REQUIREMENTS FOR EDUCATION AND QUALIFICATION OF PEOPLE IN INDUSTRY 4.0

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Abstract

We are on the threshold of a technological revolution that fundamentally changes the requirements for people's education and qualifications. The main aim of the paper is to identify the existence of education availability in the Slovak Republic, which would support the creation of new jobs related to the onset of industry 4.0. At the same time to find out what are the requirements for education and qualification of people in the industry 4.0 who would hold new jobs. For the purpose of our contribution, we chose unions at secondary vocational and industrial schools, universities for individual regions of the Slovak Republic with potential potential for future professions brought by industry 4.0. The paper was processed using methods of analysis of secondary and primary sources, synthesis of knowledge, induction, deduction and comparison. The primary data were obtained from the scientific article Benešová - Tupá (2017), whose job profiles and strategies were baseline for the purpose of the paper. However, the requirements placed on schools often conflict with real results. Schools are not able to go with the pace of turbulent change, and future generations are not adequately preparing for today and tomorrow. Digitization can be seen as an enormous contribution in the field of education that allows for the use of new innovative methods, but must be treated critically. Not all changes are positive and automatically lead to better individual performance. The digitization of society is essential, so it is necessary to create an ideal environment for its implementation, also in view of its negative effects.

Keywords: education, Industry 4.0, labor market, qualification

1 Introduction

In the past, industry has been influenced by technological change and innovation. These changes were caused by mechanization (1st Industrial Revolution), by the use of electricity (2nd Industrial Revolution) and electronics and automation (3rd Industrial Revolution). Not all of these industrial revolutions affected not only production but also the labor market and education system. As a result of these changes, some professions and jobs have disappeared. We are currently facing another industrial revolution known as Industry 4.0 due to the development of digitization and robotics. With the advent of Industry 4.0, it is confirmed that flexibility in terms of readiness for technology-related changes is an important part of this process. As technology progresses, skills become more out of date, and responses to globalization and the quality of working life are also important.

2 Description of the approach, work methodology, materials for research, assumptions, experiments, etc.

Skills and qualities are not limited to the level of employee's equipment when taking up a new job. Possibilities to improve human capital are found both outside the company and within the company. It is important to pay attention to the training and development of employees, especially within the company, if it is to remain competitive, profitable and ensure a risk-reducing function. The basic prerequisite for the successful operation of the company is the skills and knowledge of workers. The sum of these characteristics is human capital. The realization that the added value of a company is not only in product or technical equipment, but mainly in the form of human capital, has been known since Adam Smith. (Armstrong, 2015). Today's **educational systems** are based on models invented by people in the last century. Employee education and development is static in the long term and insufficient in today's dynamic world. Insufficient education slows down adaptation to new conditions (World Economic Forum 2017). The labor market is changing rapidly and there is a likelihood that people who have a narrow focus will not be able to keep their jobs in the long term. According to Háš (2016) and the World Economic Forum (2017), he mentions that workplace education should be about future employability and career security and not about a specific job.

New technologies have a huge impact on people's education. Only qualified and highly educated employees can master these technologies. Industry should work with universities. The main vision of following Industry 4.0 is the emergence of "intelligent factories", which are connected to Cyber-Physical Manufacturing Equipment called CPS. The use of the Internet of Things, the Internet of Services and the Internet of People will come together: machine-machine, man-machine or human

man, while gathering huge amounts of data. For this reason, large data (large data) will need to be analyzed in order to predict possible failures and adapt in real time to changed conditions. At present, man is a machine operator and these machines passively follow the operator's instructions (Lasi, 2014) , (Baygin, 2016), (Lee, 2014).

Education 4.0 is a response to needs where human and technological capabilities are aligned to allow for new opportunities. Fisk (2017) explains that the new vision of education encourages students to learn not only the skills and knowledge they need, but also to identify the source that these skills and knowledge will learn. Learning is built around them on where and how to learn and track their performance is accomplished through data customization. Partners are becoming very important in learning. They learn together and from each other, while teachers assume the role of facilitators in their learning.

There are nine trends related to education 4.0 (Fisk, 2017):

1. Learning can take place anytime, anywhere. E-learning tools offer great opportunities for distance learning at your own pace. Reverse access in the classroom also plays a huge role in allowing interactive learning in the classroom, while theoretical parts can be taught outside the classroom.
2. Education will be tailored to individual students. The difficult tasks will only come to a certain level.
3. Students have the choice of how they want to learn. Although the learning outcomes of the course are preset by the institutions / bodies responsible for the curriculum, students can still choose the learning tools or techniques they prefer.
4. Students should be more involved in project education. Students are required to apply their knowledge and skills to the completion of several short-term projects. By participating in projects, they practice their organizational, collaborative and managerial skills that are useful in their future academic career
5. Students should be provided with practical training through practical experience such as traineeships, mentoring and cooperation projects. Advances in technology make it possible to learn effectively in certain areas, thereby creating more scope for acquiring skills that include human knowledge and interaction.
6. Students are required to apply their theoretical knowledge to numbers and use their intellectual skills to draw conclusions based on logic and trends from given datasets.
7. Students should be treated differently and conventional student assessment platforms may become irrelevant or inadequate. Students' real knowledge can be assessed during the learning process, while their application can be tested while working on their field projects.
8. Student feedback will be taken into account when designing and updating curricula. Their inputs help curriculum designers maintain the present, timeliness and usefulness of curricula. Ultimately, students will become more independent in their own learning, forcing teachers to take on a new role as intermediaries to guide students in their learning process
9. Students will become more independent in their own learning, forcing teachers to take on a new role as facilitators to guide students in their learning process.

Nine education trends 4.0 shifts the main educational responsibilities from instructors to students. Instructors should play their part in promoting the transition and should never consider this a threat to the traditional teaching profession (Diwan, 2017), (Fisk, 2017), (Shwab, 2016). Education 4.0 is the future of education and learning that is the result of technological integration to prepare students for the future. Education 4.0 uses tools and methodologies, such as combined learning and inverted classes, to convey not only knowledge but also develop their skills through practical exposure and experiential learning. It emphasizes the need to prepare students for future projects, training and non-classroom work and to integrate aspects related to fieldwork into existing curricula. Finally, it is possible to get rid of these prose methods of learning. Today's world is a digital world and generation is a digital generation. Education 4.0 also **facilitates access to learning** - from using dynamic learning materials such as pictures and videos to make students interested in making learning materials more accessible to students via devices and platforms, and even students to sign in anytime, anywhere to learn at their own pace. Education 4.0 is truly revolutionary in terms of significantly improving student learning outcomes (Fedena, 2019).

The aim of the paper is to identify the existence of the availability of education in the conditions of the Slovak Republic, which would support the creation of new jobs related to the advent of industry 4.0. At the same time to find out what are the requirements for education and qualification of people in the industry 4.0 who would hold new jobs. For the purpose of our contribution, we chose unions at secondary vocational and industrial schools, universities for individual regions of the Slovak Republic with potential potential for future professions brought by industry 4.0. The paper was processed using methods of analysis of secondary and primary sources, synthesis of knowledge, induction, deduction and comparison. Scientific articles from individual databases were analyzed from secondary sources. We used a study from the World Economic Forum that lists the top 10 skills needed for 2020, as well as a strategy to promote social and emotional education. The primary data were obtained from the scientific article Benešová - Tupá (2017), whose job profiles and strategies were baseline for the purpose of the paper.

2.1 Tables

The Fourth Industrial Revolution fundamentally changes the creation and development of job positions, in this context the question and problem arises as to what requirements will be imposed on newly created jobs. We are talking mainly about the needs of education and qualifications to fill a given position with sufficiently qualified workers. The following problem was also dealt with by Benešová and Tupa (2017), on the basis of which they formed profiles of job positions in the area of production and information technologies. At the same time, the World Economic Forum has created a study that results in the formulation of the Top 10 skills needed for year 2020, as well as a Strategy To Promote Social and Emotional Education.

These profiles and strategies will be the starting point for subsequent comparisons and analyzes of the branches available at secondary vocational and industrial schools, as well as universities in Slovakia with potential potential for future jobs in industry 4.0. The problem we want to point out or refute is directed precisely to the availability of education in the conditions of the Slovak Republic, which supported the creation of new jobs related to the advent of industry 4.0. Because only a sufficiently qualified workforce will be able to work in emerging jobs.

Table 1 *Profiles of job positions in production*

	Qualification	**Skills**
Electronics Technician	secondary education focused on mechanics, experience in the field of handling equipment and industrial equipment, performing service inspections, basic knowledge of working with databases, virtualization and external storage	manual skills, independence, responsibility, flexibility, basic knowledge of electronics and hydraulics, service of pressure cylinders, ability to learn how to manage and repair new machines
Automation Technician	secondary education focused on electrical engineering, mechanical engineering and automation, experience and experience in the maintenance of automated line machines and machinery	knowledge of safety standards, language skills - English or German, flexibility, independence and responsibility
Production Technician	higher education in electrical engineering	language skills - English or German, logical thinking, flexibility, independence, responsibility, ability and willingness to learn new things, reliability, knowledge of simulated process
Manufacturing Engineer	secondary / postgraduate education in electrical engineering and mechanical engineering	language skills - English or German, technical skills, independence, responsibility, flexibility and creativity, ability and willingness to learn new things, organizational and communication skills, knowledge of technical documentation

Source: Benešová, Tupa (2017)

In the previous Table 1, we can see the various manufacturing jobs in the context of industry 4.0 that are required and expected for the future. That most jobs require qualifications in a given field are also highly specialized. For example, if we focus on electronics technician, this job position requires practice primarily in the field of handling technology and industrial equipment, as well as basic knowledge of working with databases and virtualization and

external storage. Skills generally require language skills, flexibility, autonomy and responsibility. But there are also jobs that require technical skills or knowledge of the simulated process in production. By contrast, if we focus on job profiles of IT jobs, table 2. Here we can see the most striking narrow specialization in each job. It is therefore a prerequisite that candidates for a particular job have sufficient education and experience. It was this issue that was directed to the analysis of individual secondary vocational and secondary technical and industrial schools, but also universities in Slovakia. We want to find out whether there are enough schools able to create a qualified workforce in individual fields. At the same time there are skills that correspond to the difficulty of the job. There are leadership skills, language skills, the ability to learn new things, as well as flexibility and reliability.

Table 2 *Profiles of job positions in information technology (IT)*

	Qualification	**Skills**
IT specialist	secondary / postgraduate education in IT, practice in similar positions, advanced knowledge of network management, basic knowledge of working with databases, virtualization and external storage	language skills - English or German, independence, responsibility, flexibility, communication, reliability, ability to plan, solve a problem and lead a team
PLC programmer	secondary education focused on electrical engineering, experience in similar positions, experience in machine programming, PLC programming and knowledge	language skills - English or German, independence, responsibility, flexibility, communicativeness, reliability, ability and willingness to learn new things
Robot programmer	knowledge of offline and online robot programming, experience with basic robot parameterization and calibration, project management, coordination of robot program team and PLC programmers, secondary / postgraduate education focused on automation technologies	language skills - English or German, analytical and logical thinking, responsibility, flexibility and communicativeness, reliability, knowledge of simulated process
Software engineer	installation of equipment into operation, secondary / postgraduate education in IT, knowledge in C / C ++ programming, knowledge in C # /. NET, basic knowledge of working with databases (SQL)	ability to solve problems, language skills - English or German, analytical and logical thinking, independence, responsibility, flexibility and communicativeness, ability to solve problems
Data analyst	secondary / postgraduate education in technical mathematical or statistical, PL / SQL - advanced experience, UML - advanced experience	language skills - English or German, independence, responsibility, flexibility and communicativeness, knowledge of working with spreadsheets (Excel), basic knowledge of statistics
Cyber security	secondary / postgraduate education in information technology	language skills - English or German, independence, responsibility, flexibility and communicativeness, ability and willingness to learn new things, analytical and logical thinking, knowledge of security and communication standards, knowledge of servers (level - administrator)

Source: Benešová, Tupa (2017)

According to the World Economic Forum, the top skills include the ability to comprehensively solve problems, critical thinking, creativity, and ability to manage people, coordination with others, emotional intelligence, judgment and decision making, service orientation, negotiation, cognitive flexibility. Do graduates and students meet these abilities and skills? This question will be answered only in practice, but it is already possible to talk about the lack of creative people due to the brain drain abroad. And where do they get the skills they need for emerging jobs? In the following reviews, we will focus on what individual faculties, secondary vocational schools and industrial schools have the professional prerequisites for working positions in industry 4.0.

Table 3 *Faculties with technical potential for industry 4.0 in Slovakia*

University name	City	Faculties with technical potential for industry 4.0
Alexander Dubček University of Trenčín	Trenčín	Faculty of Special Engineering
	Púchov	Faculty of Industrial Technology
Slovenská technická univerzita v Bratislavy	Bratislava	Faculty of Electrical Engineering and Computer Science
	Bratislava	Faculty of Informatics and Information Technologies
	Trnava	Faculty of Materials Science and Technology in Trnava
University of Žilina	Žilina	Faculty of Mechanical Engineering
	Žilina	Faculty of Electrical Engineering and Information Technology
	Žilina	Faculty of Management and Informatics
Technical University of Košice	Košice	Faculty of Electrical Engineering and Computer Science
	Košice	Faculty of Materials, Metallurgy and Recycling
	Prešov	Faculty of Production Technologies
	Košice	Faculty of Mechanical Engineering
Technical university of Zvolen	Zvolen	Faculty of Technology

Source: Own processing

There are 5 universities in Slovakia together with 13 faculties (table 3) whose fields of study coincide with the professional demands for the newly emerging job positions mentioned by Benešová and Tupa (2017). The ratio of technical and information faculties is even, the problem may be the interest of the students themselves in individual faculties, but also in general for university studies. We encounter a shortage and struggle for university students. Students leave to study abroad or start work immediately and are shortened by important professional and specialized knowledge. It is therefore a question of how to attract and mobilize students for study while keeping them in Slovakia. Not only universities but also secondary technical and industrial schools suffer from this drawback and problems, which also have a high production potential of graduates with high expectations for emerging professions in industry 4.0. In the following tables we will focus on individual regions in the Slovak Republic and their secondary schools with professional potential for narrowly specialized new professions, which are mentioned by Benešová and Tupa (2017). We want to find out how many such schools are in our country, what departments they provide and whether it is possible to anticipate the potential for the development of industry and new professions in our conditions. In the following Table 4 we have created an overview of secondary vocational and industrial schools in individual regions in Slovakia. For more detailed specification are defined cities in which they are located and in how many. At the same time, we create an overview of fields of study in individual regions, which may have the greatest potential precisely for the newly emerging narrowly specialized technical fields in Industry 4.0.

In general, we can state the wide distribution of specialized secondary schools throughout Slovakia. At the same time, we are talking about sufficient concentration of trade unions, which are necessary for newly emerging jobs. For example, there are 13 secondary technical and industrial schools in the Trenčín region, whose branches meet the possible qualification requirements for Industry 4.0. These are mainly technical bastions with a focus on computer science, programming, information and network technologies, engineering and mechanics. By contrast, there are 10 such schools in the Prešov region, but the highest concentration is in Poprad (4) and Prešov (4). So there is a possible question whether this close concentration is a benefit or a problem and in the future it would be necessary to create such a type of secondary school in other cities. However, it is questionable whether they would fulfill their capacities and would have sufficient interest in them. We see positively the possibility of choosing from a large number of highly specialized fields that will be very beneficial for the future in Industry 4.0. It is questionable to what extent individual applicants from these secondary schools will apply their knowledge in practice and what their skills will be. As a possible and more real problem we refer to modern times, which brings not only many positive phenomena, but also negative especially with the advent of modern technologies. These have a large impact on all ages, which can result in lack of concentration, poor communication skills, lack of independence, unreliability, and other major problems, which in turn affect the application of individual candidates, but also the growth of industry 4.0 in our conditions. The second problem encountered is the possibility of gaining the necessary experience and practice, which are often decisive in recruiting a job seeker, but also in future progress and career guidance.

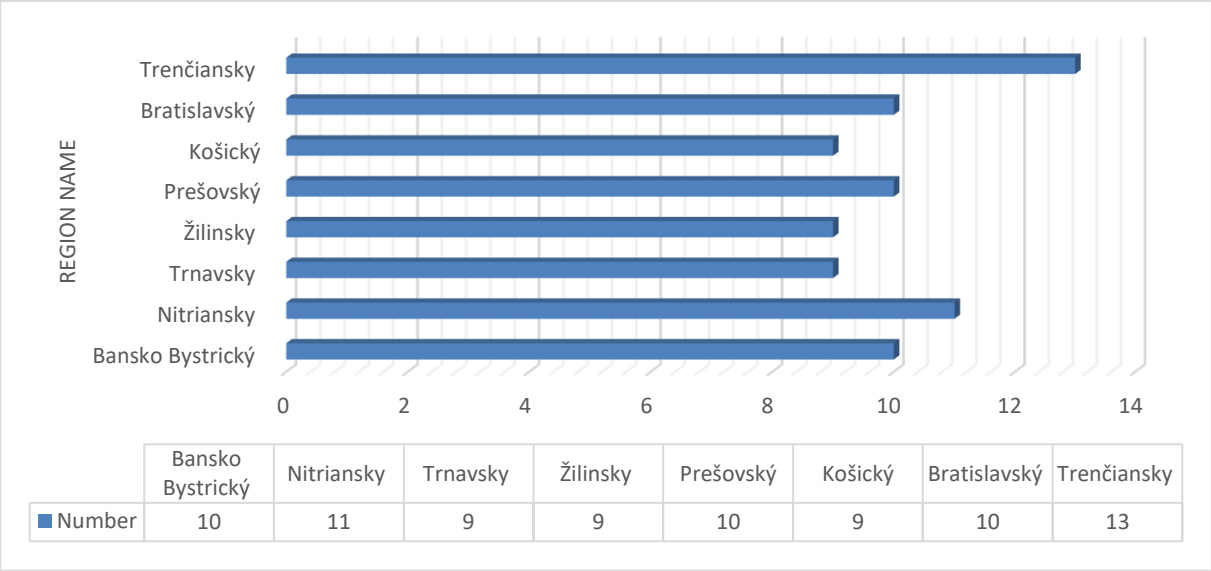
Table 4 *List of secondary and vocational schools by regions in Slovakia with field of study technical potential for Industry 4.0*

Region	Cities	Fields of study with technical potential for Industry 4.0
Trenčiansky	Bánovce nad Bebravou, Dubnica nad Váhom (2), Handlová, Nové Mesto nad Váhom, Považská Bystrica (3), Prievidza, Púchov, Stará Túra, Trenčín (2)	electrical engineering, technical lyceum focusing on informatics, engineering, programmer of machine tools and equipment, mechanics of computer networks, assembly and repair of devices, mechanic adjuster, electro-mechanic - heavy-duty / utility technology, mechanical engineering (programming of NC machines and graphic systems), information and network technologies, CNC programmer, aircraft mechanic (mechanics), aircraft mechanic (avionics)
Banskobystrický	Banská Bystrica (2), Brezno, Fiľakovo, Krupina, Revúca, Rimavská Sobota, Zvolen, Žarnovica, Žiar nad Hronom	manager of intelligent and digital systems, computer network mechanics, electrical engineering, information and network technologies, programmer of machine-tools and welding machines, mechanics of electrical engineering, operator of engineering production, programmer of machine and welding machines and equipment, electrical engineering - industrial informatics, technical lyceum
Nitriansky	Komárno (2), Levice (2), Nitra (2), Nové Zámky, Šurany, Tlmače, Zlaté Moravce (2)	computer network mechanic, programmer of machine and welding machines and equipment, electromechanic heavy-current technology, technical-administrative worker, electrical engineering - production and operation of machines and equipment,technical and informed services in engineering, technical lyceum, mechanic of building-installation equipment
Trnavský	Dunajská Streda, Hlohovec, Piešťany (2), Senica, Trnava (3), Zlaté Klasy	mechanic of machinery and equipment, mechanic repairman - machinery and equipment, electromechanic and utility technology, electrical engineer - production and operation of machinery and equipment, electromechanic and heavy-current technology, mechanic of machines and equipment, polytechnic, information systems and services
Žilinský	Čadca, Dolný Kubín, Liptovský Hrádok, Martin, Námestovo, Ružomberok, Žilina (3)	mechanic of machines and equipment, mechanic of building installation equipment, electromechanic - heavy-current technology, construction production operator, mechanical mechanic, electromechanic - heavy-current technology, autotronic, operator of building production, technician of building energy equipment
Prešovský	Medzilaborce, Poprad (4), Prešov (4), Snina	information and digital technologies, intelligent technologies, electrical engineering, information and network technologies, IT process management, technical and information services in electrical engineering, computer systems, computer network mechanic, programmer of machine tools and welding equipment, mechatronics, graphic and spatial design
Košický	Košice (5), Kráľovský Chlmec, Michalovce, Rožňava, Spišská Nová Ves	programming of digital technologies, intelligence technologies, information and network technologies, intelligence systems, computer network mechanics, building installation mechanics, information security specialist, programmer of machine and welding machines and equipment, , security systems in transport and industry, autotronics, technical lyceum
Bratislavský	Bratislava (10)	computer network mechanic, electrical engineer, electromechanic - utility technology, engineering - production, assembly and repairs of devices, computer systems, information and telecommunication systems, industrial informatics, technical lyceum, engineering, aircraft mechanic (mechanics), aircraft mechanic (avionics)

Source: Own processing

2.2 Figures

For clarity and easier representation of individual numbers of secondary technical and industrial schools with technical potential for industry 4.0, we chose the following chart 1. It is possible to observe that even though the Trenčín region is registered as the second smallest number of inhabitants, it has the highest number of secondary schools. , whose fields of study coincide with the professional potential for narrowly specialized new professions which Benešová and Tupa present (2017). The second place was taken by the Nitra Region and the third by the Bratislava, Prešov and Banská Bystrica Regions.



	Bansko Bystrický	Nitriansky	Trnavsky	Žilinsky	Prešovský	Košický	Bratislavský	Trenčiansky
Number	10	11	9	9	10	9	10	13

Fig. 1 *Secondary and vocational schools with technical potential for Industry 4.0*

3 Description of achieved results

In our research we tried to find out whether in the conditions of the Slovak Republic we have colleges and secondary schools with professional potential for narrowly specialized new professions which are mentioned by Benešová and Tupa (2017). At the same time, we have formulated our results together with the World Economic Forum research (top 10 skills for 2020, strategy to promote social and emotional education). We have found that there are 81 secondary schools in our conditions, approximately equally distributed across regions. At the same time, their study fields met the set criteria, which were the starting point for us. Speaking of universities, there were 5 colleges and 13 faculties that also met the criteria we chose. However, it should be taken into account that this is an analysis of the fields of study that are taught and not the quality of the teaching itself. So it is possible to assume that not every secondary school or university will have equally prepared graduates for practice. The individuality of individual students, their skillfulness, creativity and ability to apply the acquired knowledge into practice also come here.

4 Conclusion

The term Education 4.0 is often used with changes in industry and in services caused by the digital revolution. Almost everyone is talking about the 4th Industrial Revolution, which is so strong that change is necessary, even within the educational environment. From the educational point of view, education 4.0 is very important because the future of education and learning is the result of technological integration in order to prepare qualified students for the future. Education is understood as a process in which a person creates knowledge, acquires knowledge and develops his / her mental and physical abilities and skills. Through education, a person's personality is formed, providing him with the knowledge and skills necessary to pursue a particular profession. Thus, man becomes an integrated personality, fully aware of his value in society and mission. It is difficult to prepare graduates for a labor market that is constantly changing. The development of digital technologies significantly changes all communication channels, social conditions and, therefore, the school needs to fundamentally change its approach to education. Education 4.0 is part of the Industry 4.0 phenomenon, which primarily involves the introduction of new technologies into industrial production and the restructuring of the whole economy with the help of digital technologies that have experienced rapid technological progress since the information period. Digital technologies are now seen as cross-cutting innovations. In the field of industry, digitization is compared to previous drivers of change, such as production

mechanization, band production, electronization and automation. Just as the previous revolutionary changes have influenced the functioning of the whole society, they have changed the view of work and education, including education, as well as today's engine of change, digitization is a societal issue. Industry 4.0 brings new demands for the intellectual development of man, pushing global reforms on education. However, the requirements placed on schools often conflict with real results. Schools are not able to go with the pace of turbulent change, and future generations are not adequately preparing for today and tomorrow. Digitization can be seen as an enormous contribution in the field of education that allows for the use of new innovative methods, but must be treated critically. Not all changes are positive and automatically lead to better individual performance. The digitization of society is essential, so it is necessary to create an ideal environment for its implementation, also in view of its negative effects.

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