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Key competencies of employees in the era of industrial revolution 4.0, and the necessary changes in education

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Abstract: The world known to us today is undergoing a dynamic transformation towards the unknown. The peculiarity of this transformation is that there are no patterns that can be adopted, treated as a "hint" for a solution that can be improved and adapted to local conditions. The only thing we can do is build an education system based on the constant identification and reinterpretation of the content of key competencies. The analysis of the existing educational solutions shows that the development of competencies should not be based on a transmission (one-way) model, but on a relational (synergistic) model involving many "actors" participating in it: students, teachers and those from the socio-economic environment. The article justifies the need to introduce such thinking about the education of the future from the position of training competencies resulting from the industrial revolution 4.0.

Kompetencje kluczowe pracowników w dobie rewolucji przemysłowej 4.0 a konieczne przemiany edukacji

Słowa kluczowe: kompetencje kluczowe, edukacja ogólna, edukacja zawodowa, pedagogika pracy

Streszczenie. Współcześnie znany nam świat jest poddany dynamicznej transformacji ku nieznanemu. Osobliwość tej transformacji polega na tym, że nie ma wzorców, które można przejąć, potraktować jak 'ściągawkę' dla rozwiązania dającego się udoskonalić i dopasować do lokalnych warunków. Jedyne co możemy zrobić, to budować system edukacji oparty na stałym identyfikowaniu

i reinterpretowaniu treści kompetencji kluczowych. Analiza dotychczasowych rozwiązań edukacyjnych wskazuje, że kształcenie kompetencji oparte być powinno nie na modelu transmisyjnym (jednokierunkowym), ale na modelu relacyjnym (synergicznym) uwzględniającym wielu 'aktorów' biorących w nim udział: uczniów, nauczycieli i tych należących do otoczenia społeczno-gospodarczego. W artykule uzasadniono konieczność wprowadzenia takiego myślenia o edukacji przyszłości z pozycji kształcenia kompetencji wynikających z rewolucji przemysłowej 4.0.

Introduction

The essence of the transformation of the modern world is that there are no patterns that can be taken over, treated as a flexible model that can be refined and adapted to specific local requirements and conditions.

It is incumbent on developers of educational systems to constantly identify and reinterpret key competencies. The currently happening industrial revolution 4.0 requires just such an approach[1]. As a result of the development of information technology, including artificial intelligence, there is a dramatic increase in the automation (robotization) of processes in virtually all industries, including business and consumer services. Technological change is being felt through a severe shortage of creative human resources, with an excess of workers able to perform routine tasks well. In studies on the subject, deficit competencies are defined differently. However, general competencies can be assumed to be those that are transferable between jobs and that provide rapid adaptation to change and the ability to cooperate effectively in task teams. Among the most often mentioned key competencies, the most frequently cited are such as skills in information technology, from operating computers and their software to programming skills; the ability to solve complex problems; critical reasoning; ingenuity and creativity; intellectual flexibility; openness to novelty and the ability to learn quickly; the ability to build and manage interpersonal relationships, including resolving conflicts and tensions; the ability to cooperate with others in an organized manner; the ability to make decisions and organize one's own work well.

What emerges here is a clear disconnect between the demand for the above-mentioned competencies of an employee in the era of Industrial Revolution 4.0, and the characteristics of contemporary educational systems – let

[1] There are already studies predicting the change of human labour in the Industrial Revolution 5.0 (Furmanek, 2018).

us add – systems unsuited to the character of modern man, whom we describe as "homo interneticus" (Walat, 2020).

Information society – sources of competence in the era of industrial revolution 4.0

The development of information technologies has resulted in a remarkable enrichment of the modern human communication system. These technologies have a tremendous impact on all areas of human activity and even on the way people think. The improvement of the techniques of collecting, processing and generating information, and consequently the control of production processes, scientific research, education, and management causes changes in the social structure, in a word, the formation of an information society.

However, today we already know that information technologies provide only seemingly unlimited possibilities in the spread of education and communication without spatial and temporal limitations. This leaves the ever-present and often overlooked problem of the subjectivity of human beings caught up in the transformation of work (Gerlach, 2014).

The great change-forming role of information technology (in cultural and civilizational dimensions) was recognized and emphasized by the editors and authors of well-known – and already historical – reports: *Learning to Be (Faure, 1971); Microelectronics and Society. For better or for worse. A Report for the Club of Rome (King, 1982); White Paper. Teaching and Learning. Towards the learning society. European Commission (1995); Learning: the treasure within, UNESCO (Delors, 1996), Poland and the Global Information Society: Logging on Human Development Report* (W. Cellary, 2002).

How predictive the words of the Report for UNESCO prepared under the editorship of Jaques Delors (1998) sound today: *As the coming century will create unprecedented conditions for the circulation and accumulation of knowledge, it will subject education to a dual imperative that at first glance may appear contradictory. Education should transmit en masse and effectively more and more knowledge and skills that evolve, relevant to cognitive civilization, for they are the basis of tomorrow's competencies. At the same time, it should find and mark reference points that will protect the public and private spheres from the flood of information, more or less ephemeral, and keep individual and collective development projects on the right track. Education is, as it were, obliged to provide a map of a complex and perpetually troubled world and a compass for navigating it.*

We also have to agree with the aptly made diagnosis that the amount of knowledge transmitted at school cannot be increased indefinitely, we should bet on reorganizing the education system through the use of a kind of four filters/pillars that allow constant updating and reinterpretation of information flowing to a person. This is only possible through functional literacy. *In order to fulfil its mission in its entirety, education should organize itself around four aspects of education, which throughout life will be, as it were, for each individual the pillars of their knowledge: "learn to know", i.e., to acquire the tools of understanding; "learn to act", in order to have the power to influence one's environment; "learn to live together", in order to participate and cooperate with others at all levels of human activity; and finally, "learn to be", an aspiration that is related to the previous three. Of course, these four paths of knowledge form a whole, for they have many points of convergence, intersecting and complementing each other* (Delors, 1998).

The education pillar "learn to be" is taken from a report prepared under the editorship of Edgar Faure back in the early 1970s (1971), which already predicted the importance of education for being a human being who understands the rapidly changing world[2], that is, for functional literacy. The principles identified therein for a new educational policy are extremely interesting (Faure, 1971). These principles state that:

1) every person should have the opportunity for lifelong learning, and this should be the guiding idea of educational policy,
2) the character of life experience should be restored to education; education should form a social movement,
3) it is necessary to deformalize institutions, education should be carried out with the help of multiple means, the most important thing should be what a person has learned and what they know, the choice of means and methods of education must be free, the final result of education should count, as all paths to obtain it should be considered valuable,
4) there should be permeability and a wide range of choices; the system should be full and open, it is supposed to make it easier for learners to move from one institution to another, it is necessary to remove artificial

[2] Functional literacy, i.e. the understanding of the rapidly changing world, is a special and fundamental challenge for modern educational systems, because today's man "homo interneticus" (i.e. constantly connected to the Internet) is characterized by cognitive fluctuations, loss of thought and disappearance of rational action in the basic areas of life. I have described this problem in more detail in the publication: Walat W., *Homo interneticus – Problems of Education in the Age of Functional Illiteracy* [in:] Cyberspace Human Education. Open educational resources from a pedagogical perspective. M. Tanas, S. Galanciak. Ed. Impuls, Krakow 2020, pp. 181-194.

barriers between different types, cycles and levels of education and between formal and informal education,
5) the effectiveness of educational and cultural policies depends on the strategy of pre-school education,
6) everyone should be provided with full-time elementary education,
7) general education should be expanded to be theoretical, technical and practical; we must aim to remove artificial divisions between different types of education,
8) young people should be taught the skills to perform a variety of tasks and allowed to continuously improve themselves as working conditions change, this is primarily about optimizing occupational mobility,
9) workplaces are to play an educational role, educational institutions are to cooperate with enterprises,
10) should diversify higher education so that institutions are able to meet the growing number of individual and collective needs,
11) knowledge, abilities and skills should be a criterion for admission to the chosen type of school and job,
12) the most important issue in the educational strategy should be adult education,
13) it should be remembered that literacy is only a part of adult education,
14) self-directed learning has irreplaceable qualities, there should be institutions and facilities to support self-directed learning,
15) new reproduction and communication techniques should be introduced to modernize the technology of education,
16) necessary to fulfil the previous principle is the emergence of a movement seeking to implement these methods,
17) hierarchies between different categories of teachers should be abolished, they should have equal status,
18) the education of teachers should prepare them for the role of educators, the first cycle of teacher training should be shortened and in-service training should be organized after it,
19) professional and non-professional educators become important, the number of voluntary or partially paid assistants in educational activities should be increased,
20) the mode of teaching should be adapted to the student; they are to be the focal point of every educational and educational activity,

21) internal processes of active participation in the educational process should be stimulated in the student, they should be able to take responsibility.

We also find a reiteration of these principles in the report *Teaching and Learning...* (1995), within the framework of the distinguished three main factors causing social change: the development of the information society; the processes of globalization; the transformation of scientific and technological civilization.

In a report prepared in Poland at the beginning of the 21st century, it was assumed that education should take into account such elements that build a model for using the world of the infosphere (*Poland on the way*..., 2002). In these model assumptions, it was assumed that future educational systems would be aimed at preparing a human being: an informer; a communicator; a learner and a creator.

Megatrends that characterize the transformation of modern education

The authors of the report *Beyond the Horizon. Course for Education. The Future of the Competency Development System in Poland* (pp. 15–23) point to four fundamental megatrends that, in the context of socio-cultural-civilizational changes, determine changes in education through the emergence of a demand for new competencies.

1. One of the main factors is the wave of **technological change**. In the face of the technological transformation towards the unknown, educational systems in the broadest sense are lagging behind, as they rely on patterns developed in earlier phases of modernity. So far, countries aware of technological changes have tried to keep up with them by introducing reforms in educational systems. The lack of satisfactory results shows that such a strategy is not appropriate. Keeping up with successive "technological revolutions" does not offer much chance of meeting the constantly emerging new challenges – such an educational policy will always be reactive and late. Underlying this ineffective strategy – yet persistently sustained – is the strong, historically formed hierarchical relationship between the state and education. Therefore, it should be significantly loosened and redefined, including by including more "social actors" in the game for its systematization, while introducing flexible mutual learning relationships. This points to an expanded field of activity for other actors, whose potential is currently an untapped resource, and whose role in the education system should grow.

A kind of "density" of technological solutions is perceptible, which should be taken into account when designing changes in the competence formation system. These changes should be kept in mind when planning both what young people should be taught, but also how and with what technologies they can be taught. Only the most important ones will be mentioned here:

- extreme connectivity (internet of things) and use of mass information;
- the rapid development of biotechnology and genetic engineering;
- qualitative leaps in computer performance (quantum processors);
- centralization (+ outsourcing) of data storage and analysis (cloud computing);
- the rise of big data analytics and its use in microtargeting;
- development of blockchain and similar technologies to manage decentralized data;
- modern materials and the way they are processed (e.g., 3D printing);
- development of technologies based on virtual reality and augmented reality;
- the growth of technologies and organizational, regulatory and investment solutions related to the circular economy;
- new solutions in the energy sector, both in terms of generation (especially renewable energy sources – RES), storage (thanks to the production and storage of "green" hydrogen, the introduction of new types of electrochemical cells, among others) and energy use.

Since 2020, the prolonged Covid-19 pandemic has revealed the social consequences of AI (*artificial intelligence*). Solutions once introduced gradually over several years, today, due to the need to protect public health, are taken immediately, which does not mean that they will be withdrawn or mitigated once the threat is over. This carries far-reaching social and emotional consequences for students, teachers, but also workers in all sectors of the economy (Warzocha, 2021; Tuczyński, 2021).

Even further in identifying possible scenarios for the development of human-work relations from the perspective of transhumanism is R. Tomaszewska (2021, p. 15) wondering: *Can the human mind really be replaced? Are we already transhumans, or cyborgs? Is the post-human and ‚singularity' coming? Will labour continue to be human? Or will there be no work in 100 or 200 years – there will be robots, and no humans?*

2. **The ageing of populations** in developed countries is already causing a noticeable number of negative consequences:

- a decline in the number of people of working age, especially those entering the labour market;
- an increase in the demographic burden on successive generations;
- an increase in migration pressure from countries with lower levels of development and at the same time population expansion;
- difficulties in being able to use the influx of migrants to fill the demographic gap – due to educational and cultural barriers.

Demographic problems generate difficulties in finding suitable workers, pressure to increase the tax and quasi-tax burden, as well as migration challenges related to the need to absorb non-European populations. The lack of solutions in this regard is one of the causes of the "migration crisis" on the Polish-Belarusian border, which has been going on since the autumn of 2021.

Intergenerational relations are changing at a rapid pace under the influence of the digitization process of ageing societies – digital exclusion is emerging not only for seniors, but also for economically active people who are not reconstructing their digital competencies. Hence, in one institution there are individuals from several generations, differing in their values, attitudes and ways of life. These institutions require significant changes, including management and motivation mechanisms, in order to integrate generations and thus integrate different worlds. Counterintuitively, this also applies to educational institutions themselves: schools and universities.

3. **The organization and nature of work** are changing diametrically. The aforementioned technological changes and turbulent environment will leave their mark on the way organizations operate. The following transformations are already widely observed:

- a decline in the importance of hierarchical and centralized organizations in favour of networked and distributed ones;
- the building of competitive advantages based on the ability to manage distributed and virtual work environments and to maintain employee motivation and loyalty under these conditions;
- increasing the importance of trust as a regulator of organizational relations;
- competing with the ability to generate and spread innovation.

The demand for currently perceived work is changing dynamically, as manifested by the disappearance of some occupations and the emergence of others, with the creation of new competence needs. Changes are also taking place regarding the work environment itself and the employee-employer relationship. Non-standard forms of employment and work (e.g. crowd work,

employee-sharing, job-sharing, home office, ICT-based mobile work), making employment relations more flexible, involvement with multiple employers at the same time, the use of irregular pay or reduced access to social security will reduce the sense of job security, stability and safety among employees (Lib, 2021). Additional phenomena include the individualization and virtualization of work, which increases the sense of social isolation and generates an increase in psychosocial burden, while non-standard and irregular working hours promote the development of civilization diseases. The phenomena outlined here cause mass discontent and protests, and are compounded by shorter or longer periods of "forced" remote work caused by pandemic shutdowns.

4. **Competency transformation**. The constant and dynamic development of information and communication technologies, including artificial intelligence, is leading to a dramatic increase in the automation (robotization) of processes in many industries, led by business and consumer services. Within the industries affected by technological change, there is a severe shortage of creative human resources, with an excess of workers able to perform their "routine tasks" well. There is a decline in the competitiveness of the economy with low-cost labour resources in favour of the availability of "talent" capable of handling modern research, production and service processes. Of great importance is the ability to quickly acquire new competencies necessary to work in constantly adapting teams. The employee of the future (and, in the already dynamically growing number of cases, the employee of the present) will benefit from having the competencies to actively adapt and meet the changes taking place.

This requires, first and foremost, preparation – already at the elementary school stage – for learning new skills and acquiring new knowledge as a basis for future competencies and qualifications[3]. The foundation is firstly the ability

[3] S.M. Kwiatkowski writes about the problem of the relationship between competencies and qualifications: *It is remarkable that competencies which are trained in formal education automatically become qualifications (on passing the relevant examinations, of course). In order to qualify as qualifications, competencies that can be acquired through non-formal and informal learning must be subject to a validation process. It is therefore possible – and this is often the case in practice – to have competencies rather than qualifications. The reverse situation, i.e. non-competence-based qualifications awarded by schools and universities, is reprehensible and reflects the poor quality of the work of formal education institutions. It should also be noted that, until recently, the concept of competence was defined as the scope of powers conferred on the basis of actual qualifications (Nowacki, 2004, p. 100). This view, i.e. a kind of precedence over qualifications, is still valid in some occupations. In the legal professions, for example, qualifications obtained through formal (academic) training are not automatically admitted as a lawyer or notary, but have to go through certain procedures that confer entitlement to practice these professions. Competencies of the future [in:] Competencies of the future*. Edited by S.M. Kwiatkowski, Foundation for the Development of the Educational System, Warsaw 2018, p. 17.

to use the mother tongue, including communicating in writing, and secondly, the ability to reason mathematically and apply its elements in everyday life. This involves so-called functional literacy, i.e. based on understanding (interpretation and reinterpretation) of cultural texts from various fields, which is necessary for the acquisition of other skills. In the case of the latter skill, mathematical reasoning is gaining in importance compared to calculative literacy, understood as basic literacy. Social-emotional competencies such as perseverance, attention, motivation, a sense of agency and confidence in one's own abilities are also gaining new importance.

The attempt to outline competencies for Industry 4. 0 against the background of the transformation of education towards functional literacy

As a result of developments in information technology, including artificial intelligence, there is a dramatic increase in the automation (robotization) of processes in many industries, including exponentially in business and consumer services (especially those based on outsourcing).

Within the industries affected by technological change, there is already a severe shortage of creative human resources, with an excess of workers able to perform routine activities well (*Beyond the Horizon...* 2020, p. 21). Among these activities, the most frequently mentioned are:

- IT skills, from operating computers and their software to programming skills;
- the ability to solve complex problems;
- critical reasoning;
- ingenuity, creativity;
- intellectual flexibility;
- openness to novelty and ability to learn quickly;
- the ability to build and manage interpersonal relationships, including resolving conflicts and tensions;
- the ability to cooperate with others in an organized manner;
- ability to make decisions;
- good organization of one's own work.

The aforementioned report distinguishes five categories of skills arising from the demands of the happening Industrial Revolution 4.0, which may become

the five pillars – the degrees of functional literacy of human beings in the education of the future (*Beyond the Horizon*... 2020, Appendix 3).

1. General competencies based on basic skills – necessary for further learning, which are crucial for understanding the world around us and interacting with it (reading, writing, speaking), i.e. resulting from basic literacy. They form the basis for the start of an individual's career and further success in the workplace. The goal of education is to support the youth in finding and maintaining employment in the workplace. Examples of competencies include literacy and numeracy, computer skills, resume writing, self-presentation, time management, professionalism, etiquette, and social norms.
2. Social-emotional competencies based on soft skills, i.e. such personal qualities, social skills and communication skills that support interpersonal relationships and interactions with others. They will serve to support young people as they integrate and collaborate with internal and external stakeholders in the workplace, such as customers, co-workers and management. Examples of competencies include communication, critical thinking, creative thinking, collaboration, adaptability, initiative, leadership, social emotional learning, teamwork, self-confidence, empathy, the focus on growth, and cultural awareness.
3. Professional competencies based on technical skills, that is knowledge of specialized professional tasks and the ability to perform them. They include the development of young people being educated with excellent knowledge of technical and domain issues needed to perform job-specific tasks. Examples of competencies include computer programming, coding, project management, financial management, mechanical functions, scientific tasks, technological skills and other professional skills (e.g., nursing, agriculture, law).
4. Entrepreneurial competencies, i.e. knowledge and skills that enable success in creating and building opportunities and ideas for the workplace. Their goal is to provide the youth with support in starting their own business, support efforts to go into business on their own, work on a contract or temporary contract (gig work) and/or develop as a person with their own initiative in the work environment (self-starter). Examples of competencies include initiative, innovation, creativity, diligence, resilience to adversity (resilience), ingenuity, curiosity, optimism, risk-taking,

courage, entrepreneurship, and execution of professional tasks (business execution).

5. Lifelong learning competencies, understood as a continuous process of acquiring new knowledge and skills and reconstructing those already mastered in the course of each person's professional and personal career.

The basic change that should take place in the existing education system seems to be a rapid but flexible transition from a transmission model to a relational one. The current problem, in fact, is not the formation of a new type of key competencies, but the formation of a new combination of them. Hence, the emphasis must be placed not on individual competencies, but on the way they are formed, acquired and creatively reconfigured. Making such an assumption, it turns out that the transmission (one-way) way (model) currently prevails, which should be replaced by a relational model, in which the experience of reality happens in a direct relationship between at least two people (this includes both peer-to-peer and intergenerational relationships), providing the basic link for building knowledge, skills, attitudes and values.

Numerous publications in the field of key competencies describe the status quo and postulate it, that is, the authors focus on how it is (from the position of the descriptive function of the research conducted) and how it should be (from the predictive function). What is missing here is an intermediate link, a focus on pragmatic and coherent organizational reconstruction of the general and vocational education system (the reconstructive-practical function of the research). Such an attempt was made in the work edited by S.M. Kwiatkowski, titled. *Contemporary Problems of Pedagogy. Towards the integration of theory and practice* (2021).

Conclusions

The sources of transformation of key competencies of employees of any business entities operating under the conditions of the Industrial Revolution 4.0, briefly presented in the article, clearly indicate the need to reinterpret the content of past competencies. These include those derived from formal education systems, as well as those acquired in non-formal and informal education systems. Analysis of the research results of numerous reports entitles us to conclude that the formal education system constantly keeping up with current changes – adaptive and transmissive – is dysfunctional here. It is therefore necessary to design a synergistic – relational system, in which the results of formal education would

coincide with the general and professional competencies acquired for students that are up-to-date with those trained and developed in non-formal and informal education.

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