

Professional Education of Adults: Technological Challenges in the Context of Neuroscience

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Abstract: *The article explores neuroscientific processes underpinning today's societal development, characterized by globalism, integration and informatization as technological challenges in adult professional education. Human development is viewed as an ongoing learning process, during which individuals constantly seek new experiences while transcending physical and conceptual boundaries across various industries, fields and styles. This extensive globalization serves as a dominant worldview and a guiding artistic direction. One lives in a new era marked by significant social advancements, scientific breakthroughs and extraordinary technological capabilities, particularly driven by the high-speed Internet, which play a crucial role in the evolution of neuroscience and highlights the importance of this research. In a world that is globalized and technologically advanced, ongoing learning and development are crucial to tackle integration processes and difficulties. Lifelong learning and self-enhancement are particularly vital for adults, especially in an increasingly competitive environment where individuals are expected to refine their knowledge and skills to deal with new social challenges effectively. This article aims to identify the neuroscientific factors that influence the evolution of adult professional education. It employs such methods as synthesis and analysis of adult extracurricular education in the context of neuroscientific insights. The findings indicate that competence in any field is cultivated throughout one's lifetime.*

Keywords: *Educational technologies, adult professional education, integration, informatization, extracurricular work, neurosciences.*

How to cite: Tymchuk, L., Vieilandie, L., Pavlova, V., Prokofyeva, L., Tadeush, O., & Bogdan, Z. (2024). Professional education of adults: technological challenges in the context of neuroscience. *Revista Românească pentru Educație Multidimensională*, 16(3), 443-455. <https://doi.org/10.18662/rrem/16.3/903>

Introduction

The social challenges of the 21st century reshape how one develops various competencies. Central to globalism is the individual, who plays a pivotal role in driving continuous progress. However, due to the achievements of humanity, individuals may choose not to engage with or influence social processes, as these often operate automatically. Thus, adult education, particularly regarding computer and technological literacy, is a vital element of progress and a foundation for future innovations.

Adult education is crucial for understanding the human capacity to learn at any age, including one's intellectual development in adulthood. Research on intellectual thinking at different life stages has been conducted by Novakova & Pashyna (2017) and Kudelia & Samokhin (2018). The exploration of intelligence is multifaceted, as seen in the theory of fluid and crystallized intelligence (Giddens, 1991), as well as that of multiple intelligences (Galtsova & Britsyna, 2017). The evolution of cognitive thinking has been examined by Goodchild & Janelle (2004). This article aims to investigate and analyze the challenges posed by technological development in adult education through the prism of neuroscience.

The problem of quality in professional education has a historical context, where interest in specific educational technologies largely depends on their level of development and the goals society sets for education. The long-standing dominance of the academic paradigm, which emphasizes the value of knowledge, has led the professional-pedagogical community to enrich the educational process with extensive information. This necessitates the cultivation of cognitive skills to acquire theoretical knowledge more effectively.

The gap between theoretical training of graduates from higher education institutions and their practical skills, coupled with market demand for young professionals who are ready for specific types of activity, has prompted a shift from the academic paradigm to a technological one. This transition has brought methods to the forefront that facilitate the acquisition of practical skills. Today, one can witness the flourishing of this approach, which has evolved into a competency-based model, aligning with the discourse prevalent in the Western education system and the language understood by employers. According to this model, professional training should bridge the gap between educational content and societal needs, thereby reducing the divide between theoretical and practical training and fostering the ability and readiness of future professionals to address specific types of challenges.

In the technological paradigm, competency is defined by the emphasis on actions and techniques implemented through active learning methods, as opposed to mere knowledge retention seen in the academic paradigm. Consequently, when evaluating learning outcomes, the focus shifts from monitoring knowledge acquisition to assessing competencies and the relevance of technologies within society, along with their practical applicability. The “usefulness” of the competencies or technologies being acquired significantly influences the type of the developed thinking (technocratic thinking) among both students and teachers, as well as the employed teaching methods. The most effective methods are those that quickly and economically achieve expected learning outcomes. This partly explains the rapid growth of online learning within the academic sphere and among individuals seeking to enhance their competencies or educational levels through a wide range of Internet-based programmes, despite the seemingly gradual digitalization of education.

The integration of digital devices and technologies significantly enhances the educational process, enabling control over the time, location and pace of learning while also reducing costs. This once again underscores the advantages of technocratism in education. However, brain-based learning, which aims to improve learning outcomes and quality, is not as widely embraced by the Ukrainian pedagogical community. The disparity between the digitalization of education and the limited application of findings from brain research, unlike advancements in neural networks or artificial intelligence, cannot be solely attributed to a lack of interest in these developments.

Neuroeducation, as a distinct approach, relies on theoretical and methodological foundations that describe the learning process at various analytical levels, namely, genetic, neural/physiological, cognitive/behavioural, phenomenological (student self-assessment of experiences) and sociocultural (the sociocultural context concerning education). Importantly, the focus is not limited to any single level, which is often the case at the neurobiological level, where many researchers initially sought to explain the mechanisms of learning.

Currently, the neurocognitive theory of learning encompasses three distinct areas: 1) neurophysiology, which focuses on the biological foundations of brain function and the study of the neural mechanisms underlying mental and nervous activity; 2) cognitive science, which investigates information processing patterns and the internal representation of experiences; 3) learning theory, which describes the essence of the

learning process and the dynamics of student-teacher” relationships (Filippova & Kovtunenکو, 2013).

Thus, the future of neurotechnology is expected to involve the development of digital applications that can directly monitor functional parameters of brain activity and enhance cognitive functions in both healthy and affected individuals through non-invasive methods.

One can see that there exists a more robust theoretical and methodological foundation for employing technical solutions based on brain function principles in other domains than in pedagogical practice. In Ukrainian research, neurotechnologies are primarily studied along with artificial intelligence, neuromarketing, neurosensory studies, cybernetics and the management of complex systems.

Theoretical principles of adult professional education in the context of technological development

The development of an individual capable of realizing their aspirations, achieving goals and expressing their distinct talents and personality traits reflects the historical evolution of human society. The origins of civilization are characterized by the emergence of humanity, which initially possessed limited knowledge and abilities, relying primarily on primitive tools. Over time, individuals improved their skills, made significant discoveries through the acquisition of new knowledge and repurposed these advancements to facilitate further revolutionary progress. In this way, humanity engaged in a continuous process of learning and use of acquired experiences, resulting in sustained advancement.

This overarching developmental trajectory can be compared to the processes occurring within one’s lifespan. An individual navigates and learns their role within society, acquires qualifications during their most productive years and, subsequently, applies their knowledge and experience for continued self-actualization in adulthood. These transformative processes are universal, suggesting that maturity is intrinsically linked to the educational experience (Gerasymova et al., 2019; Khatsaiuk et al., 2021; Kosholap et al., 2021; Nerubasska & Maksymchuk, 2020; Nerubasska et al., 2020; Ovcharuk et al., 2021).

A detailed analysis of relevant scientific sources reveals that people today tend to engage in more abstract thinking and perceive the world through a cognitive-emotional lens. This pattern of cognition is examined by Savin & Tiukhtenko (2015) and Filippova & Kovtunenکو (2013). They believe that cognitive skills reach their peak during adulthood when individuals are most effective in learning. It is during this stage that adults

possess the capacity to learn optimally. Concurrently, Voitovych (2007) investigates the individual processes of globalization that influence social needs, while Belenky et al. (1986) identify various models and stages of adult development.

Thus, one can conclude that technological advancements significantly impact professional education. Individuals acquire knowledge through personal self-development and self-directed learning, which are driven by their needs and individual perceptions of the effectiveness of such training. This self-directed approach can be effective since it is primarily fueled by internal motivation. The emergence of andragogy in the late 20th century marked a shift toward individualized, practical training for adults. This learning process incorporates effective pedagogical technologies and methods to facilitate the acquisition of new knowledge and skills by adult learners. Consequently, specialized curricula are developed, indicating that adult education is becoming more systematic, and the application of specific technologies is increasingly prevalent. Additionally, specialized institutions are being established, equipped with advanced educational technologies, to provide adults with enhanced learning opportunities.

Adult education has become the centre of professional interest for numerous researchers across various contexts. It is examined as an educational necessity, a pedagogical concept characterized by specific principles, technologies and learning methods, as well as a means of fostering social connections and relationships. Consequently, several issues emerge that contribute to the development of andragogic knowledge (Gordon et al., 2009).

The need for designing and implementing adult education programmes underscores the importance of establishing appropriate educational institutions. The 19th century witnessed the emergence of Sunday and evening schools, which continue to offer evening classes for individuals who work during the day. These learning environments leverage advancements in pedagogy and psychology tailored for adults (Gouthro, 2002). Such institutions were founded on the belief that adults face diminished opportunities and possess different learning capacities compared to their younger counterparts, necessitating the introduction of specialized approaches.

Extracurricular educational institutions were initially established to combat illiteracy and develop reading and writing skills, taking into account the unique ways in which adults perceive and retain information. The value of education is theoretically supported in the research by Cherep et al. (2019), who compare the significance of general education with overall

personal development. Sternberg (1997) further analyzes the meaning of education and develops theoretical frameworks surrounding the concept. In the context of professional education, this involves fostering cultural development within the broader population, while conventional schools prepare a specific segment of the population for this advancement.

Thus, the theoretical foundation of professional education has emerged as one of the most effective alternatives for adult learners. The findings of this research highlight the primary directions of today's educational practices aimed at teaching adults.

Much emphasis is placed on the potential of incorporating neurotechnologies as a component of digital technologies within the educational process. This integration facilitates the development of current teaching methods and the creation of favourable conditions to achieve expected learning outcomes. There is a direct link between the advancement of neuroeducation and the application of digital technologies in education, particularly through the proliferation of virtual technologies that enable contactless interaction between students and the "screen world" which simulates reality.

The prospects for using these technologies in professional education are underscored by the fact that virtual reality, augmented reality, immersive reality technologies, virtual intellectual maps, web quests and digital doubles (virtual prototypes) are grounded in one's understanding of how the brain processes information, manages temporal and spatial stimuli, as well as organizes neural interactions among various brain structures and regions. Simulation and modelling programmes immerse students in virtual environments, fostering a sense of realism that allows for developing professional skills as if they were being cultivated in real-world practice.

Therefore, theoretical principles of professional education are evolving concurrently with the technological advancement of society. They encompass the outcomes of pedagogical approaches to research and articulate concepts related to adult learning theories.

Adult professional education and technological advancements: a neuroscientific approach

Humanity currently navigates a turbulent information landscape, with technological and digital advancements occurring at an unprecedented pace. The integration of educational technologies presents significant challenges, particularly for individuals defined as adults, many of whom were born between the 1960s and 1990s and lacked exposure to digitalization or other elements that one now regards as the new normal (Tidd, 2006).

Consequently, adult education has emerged as a critical international issue. The UNESCO Institute for Lifelong Learning (2023) is actively exploring the possibilities of lifelong learning for adults, emphasizing the integration of knowledge into one's life and the accumulation of life experiences necessary for developing adult competencies.

The Internet serves as a global network that dissolves the boundaries between communities and nations. This environment fosters a complex interplay of factors that shape postmodern expressions, promoting inclusion and comprehensive integration. Adult education is fundamentally rooted in human needs within an innovative society. The concept of education encompasses a philosophical interpretation of lifelong learning, manifested in various forms and methods based on humanistic and democratic principles. This is operationalized through inclusive, distance and face-to-face educational formats, as well as diverse pedagogical technologies. International educational organizations describe the essential constants of learning, which include the ability to know, understand, coexist and cooperate.

Consequently, knowledge and skills become outdated at an accelerated pace, necessitating ongoing professional development and often retraining for specialists across various fields. In these turbulent times, adult education can serve as a “silver bullet”, providing equal opportunities for access to competitive professions through innovative technologies. The 21st-century society is characterized by mobility, with individuals increasingly willing to change their professions and places of residence in response to the dynamics of postmodern global society and new social conditions. This adaptability allows people to address societal challenges linked to technological advancement and the inherent need for socialization, which is fundamentally rooted in education (Imel, 1998). Adult education is essential for the continuous development of individuals in this new society.

Moreover, it is crucial to recognize that adult learning encompasses more than just the acquisition of technological innovations. It also involves the cultivation of values and meaningful orientations in the context of social integration and globalization, as individuals seek to understand the worldviews of other nations for effective socio-economic, political and cultural cooperation.

The professional environment of adult education fosters a competitive spirit within society, enhancing its readiness to respond to and adapt to changes while acquiring new skills and applying them effectively to achieve qualitatively new outcomes (Sternberg, 1997). Adults engage in learning consciously, so the adult learner must act with intention, harnessing

their potential. Their actions should be well-motivated, which contributes to the effectiveness of educational activities within the out-of-school education system.

Conversely, the pursuit of new knowledge and skills encourages individuals to step outside their comfort zones and confront intellectual challenges that may conflict with or challenge long-held beliefs and convictions formed over years of life experience. This process can disrupt foundational ideas about life attitudes, potentially leading to emotional distress. Thus, fostering emotional intelligence is essential to alleviate transitional difficulties and facilitate adaptation to the new challenges presented by society. Throughout the learning process, adults can transform their life goals, reshaping their perspectives and enabling such transformation. Adult students can integrate new ideas with their previous achievements in personal growth, thereby enriching their learning experience.

The examination of past actions and experiences for educational purposes involves reflection or self-reflection, leading to a deeper understanding of the new learning needs of adults. Effective learning requires a critical perspective toward new knowledge and approaches. However, the established beliefs shaped by prior experiences often prevent the acquisition of new skills across various domains.

The right to education is guaranteed by relevant international law, with the legal framework for professional education established by national legislation grounded in the principle of lifelong learning. This right is implemented through regulatory and legal institutions on a global scale, reflecting the integration of European values into society.

In today's socio-economic conditions characterized by the emergence of a new labour market, adult education has become essential. This shift necessitates the establishment of institutions dedicated to the professional training of adults aimed at acquiring new competencies. Additionally, demographic trends, such as declining birth rates, create a demand for skilled personnel from a more experienced, mature workforce, further stimulating the need for training.

Finally, European integration underscores the necessity for adult education, as there is a growing demand for specialists in various fields within the European market. Consequently, adults must acquire new knowledge and skills to adapt to the emergence of new professions.

One of the most significant factors contributing to a high level of professional education is the advancement of technologies, particularly neuroscientific innovations. Neurotechnologies encompass those designed

to enhance both hard and soft skills in students through methods such as virtual reality, immersive learning, gamification and interactive educational trajectories. For instance, experiments involving biofeedback have demonstrated that students who engage in interactive learning methods perform better on creative and cognitive tasks compared to those who rely on traditional teaching methods (Vernier Science Education, 2023).

In the context of neuroeducation, the focus is on developing personalized neurocompetencies (PNC) in students, which are grounded in the higher mental functions of the brain and nervous system, facilitating one's pre-adaptation to learning (Gerin & Fien, 2016). Concurrently, there is considerable optimism regarding the potential of virtual technologies and electronic devices to enhance the learning process (Howard-Jones, 2008).

Importantly, traditional psycho-pedagogical research often focuses on the changes in knowledge and behaviour that occur over extended periods, such as hours, weeks, months, or even years. However, these changes are mediated by neural processes that transpire in much shorter timeframes, often within milliseconds. Consequently, recent methods have been introduced into the educational process that allow teachers to receive near-instantaneous feedback regarding students' cognitive activity during lessons. For example, neurointerface technology enables the real-time monitoring of students' brain activity, providing teachers (or intelligent systems) with data that can be used to adjust the delivery of educational material according to students' current state, helping them concentrate or relax at the appropriate moments, thereby enhancing the effectiveness of material assimilation (Geake, 2008).

Currently, several promising approaches to the application of "brain-computer" interfaces in education have been identified. These include identifying the cognitive and affective states of students during instruction, monitoring the dynamics of students' cognitive activity intensity to optimize the pacing of material delivery, assessing the impact of electronic learning tools on information acquisition and promoting self-regulated learning (Gerin & Fien, 2016).

However, the shift toward a technological paradigm in neuroeducation does not negate the need for development. The conceptual foundations of this field do not adequately address the primary issue, namely, teachers' understanding of the neurobiological underpinnings of learning. One of the goals of neuroeducation is to integrate neuroscientific knowledge into the educational process to create effective educational technologies, yet this area is developing very slowly. Conversely, studies by foreign researchers indicate that teachers not trained in natural sciences can

alter their teaching methodologies after completing a master's course in the neurobiology of learning and memory, incorporating neurobiological principles into their practices (Geake, 2008). By understanding how stress and trauma can adversely affect learning, educators tend to adopt fewer authoritarian approaches and provide greater social and emotional support to their students.

The educational field itself constitutes a broad domain within adult education. As one of the first sectors to adapt to the new challenges posed by technological advancements, it has increasingly embraced innovative learning technologies and information and communication technologies. To stay current and responsive to changes in education, teachers are learning to use smartphones, laptops, multimedia boards, projectors and other technological devices, which creates a demand for additional technological training.

The Covid-19 pandemic has highlighted the challenges teachers face in effectively using the Internet for educational purposes. Considering that the average age of pedagogical professionals is between 40 and 45, many were born in an era "without the Internet and smartphones". Consequently, they require training in the latest technologies to facilitate effective educational practices. This situation underscores the necessity for targeted professional development aimed specifically at teaching staff.

Conclusions

This article studies the evolution of adult professional education in response to the challenges posed by technological development. The findings indicate that the theory of adult education emerged in the late 20th century, primarily aimed at eradicating illiteracy among the adult population. These approaches have demonstrated effectiveness by leveraging the inherent human capacity for continuing development. Consequently, there is a critical need for an organized learning environment that supports adults' self-realization throughout their lives.

An important aspect of professional education is the exploration of the neuroscientific approach. Understanding neuroconcepts, which explain the principles underlying neural processes related to memory, emotions and contextual learning, necessitates a rethinking of how teaching material is sequenced. Additionally, the persistence of neuromyths among teachers in both schools and higher education institutions remains a significant issue, despite substantial scientific evidence that proves these misconceptions.

Technological development and the challenges it causes have become essential prerequisites for establishing the foundations of

professional education. The growing trends of globalization and integration further necessitate improvements in professional education. Adults often require a more extensive and tailored adaptation period to Internet resources, as they frequently find themselves in a transitional phase and may lack confidence as Internet users.

As a result, the development and enhancement of the educational environment for adults is a pressing concern. The research findings support the view that societal technological advancement significantly impacts the quality of professional skill acquisition. Moreover, the neuroscientific approach plays a crucial role in transforming the educational process, leading to a higher level of professionalism.

Acknowledgement

Liudmyla TYMCHUK and Liliia VIEILANDIE analyzed theoretical principles of adult professional education in the context of technological development. Olena TADEUSH and Zhanna BOGDAN studied the use of a neuroscientific approach to adult professional education and technological advancements. Valeriia PAVLOVA and Lyubov PROKOFYEVA prepared the conclusion section.

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