovakia (Slovak University of Technology in Bratislava, Technical University in Zvolen and Technical University in Košice) acquire the knowledge necessary for success in practice and the development of their entrepreneurship through courses provided by economic institutes, faculties or at least departments. The need for knowledge in economics, finance and management for technical graduates is also documented by the steady and slightly increasing interest in vocational and lifelong learning programmes (e.g. MBA programmes).

The analysis of educational programs for the training of engineers in the field of informatics in technical universities of Ukraine and the Republic of Poland made it possible to determine a complex of professional and individual-personal qualities that are formed in the process of professional training of such specialists (project manager, administrator of systems, network services, servers, IT- infrastructure, programmer of computer games, etc.). Thus, basic knowledge and skills in the IT market include: the development of creativity, innovative thinking, the availability of specialized knowledge and skills in building algorithmic procedures for solving a specific problem, programming, designing and operating database systems, configuring and optimizing the operation of network services, computer networks, use of modern network operating systems, effective use of available information sources and use of technical documentation of IT products. Graduates of technical universities, in addition to the above, are characterized by the formation of integral and thorough knowledge of the basics of informatics and the latest information technologies, digitalization trends and research problems in the field of informatics. Carrying out master's studies on the specification and design of requirements for operation and maintenance of existing IT systems in the changing conditions of civilizational progress, students not only expand and deepen basic knowledge, develop professional skills, but also acquire compe-

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tencies in entrepreneurship, management and creative economy, which is especially important for making thoughtful decisions in the future professional activities in the positions of: information technology consultant, IT manager, programmer (depending on the chosen specialty: games, mobile devices, databases), designer, programmer of "in silico" simulations and experiments, programmer of mobile devices, analyst and designer of IT systems, designer and administrator of IT systems, computer networks, business analyst, software tester.

Therefore, to prepare students of engineering education for entrepreneurship, it is desirable to form microgroups (teams) of students and to interest them in the development of startups, to direct them to entrepreneurial activities even in the process of obtaining their professional education.

Conclusions. An in-depth analysis was conducted to determine the possibilities of integrating professional and entrepreneurial training of future engineers for self-realization and career growth throughout life, stimulating the desire for success in a business career. It is substantiated that the introduction of an entrepreneurial component into the educational process for the development of the entrepreneurial potential of students of engineering specialties is one of the urgent requirements that technical universities of Ukraine and Poland are trying to implement in the conditions of a market economy. It has been proven that an engineer as a subject of innovative entrepreneurial activity is distinguished by a high level of professional competence development and initiative. Being in a creative environment, such specialists acquire the skills of generating innovative ideas and finding effective ways to solve non-standard problems in various branches of production, which opens prospects for the development of personal entrepreneurship for everyone.

Further research should be devoted to the actualization of educational goals, the content of education, forms and methods of education, activities of subjects of the educational process, focused on the development of professional and entrepreneurial competence of future engineers, ensuring successful self-realization and career growth.

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ПІДГОТОВКА МАЙБУТНІХ ФАХІВЦІВ ІНЖЕНЕРНИХ СПЕЦІАЛЬНОСТЕЙ ДО САМОРЕАЛІЗАЦІЇ У ПІДПРИЄМНИЦТВІ

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Реферат:

Актуальність: професійна підготовка майбутніх фахівців інженерних спеціальностей у технічних закладах вищої освіти Європи відбувається, здебільшого, за однією з двох стратегій (спеціалізована діяльність чи адміністрування) й безпосередньо не передбачає підготовку здобувачів вищої інженерної освіти до самореалізації в підприємстві; однак за сучасних обставин цивілізаційного поступу саме підприємництво може бути найбільш дієвим і ефективним способом самореалізації спеціалістів інженерного фаху.

Мета: охарактеризувати особливості стимулювання підготовки майбутніх фахівців інженерних спеціальностей до самореалізації, у т.ч. започаткування власного бізнесу, на основі аналізу кращих практик підприємництва в сфері інженерії й розгляду освітньо-професійних програм підготовки молодших спеціалістів інженерного фаху.

Методи: методологія дослідження представлена концептуальними положеннями особистісно-орієнтованого, екзистенційно-феноменологічного, компетентнісного, середовищного й інтегративного підходів, що дало змогу врахувати галузеві особливості інженерії, зокрема машинобудування, цільові, змістові й організаційні особливості освітнього процесу у закладах вищої інженерної освіти.

Результати: обґрунтовано теоретичні ідеї щодо забезпечення якості підготовки майбутніх фахівців інженерних спеціальностей до самореалізації, зокрема на основі самозайнятості й успішної реалізації бізнесу.

Висновки. Підприємницька складова є необхідною компонентою професійної підготовки молодших спеціалістів інженерного фаху, що сприятиме актуалізації та розвитку їхніх особистісно-підприємницьких якостей щодо відкриття й успішного просування власної справи. Отримані результати можуть стати основою для подальшого наукового обґрунтування змісту та інноваційних технологій підготовки здобувачів інженерної освіти до самореалізації в інноваційному підприємстві, а також запровадження ігрових методів, бізнес-акселераторів, тренажерів та симуляторів.

Ключові слова: фахівці інженерних спеціальностей, молодші спеціалісти, самореалізація фахівців, професійна освіта, інноваційне підприємництво, підготовка майбутніх фахівців до підприємництва.

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