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TRANSFORMING THE COGNITIVE CONDITIONS OF ONLINE LEARNING IN HIGHER EDUCATION

ТРАНСФОРМАЦІЯ КОГНІТИВНИХ УМОВ ОНЛАЙН-НАВЧАННЯ У ВИЩІЙ ОСВІТІ

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ABSTRACT

The current stage of higher education development is characterized by a deep digital transformation, accompanied by the active implementation of online and distance learning. The availability of information, the increase in the number of digital stimuli and multitasking significantly change the nature of the cognitive activity of higher education students, which significantly affects the cognitive conditions

Сучасний етап розвитку вищої освіти характеризується глибокою цифровою трансформацією, що супроводжується активним впровадженням онлайн- та дистанційного навчання. Доступність інформації, зростання кількості цифрових стимулів і багатозадачність істотно змінюють характер пізнавальної діяльності здобувачів вищої освіти, що суттєво впливає на когнітивні умови освітнього

of the educational process, in particular, on concentration of attention, cognitive load, information processing and the ability to self-regulate educational activity. The growth of information noise, multitasking, the constant presence of digital distractions, and the use of artificial intelligence tools are shaping a new cognitive reality of learning that requires scientific understanding. Therefore, the task of higher education is to reorient the educational process from the transmission of knowledge to the development of students' cognitive competencies, in particular the skills of conscious thinking, concentration, information hygiene, and self-regulation in the digital educational environment. This problem becomes particularly important in conditions of long-term distance learning, which increases the cognitive load and the risks of superficial assimilation of educational material.

*The **purpose** of the article is to study changes in the cognitive conditions of higher education students in online format in order to substantiate recommendations for organizing the educational process in conditions of increasing information load and digital transformation of education.*

*The research **methodology** is based on a combination of systemic, interdisciplinary and cognitively oriented approaches, which made it possible to carry out a holistic analysis of changes in cognitive conditions of learning in higher education in the online learning environment. In the research process, general scientific (comparative analysis, systematization, classification, generalization) and empirical methods (search, questionnaire, quantitative and qualitative analysis) were used.*

*The following **results** were achieved as part of the study: a theoretical analysis of modern scientific approaches to understanding the transformation of cognitive conditions of online learning in higher education was carried out; the results of a survey of bachelor's degree applicants at the National Technical University "Kharkiv Polytechnic Institute" were provided, the purpose of which was to determine the features of concentration of attention, the level of information overload, the prevalence of multitasking, and the specifics of the use of digital technologies, in particular artificial intelligence tools, in educational activities. Changes in cognitive requirements for the organization of the educational process were identified. Based*

процесу, зокрема на концентрацію уваги, когнітивне навантаження, інформаційну обробку та здатність до саморегуляції навчальної діяльності. Зростання інформаційного шуму, багатозадачності, постійна присутність цифрових відволікаючих чинників і використання інструментів штучного інтелекту формують нову когнітивну реальність навчання, що потребує наукового осмислення. Тому задачею вищої школи є переорієнтація навчального процесу з трансляції знань на розвиток когнітивних компетентностей студентів, зокрема навичок усвідомленого мислення, концентрації уваги, інформаційної гігієни та саморегуляції в умовах цифрового освітнього середовища. Особливої значущості ця проблема набуває в умовах тривалого дистанційного навчання, що посилює когнітивне навантаження та ризики поверхневого засвоєння навчального матеріалу.

***Метою** статті є дослідження змін когнітивних умов навчання здобувачів вищої освіті в онлайн-форматі з метою обґрунтування рекомендацій щодо організації освітнього процесу в умовах посилення інформаційного навантаження та цифрової трансформації освіти.*

***Методологія** дослідження ґрунтується на поєднанні системного, міждисциплінарного та когнітивно спрямованого підходів, що дало змогу здійснити цілісний аналіз змін когнітивних умов навчання у вищій освіті в середовищі онлайн-навчання. У процесі дослідження застосовано загальнонаукові (порівняльний аналіз, систематизація, класифікація, узагальнення) та емпіричні методи (пошук, анкетування, кількісний та якісний аналіз).*

*У рамках дослідження було досягнуто наступних **результатів:** здійснено теоретичний аналіз сучасних наукових підходів до осмислення трансформації когнітивних умов онлайн-навчання у вищій освіті; надано результати анкетування здобувачів бакалаврського рівня освіти Національного технічного університету «Харківський політехнічний інститут», метою якого було визначення особливостей концентрації уваги, рівня інформаційного перевантаження, поширеності багатозадачності та специфіки використання цифрових технологій, зокрема інструментів штучного інтелекту, у навчальній діяльності. Виявлено зміни когнітивних вимог до організації навчального процесу. На основі*

on the generalization of the results obtained, practical recommendations were formulated for optimizing online learning, aimed at developing cognitive self-regulation skills, forming information hygiene, and supporting conscious learning in the digital educational environment.

*The **conclusions** substantiate that modern online learning creates contradictory cognitive conditions, combining the expansion of autonomy with increased cognitive risks, which highlights the need to revise approaches to organizing the educational process for the purposeful development of cognitive self-regulation and conscious thinking of higher education students.*

Keywords: *artificial intelligence, cognitive learning conditions, cognitive load, digital technologies, information hygiene, information noise, online learning.*

узагальнення отриманих результатів сформульовано практичні рекомендації щодо оптимізації онлайн-навчання, спрямовані на розвиток навичок когнітивної саморегуляції, формування інформаційної гігієни та підтримку усвідомленого навчання в цифровому освітньому середовищі.

*У **висновках** обґрунтовано, що сучасне онлайн-навчання формує суперечливі когнітивні умови, поєднуючи розширення можливостей автономії з підвищенням когнітивних ризиків, що актуалізує необхідність перегляду підходів до організації освітнього процесу для цілеспрямованого розвитку когнітивної саморегуляції та усвідомленого мислення здобувачів вищої освіти.*

Ключові слова: *штучний інтелект, когнітивні умови навчання, когнітивне навантаження, цифрові технології, інформаційна гігієна, інформаційний шум, онлайн-навчання.*

INTRODUCTION

The rapid development of digital technologies and the large-scale implementation of online learning have led to a significant transformation of the cognitive conditions of the educational process in higher education (García-Morales et al., 2021). While traditional face-to-face learning was based on a relatively stable learning environment with clearly defined time and space boundaries, the online format is characterized by openness, multi-channel and high saturation with information flows. In such conditions, the ways in which students perceive, process and comprehend educational information change, and the requirements for cognitive self-regulation, concentration of attention and the ability to think consciously increase.

It is necessary to take into account the fact that in modern society the stage has ended when the possession of knowledge as such determined the level of professional and educational success. The high level of accessibility of information through digital resources and the Internet has significantly transformed the role of knowledge in the education system (Sych et al., 2021). Under these circumstances, the key challenge is not the accumulation of information, but the ability to consciously select, critically understand and effectively use it. In these conditions, modern education is increasingly focused not on the transmission of knowledge, but on the development of the ability to intellectually process information in conditions of its excess.

The formation of information hygiene skills, in particular the ability to manage information flows, minimize the impact of information noise, and maintain concentration on educational and professional tasks, is becoming relevant for the educational process in online learning environments. The information overload of the modern environment directly affects the cognitive processes of education seekers, reducing the duration and depth of concentration, fragmenting thinking and complicating the process of meaningful learning. At the same time, online learning opens up new opportunities for individualizing educational trajectories, developing the autonomy of education seekers and using digital thinking support tools (Krylova-Grek & Shyshkina, 2021).

The ability to concentrate attention is considered one of the basic meta-competences of a modern specialist, which is directly related to the level of self-regulation, critical thinking and learning autonomy. The higher the level of uncontrolled information noise, the weaker the mechanisms of focusing attention become, which requires targeted pedagogical strategies for the development of cognitive stability.

In this context, the need for scientific understanding of changes in cognitive conditions of learning in an online environment is becoming more urgent. The study of these processes is important for the development of effective educational strategies aimed at preserving the quality of learning, developing concentration skills, information hygiene, and conscious interaction with digital technologies. The role of the teacher is to create a learning environment that promotes the formation of concentration skills, conscious perception of information, and deep intellectual work.

The **purpose** of this article is to research into the transformation of cognitive conditions of online learning for higher education students to determine pedagogical guidelines for organizing the educational process in the context of increasing information load and digitalization of learning.

THEORETICAL FRAMEWORK

The problem of information overload and its impact on the cognitive processes of higher education students in online learning is considered in both foreign and domestic literature. Online learning creates specific conditions for the formation of extragenic cognitive load, which is not directly related to the content of the educational material, but significantly affects the effectiveness of students' cognitive activity. At the same time, an excessive number of visual and informational elements of the digital educational environment can reduce the depth of understanding and contribute to the superficial processing of knowledge. A review of the cognitive load theory in the digital educational context shows that excessive external load reduces resources for deep learning (Skulmowski., & Xu, 2021).

The educational environment significantly influences the online learning process. Due to its flexibility, it enhances both the positive and negative aspects of distance learning compared to traditional face-to-face learning. Empirical evidence highlights the importance of a “low-noise” environment for maintaining attention (Liu, 2023).

At the same time, the active introduction of digital technologies into the educational process expands the possibilities of engaging students in learning and at the same time increases the risks of cognitive distraction (Hasynets et al., 2024). Digital tools that support educational activities often become factors in reducing concentration and productivity (Pérez-Juárez et al., 2023).

Cognitive limitations of attention, memory and thinking are exacerbated by constant, disparate information stimuli that arrive fragmented, unsystematic and often without logical connection between them. Even short-term digital interruptions lead to a significant decrease in cognitive efficiency. In particular, switching between media and educational documents impairs integrative processing and understanding of information (Haverkamp et al., 2024), and smartphone use negatively affects concentration and academic engagement (Deng, et al., 2024). Students who frequently switch between academic activities and non-academic digital content demonstrate superficial information processing strategies, poorer retention, and lower analytical thinking skills. Upon returning to the main task, participants typically require additional time to regain full concentration. (Kostić & Ranđelović, 2022). In the behavioral

dimension, overload can alter decision-making, cause avoidance strategies or superficial processing of information.

In modern conditions, the negative impact of information stress on the mental state of higher education students is increasing. This impact is especially noticeable due to the significant volume of educational tasks that must be completed in a short time, as well as due to constant information overload (Pundiev, 2024). Such redundancy is subjectively experienced as a stressful situation that reduces the effectiveness of cognitive and mental processes, activates the protective mechanisms of the psyche, and prevents full, deep intellectual processing of information and its transformation into conscious personal knowledge. (Grabovska & Musakovska, 2020).

Due to the fact that the development of intellectual capital is based on the qualitative updating of knowledge, the modern system of higher education should focus not only on the transmission, processing and accumulation of information. Its key task is the creation of new knowledge and the active transformation of information resources, performing a kind of "engineering" role in working with modern information flows. (Pshenychna, 2023).

In this context, the role of the teacher as a moderator of the learning environment, capable of forming in students a critical attitude towards digital stimuli, awareness of their impact on learning outcomes, and skills for self-regulation of behavior, is growing. The formation of such skills is a necessary prerequisite for the long-term effective and pedagogically balanced use of technologies in higher education.

METHODOLOGY

To achieve the goal, a complex of general scientific methods was applied, in particular comparative comparison, systematization, classification and generalization, as well as empirical methods – information search, questionnaires, quantitative and qualitative processing of the obtained data, which ensured the scientific validity, integrity and reliability of the research results. To study the transformation of students' cognitive conditions of online learning, a questionnaire with a Likert scale (1–5) was developed, where 1 – the student completely disagrees, 5 – the student completely agrees. The questionnaire included blocks aimed at assessing the cognitive conditions of learning, the impact of information noise, the level of cognitive self-regulation, the use of artificial intelligence tools, and the perception of transformations in the educational process.

Questionnaire structure:

BLOCK 1. Cognitive conditions of learning.

1. I have difficulty maintaining my attention for long periods of time during study sessions.
2. I often get distracted while completing study tasks.
3. The study material requires more effort from me to concentrate than before.
4. I feel information overload when studying.

BLOCK 2. Information noise and digital distractions (scale 1-5).

1. Messages in messengers prevent me from focusing on my studies.
2. Social media reduces my ability to immerse myself deeply in the learning material.
3. I often combine studying with viewing other digital content.

4. I feel tired from the constant flow of information.

BLOCK 3. Concentration and cognitive self-regulation (scale 1-5).

1. I can consciously manage my attention while studying.
2. I find it easy to focus on complex intellectual tasks.
3. I use my own strategies to maintain concentration (planning, pausing, etc.).
4. I experience a decrease in the quality of thinking when multitasking.

BLOCK 4. Use of artificial intelligence in education (scale 1-5).

1. I use artificial intelligence tools (ChatGPT, etc.) for training.
2. Artificial intelligence helps me complete learning tasks faster.
3. Using AI reduces my need for deep understanding of the material.
4. I believe that AI cannot replace the thinking work of a teacher.

BLOCK 5. Perception of learning transformation (scale 1-5).

1. Modern learning requires more concentration skills than knowledge.
2. The ability to focus is a key condition for successful learning.
3. The role of the teacher has changed from a source of knowledge to an organizer of thinking.
4. I feel the need to develop information hygiene skills.

BLOCK 6. Open questions.

1. What factors most interfere with your concentration while studying?
2. What conditions help you concentrate better?
3. How, in your opinion, should the educational process change to take into account digital challenges?

To process the results, quantitative analysis of scale data and qualitative analysis of open-ended responses were used.

RESULTS

The transformation of cognitive conditions of online learning is manifested in the increased influence of information noise, fragmentation of attention, increased multitasking, and a decrease in the depth of intellectual processing of educational material.

Disparate information stimuli in the modern educational environment represent fragmented, unsystematic, and contextually inconsistent information signals that reach learners from various digital and communication channels and make it difficult to maintain sustained cognitive focus. Such stimuli include numerous notifications from messengers and social networks, push notifications from mobile applications, emails, multimedia content with a clip structure, as well as the parallel use of several educational platforms and digital resources during learning activities. A characteristic feature of these stimuli is the lack of logical sequence, semantic hierarchy and clear structure, which causes constant switching of attention.

From the point of view of cognitive psychology, the impact of disparate information stimuli is manifested in a decrease in the ability to concentrate for a long time, superficial

processing of educational material and limited opportunities for deep understanding of information. An excess of such stimuli increases information noise, activates multitasking and leads to an increase in cognitive load. As a result, educational activities increasingly become fragmented, which negatively affects the formation of holistic knowledge, analytical thinking and cognitive self-regulation of higher education students.

The transition to a remote format has significantly increased the time spent by students in front of screens, potentially affecting their psychophysical and cognitive well-being and causing digital fatigue. identified four forms of digital fatigue (J.-M. Romero-Rodríguez, F.-J. Hinojo-Lucena, K. Kopecký, A. García-González, (2023):

- visual fatigue, associated with prolonged focus on the screen;
- social fatigue, associated with the loss of living social contacts;
- motivational fatigue, which reduces the desire to learn;
- emotional fatigue, which manifests itself through decreased emotional stability.

Digital fatigue has not only cognitive but also emotional and physiological manifestations. This phenomenon can affect:

- ability to concentrate and learn;
- motivation to study;
- general well-being of students in remote mode.

One of the current components of the modernization of the educational process in higher education is the introduction of artificial intelligence (AI) tools that contribute to the individualization of learning and support of cognitive processes of students (Tverdokhliebova & Yevtushenko, 2025; Gulich, & Chetveryk, 2025). The use of artificial intelligence effectively works with formalized knowledge, completed structures and algorithmized processes. It is able to imitate the stylistic features of texts, generalize information, and quickly process large data sets. At the same time, artificial intelligence does not have a holistic worldview, value orientations and the ability to creative pedagogical thinking, which are the defining components of a teacher's activity.

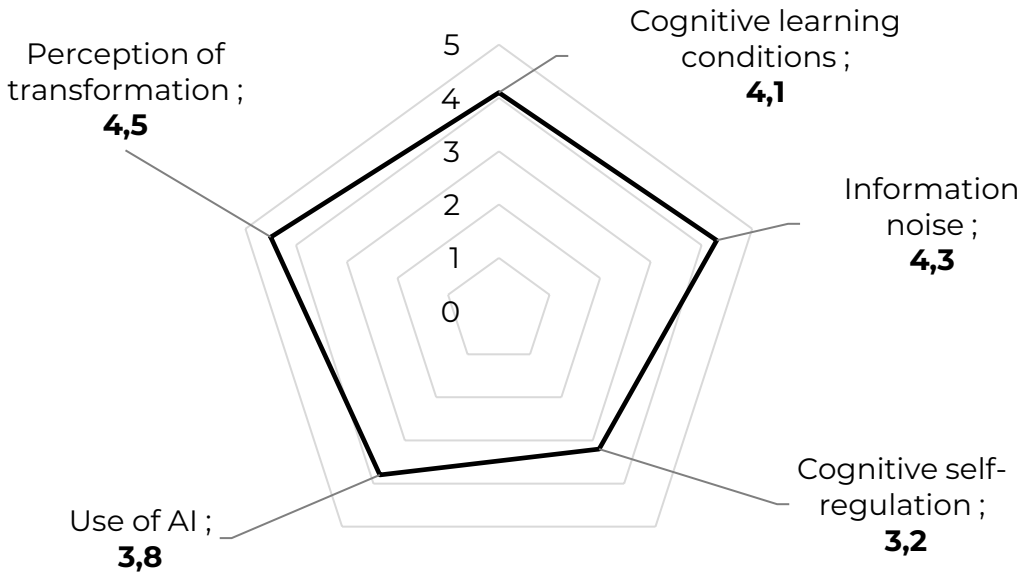
The key advantage of a modern teacher remains the ability to formulate problematic, open-ended and non-standard questions, to create situations of intellectual search and pedagogical dialogue. It is precisely such tasks that contribute to the development of critical thinking, reflection and creative potential of students. Under these conditions, artificial intelligence can only act as an auxiliary tool, and not as a subject of the educational process.

To study the transformation of cognitive conditions of online learning, an online survey was conducted using Google Forms among 4th-year undergraduate students of the National Technical University "Kharkiv Polytechnic Institute" who are studying remotely. The survey is aimed at assessing the level of concentration of education seekers, the impact of information noise and the use of digital technologies, in particular artificial intelligence tools. 40 students participated in the survey.

The results were analyzed by summarizing responses on a Likert scale (1–5) and qualitative analysis of open-ended responses (Figure 1).

Figure 1

Radar Chart of Cognitive Learning Conditions Transformation (Generalized Survey Results)



Analysis of answers to block 1 (Cognitive learning conditions) showed that most respondents experience difficulties with maintaining attention during classes. More than two-thirds of respondents (about 70%) chose values of 4–5 for statements about the difficulty of prolonged concentration and increased efforts required to process educational material. A significant part of students also noted a feeling of information overload, which indicates a change in the cognitive conditions of learning towards an increase in the intensity of information processing.

Results of block 2 (Information noise) showed a high level of impact of information noise on learning activities. Most respondents (over 75%) agreed that messages in instant messengers and social networks negatively affect the ability to deeply immerse themselves in educational material. More than half of the respondents noted that they often combine learning with viewing other digital content, which confirms the prevalence of multitasking and fragmented style of cognitive activity.

Analysis of block 3 (Cognitive self-regulation) revealed a contradictory trend. On the one hand, some students (approximately 45%) indicated the presence of their own strategies for maintaining concentration (time planning, pauses, task structuring). On the other hand, more than 60% of respondents noted a decrease in the quality of thinking in conditions of multitasking and difficulties with concentration on complex intellectual tasks. This indicates an insufficient formation of cognitive self-regulation skills in the digital learning environment.

Results of block 4 (Use of AI) showed that artificial intelligence tools are actively used by students in the educational process: about 80% of respondents confirmed their use for completing tasks.

At the same time, most respondents agreed that AI helps to accelerate the completion of educational tasks, but almost half of students noted a decrease in the need for deep understanding of the material. The vast majority of respondents (over 85%) believe that artificial intelligence cannot replace the thinking and pedagogical role of a teacher.

According to the results of block 5 (Perception of transformation) it was found that students are aware of the changing requirements for learning activities. Most respondents agreed with the statement that modern learning requires, first of all,

developed skills of concentration and focusing of attention. There was also a high level of agreement with the need to form information hygiene skills and rethink the role of the teacher as an organizer of thinking activities, and not just a source of knowledge.

A qualitative analysis of open-ended questions showed that the main factors that hinder concentration are constant notifications, information overload, lack of a clear study routine, and emotional fatigue. Among the conditions that promote concentration, respondents noted structured classes, clear tasks, limiting digital distractions, and lively intellectual interaction with the teacher. The responses also indicate a request for training in attention management skills and the conscious use of digital technologies.

Online learning creates ambivalent cognitive conditions: on the one hand, it expands the possibilities of individualization and self-regulation of educational activities, on the other hand, it increases the risks of information overload, cognitive fatigue, and a decrease in the quality of deep thinking (Table 1).

Table 1

Positive and negative aspects of cognitive conditions of online learning

Positive cognitive conditions	Negative cognitive conditions
Flexibility of learning pace, possibility of re-working the material	Increased cognitive load due to information overload
Access to a variety of digital resources and multimodal formats (video, visualizations, simulations)	Information noise and frequent digital distractions
Developing independent learning and self-regulation skills	Decreased ability to concentrate for long periods of time
Possibility of individualizing the learning trajectory	Predominance of superficial processing of information
Supporting asynchronous thinking and reflection	Cognitive fatigue due to prolonged screen time
Instant access to analysis, search and information processing tools	Working memory overload due to multitasking
Formation of digital and information competence	Weakening of deep critical thinking
The ability to use artificial intelligence tools to support learning	The risk of cognitive dependence on digital tools
Increasing student autonomy in making educational decisions	Decreased intrinsic learning motivation
Supporting different learning styles	Limited opportunities for social cognitive learning

It should be noted that personal transformations are not limited to purely professional competencies, but include deep cognitive and psychological changes that arise in response to external challenges of the educational and professional environment (Tverdokhliebova, 2025; Kostikova et al., 2023).

The obtained survey results confirm the presence of a transformation of the cognitive conditions of higher education students' learning in the online environment, which is manifested in a decrease in the stability of attention concentration, an increase in the

influence of information noise, and the ambivalent role of digital technologies and artificial intelligence. This highlights the need to review approaches to organizing the educational process, reorienting the educational process to the development of cognitive self-regulation skills, information hygiene, and conscious thinking.

Based on the analysis of the questionnaire, the following recommendations were formulated.

First, it is advisable *structuring of educational material* taking into account the limited duration of students' attention span. Online training sessions should provide for a clear logic of presentation, division of the material into meaningfully completed blocks, and alternation of informational load with pauses for reflection and comprehension.

Secondly, an important direction is *developing cognitive self-regulation skills*. The educational process should include elements of teaching students how to manage their own attention, plan learning activities, reduce multitasking, and use digital resources consciously.

Third, the survey results highlight the need *implementation of information hygiene principles*. It is advisable to limit the excessive amount of parallel digital stimuli during classes, minimize irrelevant messages, and recommend that students create a “low-noise” learning environment.

Fourth, the use of artificial intelligence tools in education should be *pedagogically regulated*. AI should be used as an auxiliary tool for explanation, examples, and feedback, without replacing the analytical and thinking activities of the teacher and student.

Fifth, taking into account the changing role of the teacher, it is effective to *orientation towards organizing students' thinking*, rather than just transferring knowledge. This involves the use of problem-based tasks, open-ended questions, reflective exercises, and discussions aimed at deepening understanding of the learning material.

Thus, reorienting online learning towards developing concentration, conscious thinking, and cognitive resilience of learners is a key condition for increasing its effectiveness in the modern digital educational environment.

DISCUSSION

In the modern educational discourse, the issue of the transformation of pedagogical activity under the influence of digital technologies and artificial intelligence is actively discussed. We agree with the opinion of Broadbent and Lodge (2021) that the online environment is not only a technical platform, it is a new cognitive ecosystem that changes the nature of attention, control of thinking and learning behavior of students. It is recommended to integrate elements of metacognitive learning into training courses, in particular, setting learning goals, reflecting on completed tasks, and self-assessment of cognitive activity. It is important to introduce tasks that involve planning intellectual activity, step-by-step completion of complex tasks, and conscious analysis of mistakes. This approach promotes the transition from impulsive information consumption to guided thinking.

Given the increasing information noise, it is advisable to include in educational programs separate modules or practical classes aimed at developing information hygiene skills. This involves teaching students to consciously limit digital distractions, critically select information sources, manage messages and digital notifications. It is recommended to form a culture of intellectual work during educational classes, in particular by regulating the use of digital devices and creating conditions for focused intellectual activity.

Educational tasks should be designed to require students to interpret, critically evaluate the results obtained using digital tools, and form their own conclusions.

To develop conscious thinking, it is advisable to systematically introduce reflective practices, including short analytical discussions, written reflections, and self-analysis of learning experiences. Such practices contribute to the formation of students' ability to be aware of their own cognitive processes, emotional reactions, and learning strategies. Particular attention should be paid to creating a psychologically safe educational environment that supports concentration, intellectual activity, and a responsible attitude to learning.

CONCLUSIONS

Thus, the development of digital technologies does not eliminate the role of the teacher, but changes the emphasis of his professional activity. From a translator of knowledge, the teacher moves to the role of a moderator of the educational process, a mentor and facilitator of cognitive activity, which is especially relevant in the context of the formation of social and emotional intelligence of students.

Reorienting the educational process towards the development of cognitive self-regulation, information hygiene, and conscious thinking involves comprehensive changes in the content, methods, and organization of learning that meet the challenges of the digitalized educational environment and contribute to the formation of sustainable cognitive and professional competencies of higher education students.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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No artificial intelligence tools were used in the preparation of this manuscript.

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