Development of Smart Technologies in Education in the Context of Modern Neuroscience and the War in Ukraine

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Abstract: *The article examines the problem of interdependence of post-industrial society and the level of education based on the study of scientific and periodical sources. The meaning of the concept of "smart education" is clarified, its main elements are described. Studying the development of smart education in different regions of the world, conclusions are made about the impact of economic inequality and objective negative processes such as war. On the other hand, if previously weaker states involved the elements of intelligent education at a slow pace, today the acceleration of this pace is dictated by the objective world situation. The topicality of the topic is confirmed by the global focus on education problems, since today the crisis demonstrated the practically underdeveloped mechanism of smart education in all countries, which in difficult conditions was the most unbalanced, and in some regions was absent at all. The practical significance of the article is that the conclusions about the application of neuroscientific analysis of smart technologies, especially foreign ones, can be used in the smart concept of our country.*

Keywords: *Information society, interactive educational environment, neuroscientific technologies, open universities, distance education.*

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Introduction

The purpose of the article is a theoretical study of the neuroscientific aspect and the level of development of intelligent education as a necessary condition for the existence of this society on a global scale, an analysis of achievements and difficulties, the ability to function in war conditions and options for further growth.

The analysis of the sources shows the lack of a single point of view regarding the interpretation of the concept of "smart education", since the study is based on various manifestations of social development: economy, digital technologies, psychological influence and neuroscientific aspect, etc. For the first time, the theory of post-industrial society was developed by Bell in the work "Future Post-Industrial Society: An Experience in Social Forecasting". Society progresses depending on the development of innovative technologies (Kalnytskyi, 2013). His theory is based on the economic side of the development of society and considers education and science as direct factors of production. Researcher Toffler defined the period in history of mankind since the second half of the 1970s as a time of great changes (Martynov, 2011). Lyotard (1979) believes that knowledge gives unlimited power in society. Later, there were more theories of post-industrial society, but all authors claimed the great role of scientific knowledge and education at this stage of development (Masuda (1981).

Empirical and theoretical studies demonstrate the profound achievements of smart education, powerful digital technologies and formats in advanced countries, but in practice these achievements cannot be used by the entire world community, since most regions do not have the financial, labor and cultural opportunities to implement them. . Therefore, from the point of view of axiological assessment, the availability of education for all regions of the world through the organization of effective distance education is more valuable. And through financing the industry on a global scale, creating at least the simplest basis for organizing distance learning, bringing the content of school programs closer to life needs, creating forms of work that would be interesting and motivating for students, forming sufficient competence among teachers. Distance education became especially important during the war.

The study of literary sources proves that in the interpretation of the theoretical features of post-industrial society and intelligent education, the opinions in principle coincide, but the analysis of its practical development by different authors is fundamentally different, since the research regions are different and the level of socio-economic development plays a decisive role.

In some regions, smart education using advanced information technologies is impossible for technical reasons: (lack of Internet, lack of digital resources, lack of skills and abilities of participants in the process). But a difficult test for world education was the war, which demonstrated large-scale inconsistencies in the organization of mass education regarding the need for distance learning. The state of education in Ukraine within the framework of distance learning is considered. War response programs for all countries are being developed, planning huge investments in education, changes in curricula and bringing education closer to real life and analyzing it from a neuroscientific point of view, because the problem turned out to be common, and the participants in the process are interdependent.

Educational inquiries in the context of neuroscience

In accordance with this in scientific approaches, there is a complex and contradictory process of reassessment of axiological orientations of a contemporary individual (Horbatenko, 2010; Nerubasska&Maksymchuk, 2020; Nerubasska et al., 2020). Cognitive science, as an interdisciplinary complex of various fields of knowledge, deals with the study of cognitive activity and functioning of the brain (Forey, 2004).

Cognitive science is based on the following disciplines:
1. Experimental psychology of cognition.
2. Philosophy of consciousness.
3. Neuroscience.
4. Cognitive anthropology.
5. Linguistics.
6. Informatics and artificial intelligence.

Cognitive science in the context of smart education includes three main theoretical approaches, which are clearly visible in modern publications:

1). A symbolic approach. The computer metaphor of human cognition considers the analogy of brain activity in the form of a personal computer, when functioning programs (software) are implemented on different "operating systems" (hardware) (Sherhin, 2008).

2). The modular approach assumes that the brain can be represented as a set of "modules" that depend on human genetics, develop and work independently of it.

3) Connectionism considers brain activity and cognitive processes in the form of a network consisting of neurons and connections between them. In the process of learning, connections between neurons can change (Luzzato, E., 2019). The neuroscientific approach is formed on the basis of

the study of the nervous system (Grosseck et al., 2011), in particular, the study of neurological and mental disorders (Lebedeva, 2012). This field of knowledge is related to the study and understanding of the working mechanism of the human brain. A central question in neuroscience is how the brain associates with observed behavior (Vakhovskyi, 2015).

Neuroscience is the latest basis in educational technologies, which studies various aspects of the functioning of the brain and nervous system, such a combination of sciences allows you to study the brain and explain how it functions in various spheres of human life. "Neurobiology" and "neuroscience" can practically be used as interchangeable aspects in smart education (Bembel, 2016). This approach has become a model for countries such as the United States, South Korea, Japan, and many European countries, where the global trend has been the creation of a smart society (Thienen et al., 2015).

The development of neuroscience also gave rise to new directions in psychology and physiology - neuropsychology (understanding the psyche through the study of cognitive processes), neurophysiology (the study of the functions of the nervous system), neuroethology (the understanding of animal behavior through the comparative study of the human nervous system) and neuroanatomy (the study of nervous structures and nervous systems person). New directions of research appeared, for example, social neuroscience (Development of the world market of educational technologies in the context of investment attractiveness, 2021).

One of the directions of modern neuroscience, which is actively developing, is educational neurobiology (Lyons and Beilock, 2012). This branch of neuroscience combines the efforts of researchers in the fields of cognitive neurobiology, developmental neurobiology, educational psychology, pedagogy and didactics in order to study the relationships between biological processes and learning activities. Most often, researchers in the field of pedagogical neurobiology study the neurobiological mechanisms of reading, mathematical calculations, attention and related difficulties (dyslexia, dyscalculia, etc.). According to the estimates of pedagogical neurobiology enthusiasts, the interdisciplinary data obtained in this field will allow in the near future to connect neurobiology and educational technologies and improve the quality of studying the disciplines in schools and universities, as well as to establish a direct dialogue between neuroscientists and teachers in the context of smart education.

One of the methods widely used in neuroeducation is biofeedback (BOS), which allows to evaluate and train cognitive abilities, as well as to present to the researcher and the researched the meaning of physiological

indicators within the framework of a clinical protocol, which includes two large groups:

- "neural feedback" (neurofeedback, neurotherapy), implemented on the basis of various parameters of the electroencephalogram (EEG) of the brain,

- biological feedback (biofeedback), which is carried out on the basis of cardiogram indicators, heart rate, breathing, etc.

Such approaches are especially important in education during the war, because smart technologies based on the neuroscientific principle are an opportunity to implement educational standards.

Development of smart technologies in education as a challenge of today

Technologies, developing rapidly and at a high level, radically change education. E-learning is emerging and has launched a new global phenomenon - smart education. Smart education is the use of interactive content from the repositories of the necessary content during learning in an interactive educational environment, i.e., computer technology, materials from the depositories of the necessary content. In contemporary education there are problems with training for the Smart-society (Vasylenko, 2014).

Since the 60s of twentieth century the education sector performs new tasks in developing a new generation that will be entirely prepared for a full life in postmodern society, focusing on self-education, self-development and self-identification (Milova, 2011, p.37). In the twenty first century education has changed dramatically. The cornerstone of these changes is new technologies that are being developed and implemented at all levels of education in many countries around the world.

Social transformations dictate new requirements to the world educational systems, because only through them modern demands for skilled labor resources, a certain level of digital literacy, linguistic mobility, etc., can be met. Educational structures are usually the most conservative in society; therefore reorganization of this industry is always associated with difficulties, to overcome which it is necessary to clearly understand the tasks, the experience of other countries in modernizing educational processes, the opportunities in one's own country (Tikhomirov, 2012). A specialist on the labor market should be competitive, and therefore their training programs must become more mobile, more realistic and practical. Every specialist in a smart society is focused on lifelong learning (Vozniuk & Yukhnevych, 2018).

FORBS magazine voiced the latest educational trends, which are fully consistent with the concept of smart education (Semenikhina, 2013),

which contains the following provisions: the leader in education is distance learning through interesting for students video lessons on different platforms, personal learning based on individual psychological characteristics, gamification of learning (simulation of situations through games), a system of rewards for performance to increase student motivation, change in presentation and interpretation of material through interactive textbooks (Gros, 2016).

The global concept of Smart-education began to take shape at regular conferences on this topic and involves creation of a smart environment that will accumulate and transform new ideas and knowledge, i.e., to form an intellectual field that will be the source and result of society development (Australia, Korea, the Netherlands, Japan).

Nowadays more and more people are learning remotely, and this will only spread. Korea, using smart technology since 1997, is now creating cyber-universities, all services of which are implemented on high technology. There are about 20 of them in the country (Education system South Korea, 2016). Researchers of online education monitor quantitative indicators of its spread (Sichkarenko, 2018). The project aims to promote twenty-first century learning through user-centric learning solutions (World experience in the development of distance forms of education in the domestic context. Analytical note, 2020).

In 2012, the United Arab Emirates (UAE) began investing in a smart learning program called the Mohammed Bin Rashid Smart Learning Program (MBRSLP), which aims to create a new learning environment and culture in their national schools by launching smart classrooms (Arbuthnott, 2009).

Obviously, the advent of information and communication technologies has changed the very concept of learning. But each country is developing this idea on its own basis. Let's compare two interesting but completely different education systems: Korean and Finnish.

South Korea deservedly holds the lead in the use of smart technologies in educational processes. Here, in 1996, the Law "On the Development of Informatization" was adopted, which began to introduce e-learning. South Korea not only proclaimed and has been promoting the concept of smart education since 2011, but has also been able to achieve high quality education and build a unique innovative economy (Yermoshenko, 2014). Practically this program has transformed all levels of education: cyber-schools are being created en masse, where about 85% of employees receive powerful advanced training in at least 10 subjects annually; 20 virtual universities have been created, which provide exclusively

all services in electronic mode. Graduates of these universities obtain diplomas of higher education. Students do not depend on place and time during their studies, choosing them independently. This form of education is much more effective for convenience in society and from an economic point of view. The interconnected educational units have formed a powerful e-learning industry under the control of special government agencies (Kalenzi, 2020). The South Korean government is building an infrastructure that promotes computer technology and develops a system of indicators to measure performance of e-universities (Mvenda, 2018).

Education departments have been set up in every province of South Korea. Each of them works in depth on a specific educational discipline, and all developments are exchanged between departments. All processes are under the control of the government, which pays constant attention to the introduction of new technologies. Open networks allow integration of students from different countries, recognition of their diplomas and improve opportunities for international cooperation. Smart education has completely changed the general approach to learning. Students were given unlimited choice of educational institutions and access to sources of information. The teacher now transforms from a source of information into a tutor who coordinates and manages the learning process. Students are not limited in time, access to content is constant, information can be expanded and deepened through interactive technologies. Teachers can pay enough attention to each student, taking an individual approach to education. This type of training allows for lifelong learning (Chun, 2018). We see a completely different approach in Finland, whose educational system today holds the focus of the world educational community (Simola, 2005). There are few private schools in Finland, no programs to work with gifted children. Finnish education is based on the concept that all children deserve equal opportunities to learn and succeed. In the Finnish educational system there are moral and material forms of teacher support, respect for teachers, equality, great attention to classes that do not belong to mathematics and science (sports, music, art) (Salminen, 2017).

The needs for education are constantly growing on a global scale and should be fully met by e-education, which unites educational institutions and teachers for the development of educational activities on the Internet on the basis of common criteria, technologies and standards. As a result, a common context accessible to the general public is formed. As a model we can consider the Single European University, where education is organized according to the principles of the Bologna Process (Euroeducation, 2021). Introduction of this process enables universities to accept students without

additional exams and this creates a smart space for Europe. The single European university organizes the learning process using a single joint depository of educational materials. In fact, the learning process in smart universities is fully organized through digital technologies, which provides ample opportunities for students who have the opportunity to get education closely related to practice at the most convenient time for them without a direct contact with the teacher. Professional sites can systematically add new information to training materials and update them. The main type of educational textbooks becomes an electronic textbook, which concentrates information from dictionaries, reference books, current textbooks, manuals and multimedia materials (Zhuang, 2017). Creation of electronic textbooks is a step towards formation of a universal educational environment, which will provide an opportunity for each student to study regardless of their place of residence. Students will be provided with up-to-date information, on the basis of which the professional competencies of a specialist familiar with the latest world achievements in a particular field will be formed. These technologies create their own learning strategy, it is possible to combine work with learning, using a convenient time for classes (Smith, 2016).

Neuroeducation is developing in two directions, on the one hand, on the initiative of neuroscientists who study the potential of the brain in order to improve the quality of education, on the other hand, teachers who are interested in new data on the peculiarities of the learning process (Papamitsiou, 2021).

However, despite the existing enthusiasm, this topic requires caution, a scientific approach to the substantiation of neurobiological ideas and the correct adaptation of the obtained data to practice.

War as a challenge of smart education

If earlier each country planned the pace of education development, based on its capabilities, then the war forced everyone to change education most actively (Guterres, 2020). Special attention is paid to the development of high-tech platforms for exchange and cooperation, the creation of innovative integration technologies and education, ensuring development in the field of education and individual growth.

The audience at the Global Smart Education Conference was very large. The event was attended by 3,000,000 people from around the world, including UNESCO and education and technology experts from the UK, Ghana, Canada, China, Russia, Serbia, Singapore, USA, France and Japan. (The Future of Education. Global Conference on Smart Education, 2021).

As part of the Global Conference on Smart Education 2020, the UNESCO Institute for Information Technology in Education, the Commonwealth of Education, the International Society for Information Technology in Education, the National Research University Graduate School of Economics and Beijing Normal University launched a joint project to rethink and change the national strategy for smart education. The goal of the five-year project is to explore key issues and trends in future education and find solutions for integrating information technology into education to ensure inclusive and equitable quality education so that everyone can enjoy lifelong learning opportunities.

During the conference, participants considered the impact of artificial intelligence on the future of education and discussed the latest achievements and trends in smart education. The conference program included 12 forums on the following topics: artificial intelligence and future education; future teacher education and professional development; smart education in the era of 5-G; governance and social aspects for artificial intelligence purposes; artificial intelligence and big data in education; K-12 education in the age of intelligence; open educational resources for inclusive education; a new ecosystem of regional smart development; smart village and smart social development; international natural education; information and communication technologies that contribute to innovation and development of higher education; smart education and education of the future. Based on the wide coverage of problems on the forums, it is possible to draw conclusions about the power of global educational developments.

It is clear that a significant number of countries cannot count on the urgency of the problems raised by the conference. Persistent inequalities in education have always been a concern, but the speed and scale of the changes brought about by the war made several serious problems apparent. First, it turned out that educational institutions are not only academic institutions; in fact, they still serve many functions. As soon as full-time education was suspended due to the war, it became immediately clear that children and families who had access to food and health care through schools now lost it had real problems. Social differences also appeared immediately: regions of residence, financial support of families, technical capabilities, basic needs, family situations, parental control capabilities, etc. - all this affected students' access to educational services.

Stressful situations also affected students' well-being and academic performance.

The need for distance education revealed problems in the content of education. Questions arose regarding the appropriateness of the content of

educational programs. After all, not only academic sciences, educational programs and student evaluations are important, it is necessary to support motivation to study, involve students in the process, activate their interest, and strengthen their connection with the school. This requires diverse, flexible and authentic learning activities. There is a serious need to rethink the content and approaches of educational programs, to reduce the excess of theoretical material, to bring education closer to the conditions of real life (Sustainable Development Goals, 2015). Representatives of almost all countries, regardless of the level of economic development, declare that education is disconnected from real life. For example, in Canada, the Council of Ministers of Education has prioritized global competencies in curricula that can be used in a variety of situations to build students' life skills for the future (Deslandes-Martineau, 2020). Indeed, school skills had little to do with real-life situations, leading students to think of boring and outdated knowledge (Long, 2021).

The OECD, in collaboration with UNESCO, UNICEF and the World Bank, monitors the situation in different countries and collects data on how each system is responding to the crisis, from closing schools and distance learning to vaccinating teachers and gradually returning to learning, the classroom. instruction. Scientists of the Department of General Secondary Education of the National Academy of Sciences of Ukraine conducted a number of studies in order to identify technical, organizational, and methodical difficulties during distance learning, and to outline ways of further development (Malyovani, 2020).

If we analyze these problems in Ukraine, we will see that they almost completely coincide with the difficulties that UNESCO voices. It is clear that every country is looking for ways to improve the situation. Thus, in Ukraine, the Ministry and the Digital Transformation Committee announced the "Laptop for every teacher" project. The national educational platform "Vseosvita", the educational project "Na Urok", etc. began to actively develop and accumulate content, but the quality of the content there does not always meet the needs of the participants.

Today, teachers use the One School, New Knowledge, HUMAN School, MOODLE, GOOGLE CLASSROOM, and other platforms. Online courses ED_ERA, PROMETHEUS, iLEARN have been created, where not only children, but also adults can get the desired knowledge (censor.net, 2021). Certainly, these are great achievements in a relatively short time. In considering a plan to prevent the consequences of war in the field of education, efforts should be made to address educational issues as a priority for organization and funding, because the crisis is so deep (UN Secretary-

General warns of education disaster, 2020). These actions should overcome the consequences of the crisis in education, provide support for students from socially vulnerable strata of the population and prevent them from dropping out, create harmonious relations between the participants of the educational process, reduce inequality, ensure the necessary investments in teaching methods and computer information technologies.

In the scientific environment, the number of terms with the prefix "neuro" is growing rapidly, which has already led to the emergence of such a concept as "neuroculture", which unites new fields of knowledge based on neuroscience. In contrast to neuroculture, the caustic term "neuromania" appeared, which mocks the modern desire to explain the complexity of human behavior by the activity of the brain.

Nevertheless, the number of advocates for using neuroscientific data in combination with other methods of analysis is growing. The assumption that the main level of analysis of human behavior is the study of the brain and the alleged personality and psyche, that is, the mental products of brain activity, can be neglected, is subject to criticism by neurobiologists and psychologists.

Conclusions

The post-industrial society, having changed the emphasis in economic tasks, really needs new approaches to education. The education system must form multifaceted professionals who will carry out the idea of lifelong learning, because in the economic sphere, changes occur instantly. People need to become mobile, capable of rapid professional transformations, know languages and digital technologies.

But in the context of globalization, it is impossible to ignore the fact that educational systems are quite conservative, they do not keep up with new needs, so they are in constant development and modernization. Developed countries are developing smart technologies that seek to expand and improve students' knowledge, communication skills, ICT literacy, form critical thinking, and apply an innovative approach to solving various communication tasks and problems. In most countries, smart education is just beginning to take shape, introducing certain elements and types. Thus, this type of education is not yet systemic on a global scale.

The war, which caused a crisis in education, forced almost the whole world to recognize unpreparedness of education for the large-scale use of information and communication technologies, while proving the need for this process in learning, because at the right time countries failed to quickly establish distance learning. And even those countries that belong to the

regions of advanced smart technologies, could not avoid termination of educational processes, specifically, in a crisis situation they could not quickly and fully deploy distance education.

Neuroscientists have so far failed to identify reliable cause-and-effect relationships between data describing the brain and behavior. Other important levels of analysis - psychological, social and cultural - cannot be ignored. It must be borne in mind that scientists have not yet come close to overcoming the gap between nervous mechanisms and mental processes. The task of neuroscience is to shed light on the mechanisms of the brain and their connection with mental phenomena.

The rapid changes in the world situation clearly demonstrate the need for accelerated global development of smart education. If earlier not all regions considered education as a primary focus in terms of investment and increased use of digital technologies.

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