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Neuropsychological Aspects of E-learning in Higher Education – Towards a New Educational Paradigm

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Abstract: *The use of e-learning in higher education institutions (HEIs) enables the development of new educational models. These models help ensure that teaching remains responsive to ongoing scientific and technological progress. It also enriches and diversifies instruction across different disciplines. E-learning enhances the didactic potential of current instructional tools. It fosters the adaptation of teaching content, forms, and methods to meet educational demands. Special attention is given to technologies that stimulate neuroplasticity, lower stress levels, and support effective teacher–student interaction. The findings are significant for improving the overall effectiveness of e-learning and for strengthening students' cognitive skills and emotional resilience. They create optimal conditions for developing students' intellectual potential in an increasingly digitalised educational environment. Finally, an empirical study was conducted to examine the attitudes of e-learning users in HEIs towards the digitalisation of education.*

Keywords: *e-learning; e-learning environment; e-learning technologies; digital education; digital literacy; cognitive skills; neuroplasticity.*

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1. Introduction

The relevance of this research topic in the international context stems from the fact that a key objective of state social policy is the establishment of a digital society. The development of a digital economy has become a central sphere of human activity. As a result, many sectors, including education, healthcare, and services, are adopting digital technologies. Accordingly, there is an increasing need to optimise distance learning technologies that enable remote education. The incorporation of e-learning is closely related to the general mechanism of digitalisation.

The process of digital transformation largely relies on the extensive use of AI tools and other technologies. These innovations shape the current educational environment. A critical requirement for implementing educational programmes at all levels in HEIs is the use of an electronic educational environment to support teaching and learning.

E-learning, which gained particular relevance during pandemics and other global crises, is now emerging as a new educational paradigm. This shift necessitates a reconsideration of its methodological and psychological foundations. In a digitalised learning process, understanding the neuropsychological mechanisms that influence students' ability to acquire information effectively is crucial.

In Ukrainian pedagogy, the concept of “digital literacy” is relatively new and has not yet received a precise definition. The development of digital literacy has been addressed in the works of Bykov et al. (2017), Demianenko (2015), and Tkachuk et al. (2021). In particular, digital literacy is viewed as an indicator for assessing human capital within the digitalisation of the economy. It reflects one's ability to use advanced ICT effectively, as well as readiness to integrate into the global digital space.

According to Muawanah et al. (2024), digital literacy consists of four important elements. They include proficiency with technology, communication skills, recognition of technological risks, and understanding of psychosocial challenges. Judrups (2016) also claims that e-learning should be seen as a distinct form of learning, alongside full-time, part-time, and external study, rather than merely a type of distance learning requiring no extra investment.

Accordingly, this article aims to: 1) demonstrate that digitalisation and digital literacy in education are driving global changes in the higher education paradigm; 2) argue that e-learning represents a current form of education; 3) examine the neuropsychological aspects of e-learning in HEIs, particularly the influence of the digital environment on students' cognitive development, and 4) present an empirical study on the attitudes of e-learning users in HEIs towards the digitalisation of education.

2. Theoretical Framework

The development of digital literacy has become a key priority in the context of e-learning. It directs new approaches to the theoretical and methodological foundations of education digitalisation, thereby establishing a new educational paradigm. Dritsas and Trigka (2025) note that this trend addresses labour market needs and, thus, broadens the scope of knowledge.

Indeed, the digitalisation of education reshapes the learning process. In this regard, the teacher acts as a consultant and mentor, interacting with students throughout the learning process. Specially designed electronic platforms and resources provide all the information necessary for lessons (Zhurat et al., 2020).

A detailed analysis of the literature on this issue led to the identification of the following functions of digital education (Gurevych et al., 2020; Haleem et al., 2022; Vovk et al., 2023; Zou et al., 2025):

- Significantly expanded opportunities for students – learners can study remotely from home via the Internet.
- Enhanced mobility of participants in the learning process.
- Broadened educational opportunities for institutions and organisations as actors in the digital economy, supporting the development of innovative learning formats.

- Simplified updating of educational resources – digital updates are faster, less labour-intensive, and more cost-effective than revising paper-based materials.
- Regular analysis of educational resources to ensure the relevance of content.
- Development of knowledge, skills, and competencies through the digital educational environment, providing learners with abilities applicable to real-life situations in the sociocultural context. This supports not only the acquisition of digital literacy but also effective interaction with digital interfaces.
- Formation of a new “digital” generation of students, acquiring essential knowledge through innovative educational approaches.
- Stimulation of students’ cognitive engagement through virtual reality, within the framework of new pedagogical knowledge known as “digital didactics”.

Thus, digitalisation serves as a primary transformer of the educational paradigm. It opens opportunities for acquiring and improving knowledge and for broadening students’ horizons. Digital technologies function as tools and environments that create new learning opportunities through technological platforms.

Todino (2025) identifies key technological platforms in e-education (see Table 1).

Table 1. Technological platforms of e-learning

No.	E-learning technological platforms	Role
1.	Cloud technologies	Enable storage of large volumes of information and provide convenient network access to educational resources.
2.	Online courses	Personalise learning, and increase flexibility.
3.	Mobile learning	Allows learners to choose the time, place, pace, and tools of learning. It relies on devices such as tablets, smartphones, and laptops.
4.	Adaptive learning	Creates a favourable learning environment. It also involves planning individual learning paths that consider each learner’s specific needs.
5.	Artificial intelligence (AI), virtual reality, and augmented reality	Facilitates interaction with the environment through visual perception, speech recognition, and intelligent behaviour, such as evaluating available information. This helps learners make informed decisions in achieving their learning objectives. AI in education is based on three key models: the pedagogical model, the educational platform model, and the learner model.

Source: Based on the findings of Todino (2025)

Today, AI functions as an effective teaching tool. It helps teachers improve the educational process, provide materials, assign tasks, and support other classroom activities (Zhou & Peng, 2025). Meanwhile, behavioural analytics examines students’ motivation and engagement in digital learning environments. It also supports the development of individual learning trajectories and includes various interventions based on psychographics, aimed at providing behavioural guidance to learners. Finally, gamification is a global trend that integrates game-based methods into learning. Playing while learning has become increasingly important for students, who have grown up surrounded by video games.

In this context, a critical issue in e-learning is the digital literacy of all participants in the educational process, including both academic staff and students. Lanham (1995) defines digital literacy as the ability to understand and use information presented in a variety of formats and from a wide range of sources using computers.

E-learning is a form of education in which the core of the learning process is focused, guided, and intensive independent work by the learner. This work is supported by specialised learning tools and supervised by a teacher. It is an interactive, often asynchronous process in which

participants engage both with each other and with digital learning resources. Importantly, the educational process is independent of learners' physical location.

Learning occurs within a structured pedagogical system. The key elements of this system include objectives, content, methods, tools, and organisational forms of learning. All of these elements are aimed at supporting independent knowledge acquisition (Beisembayeva et al., 2023).

E-learning systems are a product of society's ongoing informatisation and align with principles such as integration, humanisation, and self-sufficiency. They represent one of the most promising approaches in today's education. An e-learning environment enables students to learn from their homes. The main advantages are as follows: the ability to choose courses, more opportunities for independent study, the use of various materials, intrinsic motivation, and communicative engagement.

E-learning offers flexibility, modularity, parallelism, cost-effectiveness, and technological sophistication. Its main goal is to ensure accessibility and openness for all, regardless of location, status, or health. It is especially valuable for learners who cannot access traditional education, such as those with special needs. Open education seeks to integrate diverse information, promoting cohesion and self-sufficiency in learning (Mondal et al., 2025).

This approach ensures continuous, highly adaptable education while broadening access and addressing individual learning needs. E-learning technologies use visual aids and electronic references to provide supplementary information. They also include software tools for modelling schemes and processes, as well as testing modules for the objective assessment of knowledge (Culduz, 2024).

Artificial intelligence further enhances e-learning by enabling personalised learning paths tailored to individual learner characteristics within dynamic models. E-learning also supports a variety of study activities, including gamification elements that engage learners and maintain focus during remote learning (Melnik et al., 2021). Virtual reality (VR) combined with AI provides interactive experiences in a virtual environment, creating an integrated didactic, methodological, and interactive system. This facilitates the teaching of complex material through diverse presentation methods and research activities.

Learning becomes more effective when it is based on the direct observation of objects and phenomena. It allows learners to progress at a comfortable pace and provides opportunities for repeated practice and dialogue. The use of animation, high-quality graphics, and reference presentations helps learners perceive a course as a sequence of dynamic and visually engaging images. Learners can navigate through content modules, which enhances the clarity of material presentation. This also supports effective assessment and monitoring of knowledge acquisition (Aysolmaz & Reijers, 2021).

Therefore, e-learning provides accessibility, flexibility, objective assessment, and technological support. At the same time, challenges include the need for self-discipline, the high cost of equipment, and time management.

3. Research Methodology

Data were collected through an online questionnaire developed in Google Forms, comprising 10 questions designed to assess respondents' awareness, experience, and attitudes towards digitalisation in education. The survey was conducted in January–February 2025, and participation was anonymous and voluntary.

The sample consisted of 101 respondents (see Fig. 2), all of whom were users of digital educational platforms and applications. Ages ranged from 20 to 36 years and older (see Fig. 3). Male respondents predominated, reflecting the characteristics of the sample; however, this does not imply representativeness for the wider learner population.

The majority of participants were aged 24–35 years (45.8%), representing the largest age group in the sample. Within this range, respondents aged 26–35 years (25 %) were identified as a

subgroup. To ensure consistency in the analysis, a single age classification was applied, avoiding overlapping or duplicated categories.

Respondents over 36 years accounted for 16.7%, indicating lower representation of older participants in the sample. Those aged 20–24 years comprised 12.5 % of the sample, likely reflecting lower participation from this younger group.

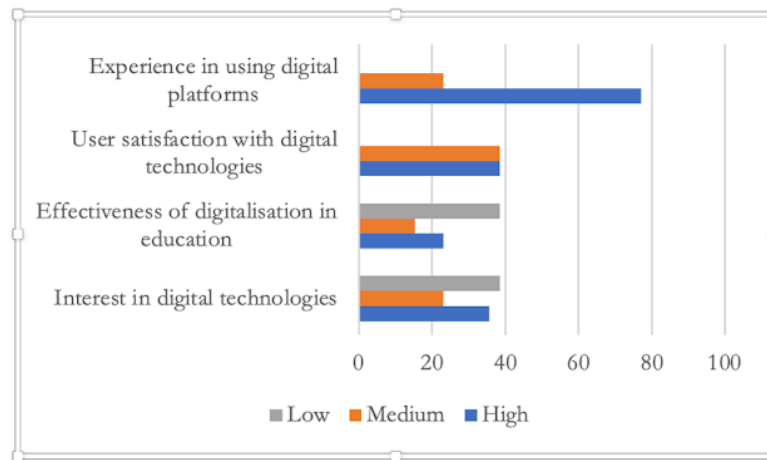


Figure 1. Overview of survey results on HEI users' attitudes towards the digitalisation of education
Source: the authors' own conception

To assess respondents' experience and attitudes towards the digitalisation of education, a three-level ordinal scale (low, medium, high) was employed. The low level indicated no experience or only occasional use of digital educational platforms, as well as little or no interest in digital tools. The medium level represented sporadic use of platforms, with neutral or selective attitudes towards digital elements in learning. The high level reflected regular use of digital educational platforms, a positive attitude towards digitalisation, and interest in further implementation.

According to Figure 1, 77% of respondents were classified in the high-level category, reporting regular use of digital platforms. However, other responses indicate variability in engagement and attitudes. For example, 63.6% reported encountering digitalisation elements only occasionally or not at all in certain contexts, and 50% expressed no interest in virtual platforms or simulations. Furthermore, 61.6 % did not support personalising the learning process with gamified elements, preferring traditional teaching methods.

Regarding the perceived effectiveness of digital technologies, 46.2 % considered them effective. Conversely, 53.9 % did not view digitalisation as an effective or desirable teaching tool, highlighting a lack of consensus on its pedagogical value. Satisfaction with digital platforms was evenly split: 38.5 % of respondents were satisfied, and 38.5 % were dissatisfied. This reflects a polarisation of opinions and an unstable evaluation of practical experience. Frequency of contact with digitalisation also varied. Around 30.8 % had no experience using digital technologies in learning, whereas 28.1 % reported that digitalisation was very frequently present.

Taken together, these findings indicate that, despite the predominance of high-level experience with digital platforms, respondents hold mixed attitudes towards their effectiveness and appropriateness. The results suggest that further investigation is required before drawing conclusions regarding large-scale implementation of digital technologies in education. Future research should investigate effective mechanisms of digitalisation across educational levels (school, college, university) and disciplines. It should also examine variations depending on learner types and specific educational needs. Continued empirical studies will help resolve existing contradictions in evaluating this educational technology.

4. Neuropsychological Aspects of E-Learning in Higher Education Institutions

E-learning is becoming an important part of the educational system, affecting all aspects of students' cognitive functioning. In the neuropsychological context, it positively affects cognitive abilities and optimises the educational process as a whole.

In addition, digital technologies promote multitasking. They enable students to analyse various information and, thus, support integrated brain activity. Interactive tasks can improve working memory and, yet, they may also limit deep learning when processing is superficial (Small et al., 2020).

An e-learning environment can cause certain neuroplastic changes (Pedersen et al., 2022). This process is primarily related to managing brain strain since information overload may lead to “digital stress” and decrease cognitive performance. It follows that mental exhaustion should be prevented with the help of regular breaks.

Excessive use of digital technologies, however, can cause memory problems and negatively impact the structure and function of the brain. Given that the brains of adolescents and young adults are still in the process of maturing, this is indeed concerning. It is during this stage that the prefrontal cortex undergoes major developmental changes.

The widespread use of digital technologies may lead to reduced productivity and increased emotional sensitivity. Difficulty in regulating thoughts and emotions is often linked to smartphone overuse. This can also contribute to social media addiction.

There is a phenomenon known as “digital anhedonia”. This condition prevents individuals, particularly young people, from enjoying the real world as a result of extensive exposure to highly stimulating digital content. Accordingly, overstimulating the brain makes the pathways for natural reward less sensitive. This issue is particularly critical during childhood brain development, when neural circuits responsible for motivation and emotional regulation are still maturing.

When used appropriately and in moderation, digital tools can support and even optimise brain function. However, excessive exposure to content that triggers dopamine release too easily carries the risk of disrupting these neural circuits.

5. Conclusion

The article demonstrates that the traditional approach to organising the educational process in HEIs is undergoing a fundamental transformation. This involves the wider use of ICT, new instructional strategies, and updated assessment methods.

The article also emphasises the role of e-learning as a key form of education. In this approach, the core of the learning process consists of focused, controlled, and intensive independent work by the learner. This work is conducted using specialised learning tools under the guidance of a teacher. E-learning is an interactive, asynchronous process in which participants engage both with one another and with learning tools. Importantly, the educational process is independent of spatial location. Learning takes place within a specific pedagogical system. This system comprises elements such as objectives, content, methods, tools, and organisational forms of learning, all designed to facilitate independent knowledge acquisition.

Research in cognitive science and neuropsychology indicates that e-learning can influence brain functioning. It can affect the development of attention, memory, thinking, and emotional stability. However, these benefits are accompanied by certain challenges, including reduced motivation, cognitive overload, and limitations in interpersonal communication.

Statement on the Use of Artificial Intelligence

AI technologies (ChatGPT, OpenAI) contributed to drafting and editing, while all analysis and conclusions remained the responsibility of the authors.

References

- Aysolmaz, B., & Reijers, H. A. (2021). *Animation as a dynamic visualization technique for improving process model comprehension*. *Information & Management*, 58(5), Article 103478. <https://doi.org/10.1016/j.im.2021.103478>
- Beisembayeva, A., Ibrayeva, K., Yerezhepov, T., Urazaliyeva, M., & Sultangaliyeva, E. (2023). *Pedagogical design as a tool to increase students' learning motivation during distance learning*. *Open Education Studies*, 5(1), Article 20220211. <https://doi.org/10.1515/edu-2022-0211>
- Bykov, V. Y., Spirin, O. M., & Pinchuk, O. P. (2017). *Problemy ta zavdannia suchasnoho etapu informatyzatsii osvity* [Challenges and objectives at the current stage of education informatisation]. In V. H. Kremen (Ed.), *Naukove zabezpechennia rozvytku osvity v Ukraini: aktualni problemy teorii i praktyky (do 25-richchia NAPN Ukrainy)* [Scientific support for developing education in Ukraine: Current issues in theory and practice (On the 25th anniversary of the National Academy of Educational Sciences of Ukraine)] (pp. 191–198). The “Sam” Publishing House. <http://lib.iitta.gov.ua/id/eprint/709026/1/%D0%9F%D1%80%D0%BE%D0%B1%D0%BB%D0%BD%D1%82%D0%B0%D0%B7%D0%B0%D0%B2%D0%B4%D0%B0%D0%BD%D1%84%D0%BE%D1%80%D0%BC%D0%B0%D1%82%D0%B8%D0%B7%D0%B0%D1%86%D1%96%D1%97%D0%BE%D1%81%D0%B2%D1%96%D1%82%D0%B8.pdf>
- Culduz, M. (2024). *Benefits and challenges of e-learning, online education, and distance learning*. In L. Gray & S. Dunn (Eds.), *Incorporating the human element in online teaching and learning* (pp. 1–27). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3693-4131-5.ch001>
- Demianenko, V. M. (2015). *Osoblyvosti pidhotovky pedahoha do vykorystannia elektronnykh resursiv* [Preparing teachers for the effective use of electronic resources]. *Osvita ta rozvytok obdarovanoi osobystosti [Education and Development of Gifted Personality]*, 8(39), 20–22. <http://otr.iod.gov.ua/images/pdf/2015/8/06.pdf>
- Dritsas, E., & Trigka, M. (2025). *Methodological and technological advancements in e-learning*. *Information*, 16(1), Article 56. <https://doi.org/10.3390/info16010056>
- Gurevych, R. S., Shakhina, I. Y., & Podzygun, O. A. (2020). *Google Classroom as an effective tool of smart learning and monitoring of students' knowledge in vocational schools*. *Information Technologies and Learning Tools*, 79(5), 59–72. <https://doi.org/10.33407/itlt.v79i5.3651>
- Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). *Understanding the role of digital technologies in education: A review*. *Sustainable Operations and Computers*, 3, 275–285. <https://doi.org/10.1016/j.susoc.2022.05.004>
- Judrups, J. (2016). *Knowledge management and e-learning integration model (KMELI)*. In *Proceedings of the 18th International Conference on Enterprise Information Systems (ICEIS 2016)* (Vol. 1, pp. 588–593). SciTePress. <https://www.scitepress.org/papers/2016/59162/59162.pdf>
- Lanham, R. (1995). *Digital literacy*. *Scientific American*, 273(3), 160–161. <https://es.scribd.com/document/14717077/Lanham-Digital-Literacy>
- Melnyk, Y., Drapak, H., Sverdlyk, Z., Tsilyna, M., Varenko, V., & Boichuk, N. (2021). *Experience of theory and practice of the process of implementing information technologies in the educational environment*. *International Journal of Computer Science and Network Security (IJCSNS)*, 21(4), 75–79. <https://doi.org/10.22937/IJCSNS.2021.21.4.11>
- Mondal, A., Kundu, D., & Chatterjee, N. (2025). *The role of e-learning in modern education*. *Journal of Scholastic Engineering Science and Management*, 4(4), 9–15. <https://doi.org/10.5281/zenodo.15194906>

- Muawanah, U., Marini, A., & Sarifah, I. (2024). *The interconnection between digital literacy, artificial intelligence, and the use of e-learning applications in enhancing the sustainability of regional languages: Evidence from Indonesia*. *Social Sciences & Humanities Open*, 10, Article 101169. <https://doi.org/10.1016/j.ssaho.2024.101169>
- Pedersen, J., Rasmussen, M. G. B., Sørensen, S. O., Mortensen, S. R., Olesen, L. G., Brage, S., Kristensen, P. L., & Grøntved, A. (2022). *Effects of limiting digital screen use on well-being, mood, and biomarkers of stress in adults*. *npj Mental Health Research*, 1, Article 14. <https://doi.org/10.1038/s44184-022-00015-6>
- Small, G. W., Lee, J., Kaufman, A., Jalil, J., Siddarth, P., Gaddipati, H., Moody, T. D., & Bookheimer, S. Y. (2020). *Brain health consequences of digital technology use*. *Dialogues in Clinical Neuroscience*, 22(2), 179–187. <https://doi.org/10.31887/DCNS.2020.22.2/gsmall>
- Tkachuk, S., Poluboiaryna, I., Lapets, O., Lebid, O., Fadyeyeva, K., & Udalova, O. (2021). *Technological aspects of the use of modern intelligent information systems in educational activities by teachers*. *IJCSNS International Journal of Computer Science and Network Security*, 21(9), 99–102. <https://doi.org/10.22937/IJCSNS.2021.21.9.12>
- Todino, M. D. (2025). *Educational technologies*. *Encyclopedia*, 5(1), Article 23. <https://doi.org/10.3390/encyclopedia5010023>
- Vovk, M., Solomakha, S., & Hryshchenko, Y. (2023). *Zmist ta orhanizatsiini zasady praktychnoi pidhotovky maibutnikh pedahohiv u zakladakh vyshchoi pedahohichnoi osvity Ukrainy: rezultaty monitorynhovoho doslidzhennia* [Content and organisational principles of practical training for future teachers in Ukrainian higher pedagogical education institutions: Results of a monitoring study]. *Visnyk Kafedry YuNESKO Neperervna profesiina osvita XX stolittia [UNESCO Chair Journal Lifelong Professional Education in the 21st Century]*, 1(7), 22–38. [https://doi.org/10.35387/ucj.1\(7\).2023.22-38](https://doi.org/10.35387/ucj.1(7).2023.22-38)
- Zhurat, Y., Lipshyts, L., Soter, M., Chumak, L., Tarasenko, H., Valchuk-Orkusha, O., & Melnyk, I. (2020). *Developing professional subjectivity in future primary school teachers in the context of a neuropedagogical approach*. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, 11(2Sup1), 64–81. <https://doi.org/10.18662/brain/11.2Sup1/95>
- Zou, Y., Kuek, F., Feng, W., & Cheng, X. (2025). *Digital learning in the 21st century: Trends, challenges, and innovations in technology integration*. *Frontiers in Education*, 10, Article 1562391. <https://doi.org/10.3389/feduc.2025.1562391>
- Zhou, M., & Peng, S. (2025). *The usage of AI in teaching and students' creativity: The mediating role of learning engagement and the moderating role of AI literacy*. *Behavioral Sciences*, 15(5), Article 587. <https://doi.org/10.3390/bs15050587>