Teaching in the Fourth Industrial Revolution: Transition to Education 4.0*

Vadim Grinshkun[1[0000-0002-8204-9179]] and Elizaveta Osipovskaya[2[0000-0002-4192-511X]]

[1] Moscow City University, 2-Y Sel'skokhozyaystvennyy Proyezd, 4, 129226 Moscow, Russia
[2] Peoples Friendship University of Russia (RUDN University), 6 Miklukho-Maklaya St, 117198 Moscow, Russia
vadim@grinshkun.ru,e.osipovskaya@gmail.com

Abstract. The current study facilitates the discussion on implications of the Fourth Industrial Revolution (4IR) on education. World technological development and digitalization are unmistakable tokens of the 4IR, they will undoubtedly have a positive impact on transition to Education 4.0. Authors examines the key challenges and features of the 4IR for the Russian educational system. Researchers also consider how Big Data, Internet of Things (IoT), Artificial Intelligence (AI), automation, robotics, Virtual and Augmented Reality (VR/AR) are shaping the future of high-quality education. The paper builds on the World Economic Forum Education 4.0 framework that embraces eight critical characteristics in learning content and experiences: global citizenship skills, innovation and creativity skills, technology skills, interpersonal skills, personalized and self-paced learning, accessible and inclusive learning, problem-based and collaborative learning, lifelong and student-driven learning. Authors also emphasize eight examples of Russian universities and education programs that are paving the way toward Education 4.0. There is a definite probability that activating a new model of education will require greater endeavors of all stakeholders – students, educators, university administrators and officials.

Keywords: Fourth Industrial Revolution, Personalized Learning, Technological Revolution, Informational Revolution, Informational Technologies

1 Introduction

Information and communication technologies are changing the teaching and learning process, therefore, the higher education (HE) system should promptly adopt new advanced tools and know how to harness their power to train learners. Education 4.0 is a response to the needs of the 4IR where technological progress aligns with human needs.

Lifelong learning opportunities, quality and affordable education (along with the fight against hunger and environmental challenges) are the key priorities of the United Nations in 2020. UNESCO believes that inequality in education could be eliminated

* Supported by the Russian Science Foundation, grant No. 19-29-14146

Copyright © 2020 for this paper by its authors. Use permitted under Creative Commons License Attribution 4.0 International (CC BY 4.0).
Proceedings of the 4th International Conference on Informatization of Education and E-learning Methodology: Digital Technologies in Education (IEELM-DTE 2020), Krasnoyarsk, Russia, October 6-9, 2020.

CEUR-WS.org/Vol-2770/paper2.pdf

through the application of online technologies, namely, services for distance learning. The World Forum (WEF) released the Education 4.0 framework to respond to the needs of the modern economy. The program involves the launch of the international knowledge marketplace, where educators can create joint projects on online platform.

The growing labor-market skills gap changes the structure of the economy. WEF experts believe that automation will displace 75 million jobs globally by 2025 but create 133 million new ones [1]. They will be occupied by employees possessing digital skills, who are in a high demand among business now. Moreover, there is shortfall of almost 1 million tech professionals in Russia today. This may mean that educational system needs training and retraining programs supported by 4IR technologies.

2 Literature Review

It has become common today to describe technological progress through eras of technological revolutions. The expansion of mechanical production, precisely, steam engine, powered the 1st Industrial Revolution and enables massive increases of manufacturing. The 2nd Industrial Revolution is generally associated with new manufacturing technologies based on electricity. The 3rd Industrial Revolution is attributed to computerization and wide array of web-based resources.

The concept of the 4IR is widely discussed in literature [2, 3, 4], for instance, the most highly cited research is paper by Klaus Schwab [4]. The increase in research on the 4IR in HE gives the impression that a whole new field of study has emerged and blossomed over the past 10 years. However, there is no common definition of the 4IR, many scholars approach the concept from different methodological angles. For instance, it could be defined as a technology fusion that involves physical, digital and biological spheres [4]. Penprase asserts that the 4IR is a compounding effects of multiple "exponential technologies," such as AI, biotechnologies and nanomaterials. In the paper the researcher examines the impact of the 4IR on American education system and how liberal arts should respond to this new human condition [5]. Nancy W. Gleason reviews the multi-faceted strategy of Singapore's higher education in preparation for the 4IR [6]. Professor Yang P. et al deals with the complex relationships between the 4IR and HE through two phenomena: international student mobility and emergence of transnational HE industry in the context of Asia [7]. Lee R.M et al studies how design thinking method prepares China's students for the 4IR and whether China can innovate in a way that promotes future economic growth and employment [8]. There are researchers who open up a new direction in the 4IR by emphasizing how deep learning technologies are changing mining sector in South Africa [9]. James D. Basham et al sets out to analyse the impact of the 4IR on preparation of learners with disabilities [10].

3 4IR technologies in Education

The 4IR is generally associated with the fields of Big Data, IoT, AI, automation, robotics, VR/AR, 3D printing and quantum computing. These inventions are the move toward new technology-rich learning spaces, therefore, this allow us to talk about special activities that must be taken by HE system. In our study we examine each technology in the retrospect of educational process.

In the field of pedagogy, it is highly essential to provide teachers with information about process of extracting useful information from Big Data, processing activities and data protection rules. It might be valuable to track students' digital footprints in order to better understand their needs, interests, expectations, moods and optimize educational process and create personalized learning pathways.

IoT encompasses a set of advanced equipment (sensors), network-level connectivity architecture and smart devices that enable machines to interchange information. Advanced IoT products and solutions have great potential benefits for the HE, that is why it should be integrated into STEM (Science, Technology, Engineering, and Mathematics) core courses and vocational education and training.

The 4IR has also unleashed the mobile technologies. The proliferation of mobile devices leads to game-based learning. Today there are a lot of researchers that investigate the implementation of game elements into e-Learning environments. The incorporation of game elements into courses increases student engagement, motivates them to complete assignments, fosters collaboration, activates a competitive spirit and enhances their digital competencies [11].

The next technology is robotics, it is a factor of development engineering education today. Therefore, it is highly essential for the HE to launch programs to train teachers in engineering and robotics industries [12].

The 4IR has elevated the role of various simulations in both education and practical application. That is why it is highly crucial to develop programs aimed at training specialists for vocational education system in the field 3D technologies such as AR, VR and 3D printing. These technologies have a great impact on personalized learning offering new ways of visualization, memorization and observation.

Moreover, it is necessary to develop a qualitative understanding of quantum computing in mathematics and engineering students. We should emphasize that there is a great need in courses that cover the core principles in quantum mechanics, quantum computation and quantum cryptography.

Alongside with the study of the 4IR technologies' impact on the HE system there should be taken into account the influence of information revolution that is closely related to industrial revolutions [13, 14]. It is suggested to distinguish six information revolutions: the human speech (the possibility of information exchange between people who are not far from each other), writing system (the possibility of long-term storage of information), book printing (the possibility of replication, dissemination of information), electronic communication that embraces telephone, telegraph, television or gramophone recording (the ability to disseminate information freely and massively), computer technology (the huge capacity and versatility of information systems; information processing that includes acquisition, recording, organization, retrieval and

display of information), global computer networks (fast distribution of multimedia information at the global scale when the recipient has the opportunity to select it and verify).

4 The World Economic Forum Education 4.0 Framework

The WEF establishes eight critical characteristics in learning content and experiences based on 4IR technologies to promote "Education 4.0" [15]. We then illustrate the list of these characteristics with the examples of various Russian education programs:

1. Global citizenship skills – content that focuses on building awareness about challenges on a global scale (climate change, civic engagement). For instance, Russian government promotes global citizenship by organizing the Interuniversity Ecological Cup. It is a platform for communication between students, representatives of business, government and public organizations about issues in the fields of environmental science and protection.
2. Innovation and creativity skills – content that fosters innovation and creativity skills. State-owned Russian banking and financial services company Sberbank is noted for a lot of events and initiatives in this sphere. For example, it held the championship for students "Sberbank challenge cup". Participants developed projects of how to feel safe and comfortable in the urban environment by using products of Sberbank ecosystem.
3. Technology skills – content that is based on developing digital skills, including computer programming and the use of technology. Ministry of Digital Development, Communications and Mass Media of the Russian Federation launched program for improving students' digital literacy skills in leading universities. Another example is the cooperation between business and education institutions. Russian multinational technology company Yandex and the Higher School of Economics formed a computer science faculty to increase the efficiency of business operations. Students learn Big data technology along with machine learning algorithms.
4. Interpersonal skills – content that focuses on interpersonal emotional intelligence, including empathy, cooperation, negotiation, leadership and social awareness. At Peoples' Friendship University of Russia there are a lot of science and social events that emphasize cultural diversity where students can train and improve communication skills.
5. Personalized and self-paced learning – content that is based on the diverse individual needs of each learner and flexible enough to enable student to progress at their own pace. The School of Advanced Studies at the University of Tyumen is best known educational institute in Russia that offers students personalized learning pathways that fit their objectives, interests, and needs.
6. Accessible and inclusive learning – increasing accessibility in learning by shaping more inclusive education. Ural Federal University, for example, offers students various forms of education: blended learning, MOOCs by UrFu and even online

courses of partner institutions. The presence of diversity and inclusion encourage active learning.

7. Problem-based and collaborative learning (PBL) – implementation of collaborative projects to create solutions to real-world challenges. PBL teaching method is widely spread in Russian medical universities, because this profession require hands-on learning and realistic learning scenarios.
8. Lifelong and student-driven learning – it focuses on the joy of learning, rather than the pressure of assessment. The supreme example of this characteristic is learning management system "School digital platform" created by Sberbank. The LMS motivates learners and boosts their engagement.

5 Results and Discussion

Today is quite difficult to predict what exactly will be in the core of the next industrial revolution. In our view, the next revolution will be based on machine translation engines supporting multiple languages (the ability to remove linguistic boundaries form between areas where people speak different languages; information as a unified international resource). Such systems are available to everyone now, and their standards of performance have been constantly improved. It should be noted that the emergence of such systems can be fully attributed to the third technological revolution, but by the nature of its development and spread it can be included in the 4IR. The usage of such information technologies could make a significant contribution to the personalized learning pathways at all levels of education.

Speaking about the HE challenges in the era of the 4IR we can state that there is a high demand in:

- Teaching at all levels of education and in all disciplines, developing critical thinking skills, skill to search, collect and analyze information by using local and global resources.
- Creating comprehensive educational programs based on library literature of foreign language resources that have a great impact on openness and personalized learning [8].
- Developing such students' personality traits as cultural flexibility, cultural humility and tolerance to other cultures.
- Training teachers to improve their search skills; developing vocational education programs about how to gather information, process and protect data, and create information resources [16].
- The internationalization of the HE through the student and teacher academic mobility, virtual mobility in the context of removing language barriers [17].

It is suggested to keep education system abreast of contemporary international standards by using the fundamental nature of education. That means to protect education environment against a rapid technological change.

The essential role in adapting the education system to the technologies of the 4IR and evolving market needs is undoubtedly played by close collaboration of education-

al organizations with new modern enterprises. Here is a list of such types of cooperation:

- Employers from world's leading companies participate in the educational process.
- Representatives of the research establishments are involved in the academic activity.
- Employers are involved in the system of final proficiency rating of graduates and their employment.
- Leading companies and research establishments donate funds for equipping and modernizing educational institutions.
- Innovative technologies are used as training tools in the learning process and internship.

6 Conclusion

Today there are a lot of scenarios of the positive and negative implications of the new industrial revolution. They embrace the increase of social differentiation, political imbalance, polarization of human communities, the economic transparency and transformation, increasing the intellectual and creative nature of people's work, and reduce routine activity. Pedagogical system improvement should include teacher training program about ways to prevent negative social consequences of the new technological revolution. To improve educational processes and outcomes the education system must be constantly reformed in the light of adjusting to the new technological changes and must be the object of continuous evaluation.

The aspects of new technological revolution and the possible measures that should be taken to improve the HE are far from being listed above. There is suggested only one of the steps for fundamental revamping of educational system that should be pushed to the forefront of public discussion. Over time, the list of measures will be expanded, refined and become more detailed. There is a lot of work ahead for preparing for lifelong learning and the ability to predict the upcoming changes.

References

1. WEF report. The Future of Jobs 2018, https://www.weforum.org/reports/the-future-of-jobs-report-2018, last accessed 2020/10/12.
2. Extreme automation and connectivity: The global, regional, and investment implications of the Fourth Industrial Revolution. UBS White Paper for the World Economic Forum Annual Meeting. 36, (2016).
3. Komissarov, A.: Technological renaissance: The fourth industrial revolution. [in Russian]. Vedomosti, M. 3938, (2015).
4. Schwab, K.: The Fourth Industrial Revolution: what it means, how to respond, https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond, (2016), last accessed 2020/10/12
5. Penprase, B.E.: The Fourth Industrial Revolution and Higher Education. In: Gleason N. (eds) Higher Education in the Era of the Fourth Industrial Revolution. Palgrave Macmillan, Singapore, (2018). doi: https://doi.org/10.1007/978-981-13-0194-0_9

6. Gleason, N.W.: Singapore's Higher Education Systems in the Era of the Fourth Industrial Revolution: Preparing Lifelong Learners. In: Gleason N. (eds) Higher Education in the Era of the Fourth Industrial Revolution. Palgrave Macmillan, Singapore, (2018). doi: https://doi.org/10.1007/978-981-13-0194-0_7
7. Yang, P., Cheng, Y.: Educational Mobility and Transnationalization. In: Gleason N. (eds) Higher Education in the Era of the Fourth Industrial Revolution. Palgrave Macmillan, Singapore, (2018). doi: https://doi.org/10.1007/978-981-13-0194-0_3
8. Lee, R.M., Yuan, Y.: Innovation Education in China: Preparing Attitudes, Approaches, and Intellectual Environments for Life in the Automation Economy. In: Gleason N. (eds) Higher Education in the Era of the Fourth Industrial Revolution. Palgrave Macmillan, Singapore, (2018). doi: https://doi.org/10.1007/978-981-13-0194-0_5
9. Xing, B., Marwala, L., Marwala, T.: Adopt Fast, Adapt Quick: Adaptive Approaches in the South African Context. In: Gleason N. (eds) Higher Education in the Era of the Fourth Industrial Revolution. Palgrave Macmillan, Singapore, (2018). doi: https://doi.org/10.1007/978-981-13-0194-0_8
10. Basham, J.D., Han, K., Zhang, L., Yang, S.: Considering the Fourth Industrial Revolution in the Preparation of Learners with and without Disabilities. In: Yuen M., Beamish W., Solberg V. (eds) Careers for Students with Special Educational Needs. Advancing Inclusive and Special Education in the Asia-Pacific. Springer, Singapore, (2020). doi: https://doi.org/10.1007/978-981-15-4443-9_3
11. Osipovskaya, E., Miakotnikova, S.: Using Gamification in Teaching Public Relations Students. In: Auer M., Tsiatsos T. (eds) The Challenges of the Digital Transformation in Education. ICL 2018. Advances in Intelligent Systems and Computing, vol 916. Springer, Cham, (2020). doi: https://doi.org/10.1007/978-3-030-11932-4_64
12. Grinshkun, V.V. Teacher training features in the field of informatization of education. [in Russian]. Informatika i obrazovaniye. M. 5. 68-72, (2011).
13. Rakitov, A.I.: The philosophy of the computer revolution. [in Russian]. Politicheskaya literatura, 287, (1990).
14. Ursul, A.D.: Informatization of society: Introduction into social informatics. [in Russian]. M. 192, (1990).
15. WEF report. Schools of the Future Defining New Models of Education for the Fourth Industrial Revolution, http://www3.weforum.org/docs/WEF_Schools_of_the_Future_Report_2019.pdf, last accessed 2020/10/13.
16. Belyaev, M.I., Vymyatnin, V.M., Grigoryev, S.G., Grinshkun, V.V., Demkin, V.P., Zimin, A.M., Krasnova G.A., Korshunov S.V., Makarov S.I., Mozhaeva G.V., Nezhurina M.I., Norenkov, I.P., Ploskovitov, A.B., Pozdneev, B.M., Robert, I.V., Safronov, V.E., Solovov, A .V., Teslinov, A.G., Schennikov, S.A.: Fundamentals of the concept of creating educational electronic publications (OEI). In: The main directions of development of electronic educational publications and resources. M. RMC. 24-50, (2002).
17. Filippov, V.M., Krasnova, G.A., Grinshkun, V.V. Cross-border education. [in Russian]. Platnoye obrazovaniye. M. 6. 36-38, (2008).