The investigation of the problems of the digital competences formation for Industry 4.0 workforce

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The investigation of the problems of the digital competences formation for Industry 4.0 workforce

Aleksandr Kozlov [1], **Alina Kankovskaya** [1] **and Anna Teslya** [1*]

[1] Peter the Great St. Petersburg Polytechnic University, Polytechnicheskaya st., 29, St. Petersburg, 195251, Russia

* E-mail: avk55-spb@yandex.ru

Abstract. The article describes results of a research performed by its authors at Peter the Great St. Petersburg Polytechnic University with the main purpose to determine the status of usage of digital technologies and state-of-the-art communication means by students while studying, and also to make conclusions on achievements in digital competences formation and readiness of university students to work for the future digital industry. The research was conducted on the basis of questionnaire prepared by the authors of the article comprising three sections and including 18 questions. The total number of respondents made 187 persons from two University institutes. Analysis of the results obtained was made both on the whole selection and on the areas of focus and students' readiness levels. Conclusions were made regarding the substantial part of students who are conservative toward up-to-date Information and Communication technologies, and, consequently, the insufficient level of digital competences of these students that may cause problems in the future, during Industry 4.0 companies staffing. Recommendations on solving the problem identified are given in the article.

1. Introduction

The title Industry 4.0 is derived from the programme proposed in 2011 within the framework of the exhibition at Hanover and initiated by the German government, both by the country's businessmen and scientists who defined the programme as a means to raise competitive advantage of the German processing industry via intense integration of “cyber physical systems” or CPS. The Industry 4.0 (i40) virtual platform presently made on the basis of the Federal Ministry of Economics and Power Engineering of Germany describes the Industry 4.0 as a smart computer and industrial process network operating with the use of information and communication technologies [1].

If the initial idea of German originators of the Industry 4.0 was preferably development of the industry (this is not by chance that very often the processes implemented within the Industry 4.0 are called the Fourth Industrial Revolution) [2], then, consequently, the aims were changed and the Industry 4.0 was defined as digital transformation of all processes for the whole products’ value chain. Thus, the gaining popularity Internet of Things may be regarded within the Industry 4.0 concept as one of its constituent elements with marketing and sales support functions, which being integrated within the single information and communication system, uses Internet capabilities for commercial success.

In Russia, the idea of the Industry 4.0 is implemented within the programme “The Digital Economy of the Russian Federation” approved by the Russian Federation Government (order No. 1632-p dated

28 July 2017) [3]. The programme is aimed at implementation of "The Strategy of Development of the Russian Federation Information Society for 2017-2030" [4].

Highlighting the factors defining the successful formation and development of the Industry 4.0, one of the leading factors should be formation of specialist generation having the necessary competences for efficient work under new conditions. One of the core trends of the "The Digital Economy of the Russian Federation" Programme is staffing, education, and formation of research competences. Experts of the world known manpower management consulting company Price Waterhouse Coopers arrived at similar conclusions on the importance of staff training and their competence development. The experts pointed out in their report "2016 Global Industry 4.0 Survey" that "for successful implementation of Industry 4.0 concept, the most important is availability of digital competences" [5]. Additional reason in favour of high value of the human factor is making the special working group "Work, Education and Retraining" [1] within the above federal German platform i40.

2. Formulation of the problem and methodology

The new generation whose representatives will work for digital companies of the future industry now are studying at technical universities. That is why, on the basis of primary data, it is very important to be aware of the technical university students' actual perception of digital technologies, the degree and options of their use in training and scientific research works, as this to a great extent defines the future professional competences.

Thus, the objective of the research whose results are given in this article has been studying the status in the area of students' usage of up-to-date information technologies and available level of their digital competences and, accordingly, their readiness to work in the digital economy of the future.

To achieve the goal set, it was necessary to solve the following tasks whose sequence itself defines the methods of achieving the goal.

- Fulfilment of analysis of today's achievements and experience gained in implementation of the Industry 4.0 concept in Germany, other foreign countries and Russia.
- Fulfilment of analysis of studies in the area of training, development and adaptation of manpower for the future Industry 4.0.
- Development of questionnaire aimed at revealing the status in the area of students' usage of digital technologies in training process defining their readiness to work in the future digital economy.
- Conduct of a poll of target group representatives.
- Analysis of results obtained during research, identification of problems and obstacles in using digital technologies by students.
- Offering measures to solve the identified problems and contributing to making avoidable the obstacles identified.

3. Analysis of achievements and experience

The problem of formation of a new type of specialists having the necessary competences for efficient work under conditions of transition to digital production arouses the interest of researchers. Occurrence of a new process paradigm IoT (Internet of Things) a global network of computers and devices capable of interacting can change the human behaviour. New technologies and associated digital transformations will change not only the nature and method of current training making the employees perfect their digital skills and competences, but also interaction with digital environment [6].

The new level of requirements to graduates of technical universities, interest in and awareness of necessity of interaction between universities and industrial enterprises is confirmed by conducted scientific and research works. Researches of the Industry 4.0 [7] show how quickly technological achievements change requirements to manpower, the importance of the skills of usage of information and communication technologies (ICT) at a working place. It is exactly the "digitalisation" that leads to new requirements to manpower [8]. The Industry 4.0 concept and the associated method of a "digital factory" form a new circle of tasks and management skills. One of the key competences for

the staff reliable work is getting the skill of computer modelling of various logistic processes at production. The trend of usage of automated systems for solving a wide range of tasks at enterprises [9] becomes more and more apparent. It has been proved that the feasibility of usage of up-to-date digital technologies and tools combined with the corresponding educational approach shape interrelation of science and industry [10] leading to mutual profit both for concerned parties and the society as a whole.

On the other hand, the digital transformation causes substantial and sometimes radical changes in many industries. Global developments, such as digital platforms (clouds) and IoT, create principally new connections at different levels between objects, organizations and people (the systems of systems) [11]. It is shown that the considerable part of operations in companies will be solved by more and more extensive usage of new software. The enlargement of arrays of data processed shapes new requirements to the efficient usage of knowledge. The options of situational and design oriented education being integrated within university programmes allow future engineers and product engineers to develop design skills while working on real innovation tasks formulated by partner companies.[12]

Despite the fact that many researchers state that investments into development of digital equipment are an important strategic factor of the economic growth, attitude of businessmen to implementation of innovations is controversial. Their way of thinking largely defines the usage of innovation in business [13]. Study of their attitude toward usage of ICT for small and medium companies demonstrated statistically significant difference in using ICT in business as related to districts, education degree, previous education, frequency of development of competence for the purposes of business and frequency of usage of various cloud applications for business. Impact of gender aspects on implementation of information technologies (IT) among small company owners [14] is analysed. The problem is urgent not only for small- and medium-sized companies. The issues of organizing competent management of digital transformation in large companies are considered. Lack of such capabilities in boards of directors becomes an urgent problem [15]. It is shown that such an approach shall contribute to growth of companies' profits.

Despite the interest to analysis of the problems of Russian companies while new requirements of digital industry occur that is confirmed, for example, by works [16–18], insufficient attention is still drawn to research works in the area of training, development and adaptation of manpower for the future Industry 4.0. Research work [19] is worth mentioning, where it is shown that modern professions require highly qualified technical and engineering specialists with high IQ, and that it is necessary to develop students' “transdisciplinary” skills, and also research work [20] is to be mentioned in which the problem of filling up training plans and programmes of technical universities is analysed from the point of view of official requirements to use the information technologies, digital tools and platforms in the process of training. That's why the proposed study in the area of real status of training and adaptation of staff for future Industry 4.0 as an example of one of the leading technical universities of Russia appears to be actual.

4. Results

The research conducted covered totally 187 students including 129 trainees studying by the programme “Management”, 47 persons, by programme “Economy” and 11 men, by programme “Electrical and Heat Power Engineering”. The structure of respondents: 70% make those studying by bachelors programme, 30%, by magistracy programmes, 42.2% make male respondents, 57.85, female ones. The majority of respondents are citizens of the Russian Federation (70%). Among the respondents, 7.5% are from France, 5.9%, from Germany, 5.9%, from China, 2.7%, from Kazakhstan.

Respondent opinions received in course of the research were grouped by training levels (bachelors – masters) and by training areas. For analysis of links between these attributes, due to their attributive nature, Pirson's mutual contingency ratio was used, and the values received (within the range from 0.05 to 0.24%) allow making a conclusion on the lack of strong links between respondent preferences and training results.

The majority of students view remote training as additional to the traditional one (40.43%, by the programme in "Economy", 36.29%, by the programme in "Management", 54.55%, by the Engineering programme "Electrical and Heat Power Engineering"). While students-economists and managers think that remote training cannot replace the traditional one (38.3% and 43.55%, accordingly), students-power engineers view remote training as replacement for the traditional one at low quality of the latter (36.36%). At that, only 65% of respondents use educational platforms among which OpenEdu, Russian EP are the leading ones and make 37.62%, the next is Russian Lektorium, 6.93%, Coursera is the third, 5.4%). The most active users of special educational mobile applications are students-economists and managers (53%). Among power engineers the number of such users makes 45%, at that, high share is of those who do not want or plan to use mobile applications for their education and makes 27%.

Regardless of the area and level of education, students do not want to pay for e-books, access to scientific articles and data bases thinking that this is the prerogative of the university (54%), otherwise, the necessary data can be found openly (23%).

As to generally accessible data bases, students-power engineers point out Google Books and E-library (36.4% per each). The same bases are the leading ones for students of economic spheres (58% and 31%), interest to Scopus, Web of Science and Springer bases is individual.

Students-power engineers highly appreciate the importance of paper books (4.18 points and economists get 3.84 points), the last place is for video courses (3.36% and 3.29%, accordingly). Paid subscriptions for training resources are practically not used (only 5% of respondents pay for them not more than 500 rubbles per month).

All the students point out the importance of direct communication with professors. 100% of power engineers and 80% of economists regard personal communication necessary for practical training and for term papers, 30% of power engineers and 43% of economists consider communication during lectures to be necessary. Only 1 economist and 4 managers think it possible not to have personal contacts with professors. By 4-point scale of preferences, personal communication is foremost (3.45 for power engineers, 3.25 for managers and 3.06 for economists), e-mail correspondence is second best (3.36, 2.50 and 2.98, accordingly), and forums of e-course, chats and communication in social network group are much less popular. If students-economists have from 1.11 to 1.5 points for these forms of communication, power engineers have less than 1 point for these forms. At that, the capabilities of social networks and messengers are actively used by students of international educational programmes only.

In their responses, students also point out that they prefer to discuss training subjects also personally (3.2 out of 4 points), using social networks and messengers for personal communication (46% and 57% of time accordingly).

Thus, we see that the considerable part (approximately, 30-35% of the selection) have rather conservative approach both to the training process itself, its contents and conduct, and to the capabilities of usage of digital and remote technologies for education and self-education that in future may cause problems for digital transformation of industry, if we suppose that this category of respondents will keep to the same conservative approach in future as well. The problem might be solved, firstly, by means of additional training of university professors in the area of digital technologies and methods of student involvement in usage of up-to-date communication means and training; secondly, development of available and more convenient for usage mobile educational applications for smart phones and i-pads widely used by students.

5. Conclusions

The main conclusion by the results of the research conducted is identification of the problem of insufficient readiness of new generation of specialists to work under new conditions of digital transformation of the Russian industry. By results of the research, 30-35% of trainees are not actively using up-to-date communication means and capabilities of information technologies now. The authors of the article offer a number of measures which are reasonable to implement to solve the problem, in

particular, additional training of university professors in the area of IT, and also development of more convenient in use mobile applications for practical usage by students while studying.

It is worth mentioning that the conclusions were made on the basis of interrogating the limited selection of students of Industrial Management, Economy and Trade Institute and University Institute of Power Engineering and Transport Systems of Peter the Great St. Petersburg Polytechnic University. Further research trend is evident, i.e. enlargement of selection, making a poll among students of other engineering and technical institutes, and also other technical universities that will allow getting more substantiated and comparable results.

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