

# *University 4.0: new education technologies in the digital economy*

Gurieva L.K.

North Ossetian State University  
Financial University under the Government of the Russian  
Federation (Vladikavkaz branch)  
Vladikavkaz, Russia  
443879@mail.ru

Btemirova R.I.

Financial University under the Government of the Russian  
Federation (Vladikavkaz branch)  
Vladikavkaz, Russia  
btemr@yandex.ru

Kovaleva M.A.

Financial University under the Government of the Russian  
Federation (Vladikavkaz branch)  
Vladikavkaz, Russia  
mary\_kovaleva@list.ru

*Abstract* — The new, often called the fourth, industrial revolution, which is often named “Industry 4.0”, is a quite expected event, which is systematically and sufficiently detailed described in the forecast studies of scientists from many countries starting from the beginning of the 20th century.

Defining the concept of the economy in the framework of Industry 4.0, we can note its main features: digitalization of products and services; digitalization and integration of vertical and horizontal value chains; digital business models and customer access through digital platforms. In fact, we are talking about the mass introduction of cyberphysical systems (CPS) based on the Internet of Things (IoT), self-regulating printing electronics factories in three-dimensional printing (3D), big data (BD) and the widespread adoption of artificial intelligence (AI) technologies.

Digital technologies are not being implemented in a fragmented way, but in a systematic way: not only in the production of material goods, but also in almost all spheres of society and the individual, including his work, education, life, and leisure. All these closely related digital technologies are the prerequisites for the coming digital revolution, and more precisely, digital technologies determine its essential characteristics, so we can conclude that the world is entering the digital age. In this regard, the training of specialists who are ready to work in the conditions of the wide and continuous development of digital technologies has been put into practice in universities not only developed but also in developing countries, and the model of a digital university (University 4.0) is being implemented with the support of leading digital companies. However, as the analysis conducted by the authors showed, the current system of university education in many countries, including Russia, despite the introduction of information and communication technologies, is still behind the needs of the emerging digital economy. And even in the leading universities of the world, while training specialists who are ready to effectively work with digital technologies for humanity, especially AI technologies, little attention has been paid to the mental and psychological factors of a new generation of future specialists who are ready to use these technologies effectively and safely for humanity.

The article presents the results of a study of new socio-technological factors that will affect the educational technologies of University 4.0.

*Keywords* — digital economy, digital society, educational technologies, development prospects of the University 4.0.

## I. INTRODUCTION

The task of changing the paradigm of higher education is facing the world community as acute as possible. In the digital age, everything is changing: the speed of goods movement and banking transactions, the methods of communication and presentation of information, the level of trust in government bodies and international laws, and the methods of producing material goods and intangible services are changing before our eyes. According to global forecasts, by 2030 year 60% of all professions in the world will be automated, about 50 million new jobs will appear in the field of information technology (IT), and 375 million people in the world will need to master digital skills due to the fact of production automation [1]. At the same time, the higher education system – even at the leading universities of the world – like any sustainable system strives for self-preservation and balances on the threshold of the last century: classical, stable and academic, it focuses on the medium-term demand of the labor market, but not on the global challenges, associated with the unpredictability of the impact of technology on social progress and threats of emergence of economic phenomena in fundamentally new class, that the world community faces.

It should be noted that the inadequacy of higher education to future changes in society, the inevitability of its qualitative transformation is discussed by experts from the beginning of the 2000s. So, professor D. Jacobs wrote back in 2006: “It has long been believed that getting an education is important for self-improvement and good for raising living standards. However, education and diploma do not necessarily mean the

same thing. Not education, but the issuance of diplomas turned into the main task of the university in North America. ... Neither ability nor the level of knowledge matter” [2, p. 69]. In Russia, as in many countries, “university education has become an industry. Administrators and legislators have been searching for ways to scale it up... Measuring the increase in the number of diplomas issued is much easier than the number of educated graduates. Quantity triumphs over quality,” – continues D. Jacobs [2, p. 69]. It is written about higher education in Canada and the United States fifteen years ago. But an expert from any country who is familiar with the realities of national higher education is unlikely to give a different overall assessment. Thus, the issues of reforming higher education are currently relevant around the world. And this, as rightly pointed out in his Russian edition of “The End of a Familiar World: Sociology of the 21st Century,” I. Wallerstein, is a global systemic problem, because “...self-sustaining systems are destroyed from time to time. They are destroyed due to their complex nature and due to the fact that the processes occurring in them with time more and more take them out of equilibrium. Ultimately, the trends manifested in their development bring to the point of bifurcation, and chaotic shifts mediate a painful transition to a new system order, the main features of which can never be foreseen” [3, p. 3].

The global technological changes of the fourth industrial revolution will inevitably lead to the transformation of the university education system, on the one hand, but they will also affect the worldview, thinking and behavior psychology of the new generation of university students, on the other hand. Without a systemic transformation of educational technologies and the subject of the impact of these technologies – students – the success of future universities is doubtful. At the same time, the existing works do not adequately reflect the problem of the correspondence of the new educational technologies of the university of the future and the socio-psychological characteristics of 21<sup>st</sup> century students.

## II. RESEARCH METHODS

Modern universities are characterized by a fairly wide variety, which involves the determination of methods for their research that are adequate to the purpose of this article.

Due to the uneven development of countries and regions, the general typology of universities allows them to be classified in an evolutionary context from relatively simple to complex. Based on a systematic approach, we consider only those typologies that correlate universities as educational organizations with the level of scientific and technological development of the national economy.

Available studies present different criteria typologies of universities. In some works, the main emphasis is on the characteristics of the scientific and educational environment, the availability of knowledge and the development level of research [4]; in other typologies, universities are evaluated by the degree of influence of the university on the development of science, technology, the state and society (according to the “triple helix” model) [5]; thirdly, the main criteria for classifying a university as one or another type is the criterion

for the significance of the added value they form [6]. Within the framework of this approach, the concept of the transformation of the university model from “University 1.0” to “University 4.0” is being developed, which has received wide recognition and international popularity in recent years. In the framework of this concept, it is considered that:

- University 1.0 is a social institution that implements the function of education. It is effective in transmitting knowledge, developing students' talents, training personnel (oriented to traditional sectors of the economy), and able to act as a social elevator;
- University 2.0 is an institution of society that implements, along with the educational, research function. A classical university in the spirit of the Humboldt University: capable of generating new knowledge through research activities; has competencies as a center for consulting services for market players; carries out research on industry orders, creates technologies for partners, is not able to manage intellectual property; capable of commercializing knowledge in the R&D format;
- University 3.0 is a social institution that implements, along with educational and research functions, the function of technology transfer and delivery to end users. “University 3.0” has an effective process of technology commercialization (including through a well-developed policy on working with the university’s intellectual property), it has developed an entrepreneurial culture, created technology startups, registered patents for the university (which can later be sold to partners, or individual rights can be transferred based on licensing agreements), the university is able to establish an effective dialogue with representatives of the business community (it promptly responds to release of new specialists that meet market expectations and implements research in areas of interest to industry representatives, so the University of 3.0 is often positioned as a corporate entity of Knowledge Economy) [5];
- University 4.0 is an institution of society designed by the intellectual elite that implements the function of a provider of knowledge about the future. University 4.0 will become a leader in the development of high-tech industries; it will be able not only to maximize the effectiveness of the capitalization of its own knowledge, but also create, in close partnership with companies, government agencies and other organizations, future markets and new ecosystems. Therefore, when moving from University 1.0 to University 4.0, the level of “redistribution” of talents and knowledge increases: more and more surplus value is produced on the university campus, and not transferred to the economy in the form of “semi-finished products”: specialists and general knowledge.

Attention should be paid to the two fundamental differences in the methods of our research:

1) some researchers associate the digital prefix 1.0 - 4.0 not with technological revolutions, as the authors of this article believe, but with the number of university missions: "University 1.0 is only an educational institution, University 2.0 is aimed at teaching and research; at University 3.0, the commercialization of knowledge is added to the last two missions" [7].

2) despite the evolutionary nature of the methodology of the "University 1.0–4.0" concept, its authors consider students to be a product and not a resource of the educational system, which, in our opinion, is incorrect. Unlike other authors, we believe that the evolution of educational technologies from University 1.0 to University 4.0 inherently involves changes in the object of influence – students, whose socio-psychological and mental characteristics are also evolving.

Thus, in this study, the authors applied a systematic methodology and, firstly, considered University 4.0 as a model of the university in the digital economy, and secondly, they accepted that the educational technologies of University 4.0 will be influenced not only by information technology, but also socio-psychological determinants of a digital society.

### III. THE RESULTS OF THE STUDY

Obviously, the development of the digital economy will be based on an information technology concept, which implies the integration of computing resources into physical entities of any kind, including biological and man-made objects. It is also obvious that the introduction of CPS, IoT, AI technologies will change entire industries and countries at different speeds and in different directions. Broad product industries such as automotive and food, benefit from digital agility and explosive productivity growth. High-quality industries such as electronics and pharmaceuticals benefit from the use of big data and analytics, and the continuous improvement of product quality and functionality. Developed countries, with the high cost of skilled labor, can take advantage of the growing demand for skilled workers. Developing countries, with young people with IT skills, can jump over several technological steps and create completely new manufacturing concepts in the digital economy. [8, p. 2].

A generalization of the results of global research allows us to conclude that, due to the influence of the external environment, the educational path of higher education is changing, the digital environment, taking into account the requirements for new professions, is changing the values of the young people generation, the orientation of students towards applied sciences, specific skills and practice prevails. Professions appear faster than educational programs are developed and formed for them [1]. Assuming that higher education in the digital age should be seriously transformed, and enumerating the possible directions for this transformation, researchers cannot yet form an integral picture of how higher education will look in the future.

For example, experts from different countries are looking for an answer to the question of how artificial intelligence will

be understood at University 4.0. And, indeed, although artificial intelligence technologies have long gone beyond the purely IT sphere and today they are one of the key components of the course towards building the digital economy of many countries, including Russia, and the term "artificial intelligence" has long become rather commonplace, its content is quite vague, as a result of which it often turns out that when using it, different things are implied. For example, in the most high-tech bank in Russia – Sberbank – they conducted a large-scale study of this issue, as a result of which three main signs of artificial intelligence were identified: imitation of human intellectual activity to develop decisions on a particular issue (or recommendations for making such decisions), the ability to learn (improve the quality of decisions based on the analysis of new information) and focus on specific areas of application. We believe that we can offer such additions to this definition of AI: "algorithms that themselves allow you to create new efficient algorithms" and "technologies for creating new knowledge" [9].

From an interview with G. Dyakonov, director of the Russian company Ntechlab, which develops AI technology, we can conclude that "artificial intelligence is decision making in order to relieve responsibility from a person". When answering the counter-question: "And who will be responsible for the decisions made?" (Including, for example, in case of violation of traffic rules by an unmanned vehicle or its participation in an accident) and the discussion that followed, it was suggested that in the end, some specific people should be responsible for AI decisions, although how to identify those responsible is not a simple question and will certainly require some correction of the legislative framework [9].

Director of the Deloitte Institute for Applied Data Analysis A. Minin believes that humanity is only at the very initial stage of creating machine analogues of human intelligence, but the fact is that even those technologies that have already been created can solve problems that a person still has were unavailable. In such a situation, the search for some precise and unambiguous definition is not the best waste of the mental efforts of experts, and it would be much more useful to show the capabilities of new technologies – whatever they are called – using concrete examples [9].

The authors of this article are far from claiming universal solutions, but it can be concluded that there is no single holistic understanding of AI as the result of the fourth industrial revolution. Guided by one of the basic principles of cybernetics: measuring means controlling, therefore, it is still difficult to determine the main characteristics of the University 4.0, and only its contours can be described in the framework of Industry 4.0.

And taking into account the focus of AI technologies on reducing the role of the human factor in decision making, we can conclude that the infantilism of University 4.0 students will increase.

Even today, when teaching masters, and especially bachelors, we are dealing with people who identify themselves as "children". The age of maturity of individuals from the

beginning of the 2000s grew sharply, moving from 20 years to 30 years and above – just in time for the end of their fertility period. Forty-year-old balding, unemployed (“they are looking for themselves!”) children living with mom and dad are now the standard situation for most countries in Europe and America. For example, the Regnum agency reports: “66.4% of Italians aged 18 to 34 continue to live with their parents. On average, in the EU, a similar indicator is 50%. Higher than in Italy, it is only in Croatia, in Malta and in Greece” [10]. This is not bad neither good, it is just an objective fact.

According to the authors, the vivid psychological traits of student infantilism in modern Russian universities are the growing irresponsibility: adult “children” are not used to responsibility. So, if the work is not done by the deadline, in real life you will be fired from your job, and the student at the university will only have a slight censure. However, if a person has no responsibility – there can be no entrepreneurial spirit. As a result, “children” do not keep their word: it is difficult to reflect in competencies, but in real business, such a habit of “gave the word – the word took” will serve the graduates in a bad way. As another consequence, “children” are indifferent to the result of anything. The child is usually passionate about the process, which gives him pleasure or arouses interest, and tries to ignore manipulations that are not fun. In our opinion, for the most part, this is precisely why in high school students ceased to experience true pleasure from finding the right answer when solving practical problems and mathematical calculations that do not have a computer application.

The growing irresponsibility of students, expressed in indifference to the quality of learning outcomes, is complemented by a second, no less important psychological characteristic of adult “children” infantilism: a new generation of students has clip consciousness, poor memory and distracted attention. They do not perceive large volumes of information and hardly understand new material if they did not manage to “switch from the previous wave”. Teachers of different universities who teach different disciplines note that they have to repeat many times at the calculation seminars the explanation of the same even the simplest new formula, and solving complex problems using power and logarithmic formulas without a calculator slows down their general psychomotor. As an experiment, we asked the first-year students of three universities of seven specialties the question “How should classes be held so that you better understand the material?” The vast majority of respondents – about 55% – chose the answer “Classes should be quick, not boring and with repetition of the same material”.

The third most important psychological characteristic of students is total dependence on gadgets, which have become part of not only their personality, but also health. Depriving a student in the classroom of a smartphone / tablet leads the student to a state of anxiety and discomfort, as if he had experienced an attack of malaise or was morally humiliated. Despite the fact that most students use an extremely limited amount of capabilities of modern smartphones: V Kontakte, Viber, WhatsApp, Instagram, YouTube and etc. They practically do not have the skills of targeted Internet surfing and

do not learn anywhere else, although such a discipline should certainly be introduced for any specialty in the first semester. Only a few of them are logged in online library systems.

The fourth basic psychological characteristic of a new generation of students is their desire for complete Internet transparency. And an excessive digital presence leads to a psychological lack of “privacy”, which forces youth representatives to independently display their thoughts, photos and videos on numerous social networks. A person in the world “without personal space” eventually ceases to feel embarrassed for his bad thoughts and actions, and universal attention to them stimulates the repeated actions of deviant behavior, which erases the ethical standards of society and the moral principles of the individual.

Of course, these four characteristics do not constitute a complete list, but they are the factors that will affect the effectiveness of training, the quality of educational technologies and the teaching processes of the university of the future.

As noted above, the younger generation is already spending a significant part of their lives in online games. Games became their life, virtual reality dominates offline in the sense of colorfulness and emotional richness. Therefore, the authors believe that educational technology in the digital environment will be a carefully designed virtual reality. This should be a uniform game for all university students, a large, very expensive and graphically perfect game, with the ability to change certain settings by a third-party administrator (teacher). A game that will last all four years of undergraduate studies, in which theoretical knowledge in each of the studied disciplines will be tested by virtual practice. This game should develop in real time, when the consequences of decisions will overtake the learner at about the same time as in the real economy. All the necessary knowledge for training accountants and financiers, for example, is easy to program. Correctly calculated cash flows in an investment project – premium. Not calculated financial risks – a fine. He did not send a report to the IFTS in time – a fine, hid the income – removing the competency category. After gaining the required number of points, the student will receive credit for the semester. And the successful completion of the game and the end-to-end rating table will allow you to set the final grade. The game must daily upload the latest legislative, financial, political and demographic data to the database and introduce an element of chance into the actions of counterparties (illness, vacation, accident, bankruptcy, etc.). The actions of all students “assigned” to the same virtual environment of the digital economy or digital society should be visible to all interested parties: this will help to solve educational problems between future specialists offline, as well as take advantage of the teacher’s advice (even online). Naturally, the game should be compatible through applications with all smartphone systems. As in real life, a student should “not leave” the university from morning to evening, solving virtual tasks tied to many players. And this will be the most useful for education use of personal gadgets.

#### IV. DISCUSSION OF THE RESULTS

The authors believe that such a digitalization of the higher education system would largely satisfy the technological capabilities of the university of the future and would correspond to the listed psychological characteristics of the new generation of students.

We believe that the proposed design for future higher education is real. Moreover, in our life today something similar is already being realized. So, Tomsk State University together with its partner, IT company Rubius, are launching a large-scale digital project – Virtual University 4.0 [11].

There are few multidisciplinary VR / AR laboratories in the world. No one has created them in Russia yet. Separate modules exist in Moscow, St. Petersburg, and the Far East. Tomsk claims to become a leader in the field of virtual education. At the Virtual University, students will be able to work with interactive 3D-models of equipment and practice the mechanics of important processes, and teachers will be able to create interactive courses based on a library of models and tools.

The idea of the Virtual University 4.0 project (VU 4.0) is to create an open IT platform for developing high-tech products (applications and services) in a wide range of subject areas – from innovative education to the interactive entertainment industry. Along with education, immersive technologies (virtual and augmented reality VR / AR) and products created using digital tools will be used for scientific and industrial purposes. Within the framework of Virtual University 4.0, a master's program with a profile of “Virtual and Augmented Reality” is launched, and a laboratory of virtual and augmented reality is created. It will be equipped with advanced equipment for the production of a wide range of 3D content. Students will be able to work with interactive 3D-models of equipment, practice the mechanics of important processes, and gain access to the widest possible range of training materials through their smartphones and tablets. In the future, using an open platform, teachers will be able to create interactive educational courses on the basis of a library of models and tools.

Along with the creation of innovative educational content, Virtual University 4.0 plans to train professionals capable of creating new VR / AR solutions and devices for configuring a virtual environment. The first virtual university pilot project is dedicated to online learning. Rubius programmers and researchers from the “Institute for the Digital Age Man” VU 4.0 will work on it. Another pilot project of the “Virtual University” is “Simulator for working with high-tech medical equipment”, which units of the “Institute of Biomedicine” VU 4.0 are equipped with. The simulator will allow visitors of the virtual laboratory to get acquainted with the unique devices that TSU scientists use to develop new methods for diagnosing and treating various diseases. More advanced users will be able to learn how to use this equipment, and high-level specialists will be able to conduct research. Developers are considering an option in which the researcher can work in virtual reality in tandem with a partner. VR laboratory will significantly expand the opportunities for acquiring new professional skills, save the user from financial and time costs, because for carrying out a

scientific experiment, you do not need to buy reagents, equipment, etc. This may be especially true for chemists, materials scientists and many other scientists.

#### V. CONCLUSION

The results of a study of the prospects for creating new educational technologies in the digital economy showed that the creation of models for the future university – University 4.0 – should be ahead of the digital economy technologies development by accumulating a large body of knowledge through the use of cyber-physical systems and widespread adoption of higher education artificial intelligence technologies.

The development of educational technologies within the framework of the modern university evolution, by virtue of the systemic qualities of higher education, is imperative and objectively depends not only on the technologies of the fourth industrial revolution, but also on the changing socio-psychological appearance of young people. In the work, new psychological characteristics of the younger generation (infantilism and personal irresponsibility, clip thinking, poor memory and low concentration of attention, dependence on gadgets and a growing digital presence) that significantly began to decrease the effectiveness of higher education were highlighted.

The authors believe that in the models of the university of the future, it is imperative to take these and other psychological characteristics of young people into account as cognitively dominant, and suggest the contours of the project of higher economic education in the model of University 4.0.

The ideas expressed by the authors correlate with the content of the pilot Russian project “Virtual University 4.0”, which has been implemented at Tomsk State University since mid-2018.

Virtual and augmented reality technologies are qualitatively changing the market for educational services around the world. Their use helps to increase the speed of learning, individualize it and increase the involvement of students in the process by 70-80 percent. Consequently, further research and experiments on dynamic simulation of intelligent educational technologies of the University 4.0 project are needed.

#### References

- [1] L. Kleimenova, “Industry 4.0 in 20 Figures and Facts: According to PwC, McKinsey, Bloomberg, The Economist”, RBC: <https://www.rbc.ru/trends/industry/5daef6429a7947c1bfe43006>.
- [2] D. Jacobs “Sunset of America. Ahead of the Middle Ages”, Moscow: Europe, 2006.
- [3] I. Wallerstein, “The End of the Familiar World: Sociology of the 21st Century”, Moscow, Logos, 2003.
- [4] M. Gibbons, C. Limoges, H. Nowotny, S. Schwartzman, P. Scott, M. Trow, “The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies”, London: Sage, 1994.
- [5] H. Etzkowitz “The Triple Helix: University–Industry–Government Innovation in Action”, N.Y. and London: Routledge, 2008.
- [6] V. Trofimov, V. Kiyayev, S. Gazul, “Use of Virtualization and Container Technology for Information Infrastructure Generation”, In: Proceedings

of the 20th IEEE International Conference on Soft Computing and Measurements, SCM 2017 c. 788-791.

- [7] J. Lane, "Higher Education System 3.0: Adding Value to States and Institutions", In: J. E. Lane, D. B. Johnstone (eds.). Higher Education System 3.0: Harnessing Systemness, Delivering Performance. Albany, NY: SUNY Press, 2013, pp. 3–26.
- [8] R. G. Sanfelice, "Analysis and Design of Cyber-Physical Systems. A Hybrid Control Systems Approach", In: Cyber-Physical Systems: From Theory to Practice / D. Rawat, J. Rodrigues, I. Stojmenovic. – CRC Press, 2016.
- [9] A. Kolesov, "Experts Are Looking for an Answer to the Question of What is Artificial intelligence", ItWeek, 04/12/2019. <https://www.itweek.ru/ai/article/detail.php?ID=206572>.
- [10] Two-thirds of Italians Under the Age of 34 Live With Their Parents, IA REGNUM according to Eurostat, 17.12.2018. <https://regnum.ru/news/society/2539225.html>
- [11] TSU and Rubius created a virtual university 4.0 <http://www.tsu.ru/news/tgu-i-rubius-sozdali-virtualnyy-universitet-4-0>.
- [12] N.A. Mardeyan, J.R. Isakova, L.K. Gurieva, A.I. Pozmogov, "The Impact of Foreign Capital on the Russian Banking Sector", GCPMED 2018 - International Scientific Conference Global Challenges and Prospects of the Modern Economic Development, 2019, T. 57 Pp. 1090-1096.
- [13] O.N. Baburina, L.K. Gurieva, "Risks and Threats of The Marine Industry Functioning in the Conditions of the World Economy Digitizing", Marine Intellectual Technologies, 2019, T. 2, V. 2 Pp. 109-115.
- [14] L.K. Gurieva, I.S. Kobersy, D.V. Shkurkin, A.B. Bekmuhametova, O.V. Ignatyeva, "Intellectual property management system of market relations", International Journal of Applied Business and Economic Research, T. 15. № 12, 2017, Pp. 121-133.
- [15] L.K. Gurieva, A.I. Borodin, A.K. Berkaeva, "Management Model Transformation in the Digital Economy", In: Proceedings of the 1st International Scientific Conference Modern Management Trends and the Digital Economy: From Regional Development To Global Economic Growth (Mtde 2019), AEBMR-Advances in Economics Business and Management Research, 2019, T. 81 Pp. 383-387.