

S. Dovgyi¹, Acad. of the NAS of Ukraine, Dr. Sc. (Phys.-Math.), Prof.,
 V. Nebrat², Dr. Sc. (Econ.), Senior Research Fellow, orcid.org/0000-0002-5419-3181,
 D. Svyrydenko³, Dr. Sc. (Philos.), Assoc. Prof., orcid.org/0000-0001-6126-1747,
 S. Babiichuk³, Cand. Sc. (Ped.), orcid.org/0000-0001-6556-9351

1 – Junior Academy of Sciences of Ukraine, Kyiv, Ukraine, e-mail: pryjmalnya@gmail.com

2 – Institute for Economics and Forecasting of the National Academy of Sciences of Ukraine, Kyiv, Ukraine, e-mail: vic-toria_nebrat@ukr.net

3 – National Pedagogical Dragomanov University, Kyiv, Ukraine, e-mail: denis_sviridenko@ukr.net

SCIENCE EDUCATION IN THE AGE OF INDUSTRY 4.0: CHALLENGES TO ECONOMIC DEVELOPMENT AND HUMAN CAPITAL GROWTH IN UKRAINE

Purpose. To summarize the experience of implementation of science education approaches in Ukraine, which takes into account the need to overcome the crisis in modern economy, in particular, as to the conformance of current system of specialists' training in Ukraine to the world trends conceptualized in theoretical provisions of the Industry 4.0 concept.

Methodology. Given the economic slowdown in Ukraine, the authors proposed to verify the potential of science education as a strategy of modernization of education to ensure its role in the formation of the 21st-century skills. Based on the correlation between the demand for the development of the 21st-century skills under modern economic conditions and the capabilities of science education as a recognized modern educational strategy, the authors sought to substantiate the responses to the challenges of economic and human capital development in Ukraine. Theoretical (analysis, synthesis, systematization, generalization) and empirical (observation, comparison) research methods are used.

Findings. The analysis of negative trends in the domestic economy (indicators of human capital development, global competitiveness, and others) made it possible to prove the idea that contemporary national education has low institutional capacity to provide an adequate response to the complex challenges of Industry 4.0 economy. The analysis of Ukrainian experience in the implementation of science education showed a beneficial effect of dissemination of modern educational practices that are closely intertwined with the modern trends in economics and management.

Originality. The approach was justified according to which the dissemination of science education ideas is one of the strategies for reorienting the Ukrainian system of future personnel training for modern global labor market, science-based and technologically rich agenda for the development of mankind, proposed by the Industry 4.0 concept.

Practical value. There were demonstrated practical examples of implementing science education approaches, their focus on the development of the 21st-century skills and on the inclusion in the modern economic processes. This study demonstrated not only a pragmatic estimation of the need for transformation of education following the principles of science education (in alignment with labor market demands, and so on), but also showed the potential of science education in the context of providing learners with real-life tools for active citizenship, helping them to become active participants of socioeconomic and socio-cultural transformations in the age of Industry 4.0.

Keywords: *economic development, Industry 4.0., human capital, innovative economy, science education, 21st-century labor market*

Introduction. Economic development in the conditions of establishment of a knowledge society is characterized by the changes in the nature of manufacturing (rapid change in technologies and organizational forms, modularity, multifunctionality, conversion of information into the main production factor, permanency of innovations based on new knowledge, growth of prosumerism, and others), specific labor content (intellectualization, creativity, process virtualization, remoteness, etc.), modification of the market mechanism (information becomes the main resource, service and commodity), and specific social relations (increased social mobility, degradation of traditional stratification as a result of the spread of sharing platforms and a culture of sharing resources, and so on). However, the main driver of economic development remains unchanged – an innovative individual – a creative person capable of producing and implementing progressive ideas. Innovation in the knowledge economy requires an individual to have high level of information technology proficiency and creative thinking.

The specific list of requirements imposed on the system of training specialists for the new social order is being revised in the context of Davos Forum (2016) provisions, according to which educational systems should respond to the need of developing 21st-century skills. Therefore, the formation of active individuals – new generation of people with critical thinking, scientific literacy, capable of non-standard solutions – is the

primary task we should perform to ensure the focus on innovation in economic development. The authors of the article seek to find an answer to the following questions: What are the ways to form new generation within the frame of the old educational system? How to increase the competitive human potential of the economic development? Can the global experience of disseminating science education ideas be a strategy for addressing strategic challenges of matching training to global challenges? The authors understand that the mechanisms of human capital formation and realization in the new economy are linked to the system of vocational educational and training, and go way beyond.

Literature review. Schumpeter J.A. laid the theoretical framework for the study of innovativeness as a basis for the development of national economies [1]. The development of the theoretical aspects for the establishment of a new science-based economy as a result of information technology revolution, exponential growth of volumes of information and ICT (with corresponding projections on the educational field) is reflected in the works by P. Drucker [2], F. Fukuyama [3], and others. Recently, numerous scientific publications by western scientists have studied the changes in the vocational and qualification structure of employees in the Ukrainian economy, reforming the educational and human resources management systems under the conditions of Industry 4.0 and the digital transformation of the economy [4].

Given the exhaustion of the resource potential of traditional manufacturing factors and significant institutional bar-

riers to the formation of an innovative model of economic growth, the relevance of research on possible ways and resources to ensure the economic development of Ukraine is increasing. The world scientific literature updated important issues of the relationship between innovative economic development and the formation of intellectual human capital, and summarized the scientific discussion on the formation and theoretical understanding of the information economy in its productive links with education [5]. Some studies have clarified the role of education in shaping the model of economic development of Ukraine with the focus on innovations and information [6, 7]. At the same time, the fundamental problem of economic theory and practice – the problem of economic development in terms of its productive relations with the educational system – requires further comprehensive scientific and practical elaboration. Currently, there are no publications devoted to combining the theoretical aspects of establishing a new quality of economic development with the practice of implementing science education in Ukraine.

Purpose. The purpose of the study is to conceptualize the experience of implementing science education approach in Ukraine in the context of the Industry 4.0 challenges, and to evaluate the potential of this educational strategy for the promotion of human capital development and establishment of an innovative economy in Ukraine.

Methods. Given the economic slowdown in Ukraine, the authors proposed to verify the potential of science education as a strategy of modernization of education to ensure its role in the formation of the 21st-century skills. Based on the correlation between the demand for the development of the 21st-century skills under modern economic conditions and the capabilities of science education as a recognized modern educational strategy, the authors sought to substantiate the responses to the challenges to economic and human capital development in Ukraine.

Results. Over the last ten to fifteen years, the domestic scientific community has developed a set of approaches to determining the priorities of Ukraine’s economic development, and substantiated the objective requirement and an indisputable need to change over to an innovative and technological model of economic development. In particular, it has been established that the stability and competitiveness of the national economy within the global information space may be ensured through mastering the key types of manufacturing characteristic of the fourth, fifth, and sixth technological orders and capable of rapid growth in the global market, and generating high volumes of intellectual rent to raise investments in modernization of economy on the basis of advanced technologies. There has also been proposed a model of endogenous growth of Ukraine’s economy with the focus on enhanced efficiency of internal resources utilization (human, scientific and technological, financial) and development drivers. The defined priorities of economic development reflect a change in the prevailing values, in particular: improvement of the quality of life and industrial safety, use of energy-saving and waste-free technologies, promotion of environmental health, social orientation of manufacturing, activation and realization of human capital of the society, innovation and technological transformation of the economy as a basis for the formation of a post-industrial information society.

The qualitative changes observed in the social production and global information space bring up new issues and concerns related to ensuring innovative development of Ukraine’s economy, its competitiveness and international integration, and taking into account the potential of education to force the mentioned reform, especially in the context of Industry 4.0 era announcement at the World Economic Forum recently.

Establishment of new economy based on digital technologies leads to the transformation of the organization of manufacturing and consumption, changes in social ties through the creation and spread of technological innovations: artificial in-

telligence, electronic databases, cloud technologies, augmented reality, the Internet, social networks, 3D printing, sensors, mobile technologies and others. This means combining people, property, equipment, processes, resources, etc. in a new way; real-time data collection and analysis; creation and dissemination of information as a new kind of economic resource; emergence and satisfaction of new needs – which, in fact, is the content of innovation as the main feature of the new economy. One of the peculiarities characteristic for information society is the rapid innovation in all spheres of public life, in particular manufacturing, distribution, exchange and consumption of goods. M. Hladchenko and H. Vossensteyn described the specific expectations by modern employers and students from education as follows: “While the former implies the student interest in developing knowledge and skills in a particular subject area and personal development, the latter refers to prospective financial benefits and employability” [8].

The global nature of contemporary changes in the types and forms of social production includes the movement of the latest technologies, products and organizational and technological relations across national borders, institutional barriers, and breaks in the levels of technological and socio-political development. However, the nature and extent of involvement of different actors in this global resource–production system still remains unclear, as well as the quality of ties between different actors of the new (digital, information) economy with information as the main resource and innovations as the driver of development. Ukraine’s place in the modern world-system, its competitiveness and prospects are determined by its capability to respond adequately to the challenges posed by the digital economy, and the need to integrate into the global information society. These include insufficient information and communication infrastructure, low level of proficiency in foreign languages and information technologies, aging of society and shortage of manpower as a result of migration of economically active young people abroad, poor adjustment of institutional environment and regulatory system, in compliance of educational system with new requirements imposed on the general and vocational training, and others. Global Competitiveness Index is a representative indicator of the country’s level of economic development, innovation potential of the national economy and institutional capacity to realize such potential. The Global Competitiveness Index is published by the World Economic Forum on the basis of the analysis and integrated assessment of a system of indicators comprising over one hundred of variables [8]. Unfortunately, Ukraine is in the third quarter of the group of 140 countries, ranking 83rd. It is surpassed by such post-socialist countries as Russia, Poland, Kazakhstan, Georgia, Montenegro, and others. The dynamics of this indicator is also disappointing, because over the last five years, the ranking according to the level of global competitiveness has decreased significantly – by 10 points, as seen from the Table [9].

Table

Changes in Ukraine’s global competitiveness ranking compared to other countries

Ranking of Ukraine and some other countries according to the Global Competitiveness Index	2012–2013 (of 144 countries)	2013–2014 (of 148 countries)	2014–2015 (of 144 countries)	2015–2016 (of 140 countries)	2016–2017 (of 138 countries)	2017–2018 (of 140 countries)
Ukraine	73	84	76	79	85	83
Georgia	77	72	69	66	59	67
Turkey	43	44	45	51	55	53
Russian Federation	67	64	53	45	43	38
Poland	41	42	43	41	36	39

The greatest fall (by 30 scores) is seen in the Efficient Labor Market pillar. Ukraine's positions in the ranking also fell significantly in the following pillars: Infrastructure (by 9 scores), Health and Primary Education (by 8 scores), and Innovation (by 7 scores). These are the key parameters for the innovation-driven development of the economy, and they show downward dynamic and low levels. In view of this, the compliance of modern Ukrainian education with the challenges of the global innovation-driven economy of Industry 4.0 age remains an urgent issue.

In this new economy, the highly intellectual creative activity conjugated with high scientific content and skills for new social organization of humanity is becoming increasingly in demand. At the same time, the knowledge society itself (the information society based on the innovation economy) provides opportunities for creative human activity free from routine, physical exertion and the need to overcome natural resource constraints. Therefore, in order to be relevant and able to integrate into a knowledge-based economy, it is necessary to master and constantly update the skills that meet the challenges of the 21st-century.

The transformation of the economy puts new demands for human capital and at the same time carries out its formation [10]. The point is that in the modern socio-economic space, a human is not only a resource, a factor, a subject, but also a result and a measure of the development of social production. Human is the holder and creator of knowledge, and new solutions. He/she forms a new reality through changing established organizational and technological structures and traditional approaches to solving issues of life support and comfort.

The economic content of human capital can be described by such a definition – it is a certain reserve of health, abilities, knowledge, skills, experience, motivation, which is formed and developed as a result of investments and accumulated by an individual, as well as a creative way of thinking, moral values and attitudes, the culture of work and communications, standards of social behaviour that are purposefully used in a particular area of economic activity, and thus contribute to the growth of social and individual well-being. The human capital is the basis of an innovative economy; it becomes a source of development, determines the competitiveness of national economies and is a key resource for their development in the age of Industry 4.0.

The level of human development is important for the assessment of economic potential, since it is the basis for the formation of human capital. In 2017, Ukraine received the Human Development Index (HDI) of 0.751, ranking 88th among 189 countries and territories. For the period from 1990 to 2017, the HDI of Ukraine increased from 0.705 to 0.751, i.e. by only 6.5 % [11]. In the course of Industry 4.0 society formation, the scientific ideas about the factors of economic development and views on productive abilities of people are changing. From the analysis of issues related to the use of available human resources, the economic science together with related socio-humanities turns to the substantiation of important skills and thinking styles, corresponding to the practices of distribution of artificial intelligence, nano-bio-technologies, and so on. The World Economic Forum in Davos in 2016 was dedicated to discussing the future of humanity, in particular, the fundamental changes in the job market among challenges centred on the Fourth Industrial Revolution. In the 'Future of Work' resolution, leading economists have warned about the changes that the future job market is expecting, and it is the holders of new skills who can meet the demands produced by the transition to Industry 4.0: 'The Fourth Industrial Revolution, which includes developments in previously disjointed fields such as artificial intelligence and machine learning, robotics, nanotechnology, 3-D printing, and genetics and biotechnology, will cause widespread disruption not only to business models but also to labour markets over the next five years, with enormous change predicted in the skill sets needed to thrive in the new landscape' [12].

Figure shows the world-recognized list of sixteen skills for the 21st-century, which should be approved within the framework of modern education. Skills are divided into three blocks: Foundational Literacies (Literacy; Numeracy; Scientific literacy; ICT Literacy; Financial literacy; Cultural and civic literacy), Competencies (Critical thinking/problem solving; Creativity; Communication; Collaboration), Character Qualities (Curiosity; Initiative; Persistence/grit; Adaptability; Leadership; Social and Cultural Awareness) [13]. Changes in education policy, management of the education system, revision of both organizational forms and content of education (from primary to higher) are required to adequately respond to this challenge.

The analysis of the skills makes it possible to establish a correlation between the list that education as a whole and the educational ideals of science education should take into account. The vast majority of skills recognized by economists and education experts are formed based on science education for their traditional purposes: mathematical skills, scientific literacy, ICT skills, critical thinking and problem-solving skills, collaboration, curiosity, and others. However, the set of knowledge, opportunities and skills that are important today is changing dynamically and is a subject of constant debate. That is why the educational system, focused on the current needs of the job market, is doomed to continuously lag behind. Traditional education, which is aimed at providing a set of knowledge (static approach), at the best case – at finding data and making informed decisions – will not be effective in the age of high demand for a scientific type of thinking to ensure science-driven social architecture. The large community of researchers and a number of leading global organizations see science education as an effective strategy for preparing young people for an active life in Industry 4.0 economy.

Science education, as a staff training concept, aims at fostering a new generation of scholars, based on specific methodologies, methods, forms of training and curricular content. The teacher does not act as the sole source of information that should pass it to students, but as a tutor who oversees the student research studies. The end result of such learning should be a new type of student thinking – when science is seen as a tool offered within the framework of the new agenda (Industry 4.0); it is a means of addressing the practical challenges of a particular individual, family, city, state, or more globally. Today, the global coordination of science education is carried out by the United Nations Educational, Scientific and Cultural Organization (UNESCO) among others. Back in 1972, UNESCO promoted the establishment of the International Council of Associations for Science Education (ICASE), the mission of which includes the dissemination and improvement of science education teaching methods worldwide. Today ICASE is a large network of scientific associations of

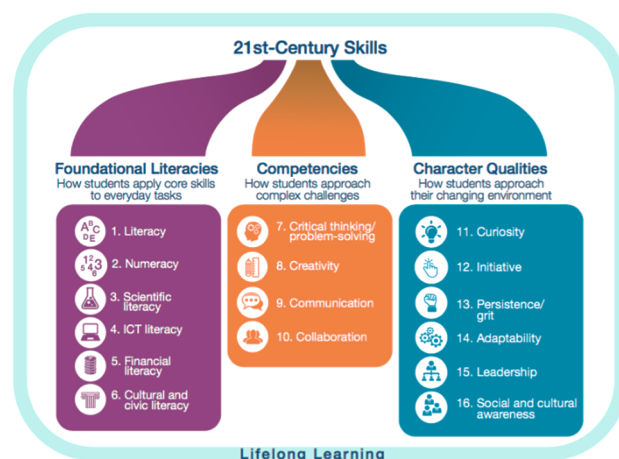


Fig. Sixteen skills for education in the 21st-century [13]

teachers, institutions, foundations and companies from more than 75 countries, including Ukraine, working together to promote science worldwide [14].

The Junior Academy of Sciences of Ukraine is engaged in the implementation of this model of preparing students for new socio-cultural and economic conditions in Ukraine. Currently, more than 250 000 students study at this institution. They participate in extracurricular research activities in 64 scientific fields. Having studied the efforts of the Junior Academy of Sciences of Ukraine at the end of 2017, UNESCO recognized the educational activities of the Junior Academy of Sciences of Ukraine in the field of science education as a leader in Eastern Europe. The 39th UNESCO General Conference adopted the resolution to establish the UNESCO Centre on the basis of the Junior Academy of Sciences of Ukraine.

The main purpose of the introduction of science education in the academic activity of the Junior Academy of Sciences of Ukraine is the development of the student scientific, design, inventive and technical literacy. The rigid disciplinary boundaries between such subjects as Geography, Biology, Chemistry and Physics, are 'softened' – interdisciplinary links are to a greater extent demonstrated in class. Taking into account the recognition by UNESCO, the Junior Academy of Sciences of Ukraine, in its practical activity is pursuing a transformative social mission: to design an effective future for prospective active members of society guided by global trends. In this context, science education should increase students' interest, based on their natural inclination to seek the meaning and understanding of the outside world, which became more complex in recent years. The study of science supports understanding by students of the important human desire for the knowledge of truth, through the systematic collection of data, their analysis and interpretation, with the subsequent use of advanced skills not only in work, but also in social activity. In this context, we believe that the implementation of the science education concept will allow us to prepare the carrier of the 21st-century skills – a socially proactive individual, armed with tools not only to fill in the job market and ensure the sustainable economic development, but also to realize his/her potential in the civilizational development of mankind.

As an example, let us consider some of the 'success stories' of the scientific projects developed by the students of the Junior Academy of Sciences of Ukraine in all-Ukrainian and international intellectual competitions. They may be considered as a sort of case-studies which confirm the feasibility of a number of statements made in this article.

Vadym Kontseba and Kyrylo Martyn won the first prize at *Startup Night Day'n'Nite* startup competition. The inventors demonstrated a device for the information support of skiers, which allows improving the safety characteristics (in case of avalanches, etc.): the invention of the development team allows measuring the exact coordinates and indicators of a holder's life, which are forwarded to the rescue services.

At the 29th *European Union Contest for Young Scientists* (EUCYS-2017), Yana Zhabura's project 'Improving Delta Robot Technical Capabilities' was awarded the second prize. Delta robot is a kind of mechanical manipulator, which is actively used in industry and other areas. The inventor has proposed a number of innovations for a robot design that can improve its performance and efficiency [15].

Viacheslav Antsybor and Natalia Monina are the winners of the *Intel-Techno Ukraine 2017–2018* competition. In particular, Viacheslav Antsybor proposed an author's project for the use of alternative energy sources in refrigerated semi-trailers, namely he justified the possibility of using solar panels to power the system of cooling the contents of refrigerators. Due to the fact that these technologies are unique to the modern industry, the author applied for a patent with the purpose of its further implementation.

Natalia Monina proposed an invention for generating electricity by solar panels located on railway tracks. The expe-

rience of solar panels use (outdoor installation on the lots suitable for agriculture purposes) demonstrates that it causes the soil degradation due to lack of sunlight. The author substantiated the prospects of installing solar panels between railways for preserving farmlands with minimum solar battery impact on the ecosystem. The author also applied for a patent for the invention.

In 2017, as part of the International *Business Cup Extreme* Competition, Ukrainian researcher Pavlo Mikush won first prize for his project: 'Universal Robotic Assistant for People with Visual Disabilities'. The success of the inventor stems from the fact that his device helps people with visual impairments to feel more comfortable in the local conditions with many stairs, underpasses and others. The device is equipped with state-of-the-art communication and GPS integration tools, providing a high degree of autonomy for the user with special needs.

The success of projects by young people involved in science education practices shows that science education, as a basic concept of educational activity, has a positive impact on both the personal development of young scientists and various scientific and economic spheres in our country. In addition, we can see that science education responds to the Fourth Industrial Revolution's demands for the spread of robotics, artificial intelligence, and others. In science education, young inventors may bring their inventions to the level of patents or start-ups, enhancing productive links with modern knowledge-based economy.

Science education approaches are recognized in the world as an effective tool for engaging creative youth in active social changes of the modern world, both globally and nationally. This is also emphasized in a recent report by the European Commission 'Science Education for Responsible Citizenship' (2015), which states that science education promotes a culture of scientific thinking and inspires citizens to use evidence-based analysis to make decisions; helps to provide citizens with the knowledge, skills and confidence to take an active part in the world life built on complex scientific and technological principles; facilitates the development of problem-solving and innovation skills, as well as the analytical and critical thinking necessary to enable citizens to live an informed, socially responsible and professionally active life; inspires children and students of all ages and abilities to build a future career in the natural sciences or another professional spheres [16]. Based on the methodological guidelines of the article (Code of Publication Ethics, and others), the authors tried to disengage from evaluation judgments, not to offer the concept of science education as a 'panacea' for modernization projects in the field of Ukrainian education.

Conclusions. The article analyses the negative trends in the Ukrainian economy, whose integral indicators include the level of the human capital development, global competitiveness, and so on. Unfortunately, our country demonstrates demodernization trends caused by a wide variety of factors, each requiring a separate study. The authors of this article illustrated the institutional inability of modern domestic education to respond adequately to the complex challenges of the Industry 4.0 economy. The article shows that modern advanced educational systems feature a number of 21st-century skills as an educational ideal, and these very systems, over the past decades, have modernized education towards the implementation of science education approaches as a recognized trend for education in the new century.

The analysis of the Ukrainian experience in the implementation of science education demonstrates the positive dynamics in the spread of modern educational practices that resonate with the economic and managerial trends of the present time. The dissemination of science education ideas is one of the strategies for refocusing the future training system for today's global job market, the science-intensive and technologically rich human development agenda offered by the Industry 4.0 concept.

The research nature of learning and group-based scientific activity contribute to the motivation for work, success, focus on socially significant goals, partnerships and social responsibility [17]. Science education fosters in young people the skills of independence in defining goals and objectives, which is crucial for the development of innovative thinking and economic behaviour. Consequently, science education aims at cultivating students' curiosity, teaching to think as an innovator and scientist, shifting the educational focus from the study of particular facts and theories to the formation of skills of applying this knowledge in future for addressing specific applied problems. The analysis of EU education policy (European Commission's Report 'Science Education for Responsible Citizenship' (2015), and others) demonstrates not only the pragmatic dimension of the need for educational transformation on the basis of science education (matching the job market demands, etc.), but also asserts the potential of science education in the context of providing learners with real tools for active citizenship, inclusion in the processes of civilization progress in terms of innovation, helping them to become real participants of socio-economic and socio-cultural transformation process of Industry 4.0 age.

References.

- Schumpeter, J. A. (2017). *Theory of Economic Development*. Imprint Routledge. <https://doi.org/10.4324/9781315135564>.
- Drucker, P. (2012). *The Practice of Management*. Imprint Routledge. <https://doi.org/10.4324/9780080942360>.
- Fukuyama, F. (2014). *Political Order and Political Decay: From the Industrial Revolution to the Globalization of Democracy*. Farrar, Straus and Giroux.
- Hladchenko, M., Dobbins, M., & Jungblut, J. (2018). Exploring Change and Stability in Ukrainian Higher Education and Research: A Historical Analysis through Multiple Critical Junctures. *Higher Education Policy*. <https://doi.org/10.1057/s41307-018-0105-9>.
- Fotea, A., & Gutu, C. (2016). Historical and Theoretical Framework of the Relation between Higher Education Institutions and the Process of Regional Economic Development. *Entrepreneurial Business and Economics Review*, 4(1), 23-42. <https://doi.org/10.15678/EBER.2016.040103>.
- Oleksiyenko, A. (2014). Socio-economic forces and the rise of the world-class research university in the post-Soviet higher education space: the case of Ukraine. *European Journal of Higher Education*, 4(3), 249-265.
- Kyvliuk, O., Polishchuk, O., Svyrydenko, D., & Yatsenko, O. (2018). Educational management as education diplomacy: strategies for Ukraine. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, (3), 139-144. <https://doi.org/10.29202/nvngu/2018-3/23>.
- Hladchenko, M., & Vossensteyn, H. (2019). Ukrainian students' choice of university and study programme: means-ends decoupling at the state level. *Quality in Higher Education*, 1-22. <https://doi.org/10.1080/13538322.2019.1634878>.
- The Global Competitiveness Report 2018. Performance overview for Ukraine* (n.d.). Retrieved from <http://www.reports.weforum.org/global-competitiveness-report-2018/country-economy-profiles/#economy=UKR>.
- Benešová, I., Smutka, L., & Laputková, A. (2018). Specifics of the Mutual Trade of the Post-Soviet Countries. *Entrepreneurial Business and Economics Review*, 7(1). <https://doi.org/10.15678/EBER.2019.070102>.
- Human Development Indices and Indicators: 2018 Statistical Update* (n.d.). Retrieved from http://hdr.undp.org/sites/default/files/2018_summary_human_development_statistical_update_en.pdf.
- The Future of Jobs* (n.d.). Retrieved from <https://www.weforum.org/reports/the-future-of-jobs>.
- 16 Skills for 21st-century education* (n.d.). Retrieved from <http://www.tomorrowtodayglobal.com/2016/04/25/16-skills-21st-century-education>.
- ICASE: International Council of Associations for Science Education* (n.d.). Retrieved from <https://www.icasonline.net/link2.html>.
- EUCYS-2017: Ukrainian students were honored with three European awards* (n.d.). Retrieved from http://man.gov.ua/ua/news/academy_news/mizhnarodni--zdobutki-br-eucys-2017--ukrayinskikh-uchniv-vidznacheno-troma-evropeyski-mi-nagorodam.
- Science Education for Responsible Citizenship. Report to the European Commission of the expert group on science education* (n.d.). Retrieved from http://ec.europa.eu/research/swafs/pdf/pub_science_education/KI-NA-26-893-EN-N.pdf.
- Czyż, A., & Svyrydenko, D. (2019). Science Education as a Response to the Needs of the Modern Open "Education for Everyone" System. *Future Human Image*, 11, 14-21. <https://doi.org/10.29202/fhi/11/2>.

Наукова освіта в добу Industry 4.0: виклики економічному розвитку та зростанню людського капіталу України

С. Довгий¹, В. Небрат², Д. Свириденко³, С. Бабійчук³

1 – Мала академія наук України, м. Київ, Україна, e-mail: pryjmalnya@gmail.com

2 – Інститут економіки та прогнозування НАН України, м. Київ, Україна, e-mail: victoria_nebrat@ukr.net

3 – Національний педагогічний університет імені М.П. Драгоманова, м. Київ, Україна, e-mail: denis_sviridenko@ukr.net

Мета. Узагальнення досвіду реалізації підходів наукової освіти в Україні, що враховує необхідність подолання кризових явищ у сучасній економіці, зокрема, щодо відповідності сучасної української системи підготовки кадрів світовим тенденціям, концептуалізованих у теоретичних положеннях теорії Industry 4.0.

Методика. Виходячи із факту негативної динаміки показників розвитку української економіки, автори пропонують верифікацію потенціалу наукової освіти як стратегії модернізації освіти для забезпечення нею ролі у формуванні навичок для XXI ст. Виходячи із кореляції між наявністю запиту на розвиток навичок для XXI ст. у контексті вимог сучасної економіки та можливостями наукової освіти як визнаної сучасної освітньої стратегії, автори намагаються обґрунтувати відповіді на виклики економічного розвитку та розвитку людського капіталу України. Застосовані теоретичні (аналіз, синтез, систематизація, узагальнення) та емпіричні (спостереження, порівняння) методи дослідження.

Результати. Аналіз негативних тенденцій у вітчизняній економіці (показники розвиненості людського капіталу, глобальної конкурентоспроможності тощо) дозволив обґрунтувати тезу щодо низької інституційної спроможності сучасної вітчизняної освіти надавати адекватну відповідь на складні виклики економіки Industry 4.0. Аналіз українського досвіду реалізації наукової освіти продемонстрував позитивний ефект від поширення сучасних освітніх практик, що резонують з економічними та управлінськими трендами сучасності.

Наукова новизна. Вдалося обґрунтувати підхід, відповідно до якого поширення ідей наукової освіти є однією із стратегій переорієнтації української системи підготовки майбутніх кадрів для сучасного глобального ринку праці, наукомісткого й технологічно насиченого порядку денного розвитку людства, пропонованого концептом Industry 4.0.

Практична значимість. Продемонстровані практичні приклади реалізації підходів наукової освіти, їх орієнтованість на розвиток навичок XXI ст. та на включення до

сучасних економічних процесів. Дослідження продемонструвало не тільки прагматичний вимір потреби у трансформації освіти за принципами наукової освіти (відповідність запитам ринку праці тощо), але й потенціал наукової освіти в контексті забезпечення суб'єктів навчання реальними інструментами для активного громадянства, допомагаючи їм поставати реальними учасниками соціально-економічних і соціокультурних трансформацій доби Industry 4.0.

Ключові слова: економічний розвиток, Industry 4.0, людський капітал, інноваційна економіка, наукова освіта, ринок праці XXI ст.

Научное образование в эпоху Industry 4.0: вызовы экономическому развитию и росту человеческого капитала Украины

С. Довгий¹, В. Небрата², Д. Свириденко³, С. Бабийчук³

1 – Малая академия наук Украины, г. Киев, Украина, e-mail: pryjmalnya@gmail.com

2 – Институт экономики и прогнозирования НАН Украины, г. Киев, Украина, e-mail: victoria_nebrat@ukr.net

3 – Национальный педагогический университет имени М.П. Драгоманова, г. Киев, Украина, e-mail: denis_sviridenko@ukr.net

Цель. Обобщение опыта реализации подходов научного образования в Украине, который учитывает необходимость преодоления кризисных явлений в современной экономике, в частности, соответствия современной украинской системы подготовки кадров мировым тенденциям, концептуализированных в теоретических положениях теории Industry 4.0.

Методика. Исходя из факта негативной динамики показателей развития украинской экономики, авторы предлагают верификацию потенциала научного образования как стратегии модернизации образования для обеспечения ним роли в формировании навыков для XXI века. Исходя из корреляции между наличием запроса на развитие навыков для XXI века в контексте требований современной экономики, и возможностями научно-

го образования как признанной современной образовательной стратегии, авторы пытаются обосновать ответы на вызовы экономического развития и развития человеческого капитала Украины. Применены теоретические (анализ, синтез, систематизация, обобщение) и эмпирические (наблюдение, сравнение) методы исследования.

Результаты. Анализ негативных тенденций в отечественной экономике (показатели развитости человеческого капитала, глобальной конкурентоспособности и т.д.) позволил обосновать тезис о низкой институциональной способности современного отечественного образования предоставлять адекватный ответ на сложные вызовы экономики Industry 4.0. Анализ украинского опыта реализации научного образования продемонстрировал положительный эффект от распространения современных образовательных практик, которые резонируют с экономическими и управленческими трендами современности.

Научная новизна. Удалось обосновать подход, согласно которому распространение идей научного образования является одной из стратегий переориентации украинской системы подготовки будущих кадров для современного глобального рынка труда, наукоемкой и технологически насыщенной повестки дня развития человеческого капитала, предлагаемой концептом Industry 4.0.

Практическая значимость. Продемонстрированы практические примеры реализации подходов научного образования, их ориентированность на развитие навыков XXI века и на включение в современные экономические процессы. Исследование показало не только прагматическое измерение потребности в трансформации образования на принципах научного образования (соответствие запросам рынка труда и т.д.), но и потенциал научного образования в контексте обеспечения субъектов обучения реальными инструментами для активного гражданства, помогая им стать реальными участниками социально-экономических и социокультурных трансформаций эпохи Industry 4.0.

Ключевые слова: экономическое развитие, Industry 4.0, человеческий капитал, инновационная экономика, научное образование, рынок труда XXI века

Recommended for publication by V. M. Feshchenko, Doctor of Economic Sciences. The manuscript was submitted 27.03.19.