



**Axiological and institutional potential of digital avatars in the context of
digitalization of higher education**

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***Abstract.** The aim of the article is to develop a conceptual model of a teacher's digital avatar as a key element of a personalized learning environment in higher education in the context of digital transformation. The architecture, functionality, and axiological and institutional potential of digital avatars within the ecosystem of the digital university are studied using an interdisciplinary approach. The emphasis is placed on defining the role of the avatar as an autonomous participant in the educational process, capable of cognitive adaptation, emotional feedback, and modeling of pedagogical practices.*

The methodological basis of the research is a combination of elements of systemic, structural and functional, and interpretive analysis. Analytical reconstruction of technological solutions in the field of EdTech, content analysis of



relevant international studies, regulatory and legal analysis of copyright cases in the educational environment, as well as elements of a comparative approach to digital strategies of leading universities, are applied. A three-component model of a digital avatar is proposed, which combines knowledge sources, service and analytical modules, and blocks of user needs.

***The results** of the research showed that digital avatars are an effective tool for hyper-personalized learning based on the integration of new generation NLP models, biometric feedback, emotional analytics systems, and simulation visualization. The article identifies the advantages of using digital avatars in professional training, in particular in the context of engineering, medicine, and law. The efficiency of adaptive learning scenarios built on the analysis of students' cognitive models, as well as the possibility of democratizing access to leading educational practices, are demonstrated. Particular attention is paid to the risks associated with the “uncanny valley” effect, legal conflicts over copyright, and ethical challenges of using autonomous digital agents in higher education.*

***The conclusions** emphasize the need for further regulatory, ethical, and technological reflection on the introduction of digital avatars as a new type of digital presence in higher education. It is substantiated that digital avatars are able not only to support the learning process, but also to participate in the management of educational processes, transforming the architecture of interaction between all participants of the digital university.*

***Keywords:** digital avatar, digital university, personalization of learning, EdTech, artificial intelligence, digitalization, cognitive adaptation, immersive learning, digital transformation.*



Аксіологічний та інституційний потенціал цифрових аватарів у контексті цифровізації вищої освіти

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***Анотація.** Метою статті є розробка концептуальної моделі цифрового аватара викладача як ключового елемента персоналізованого навчального середовища у вищій освіті в умовах цифрової трансформації. На основі міждисциплінарного підходу досліджено архітектуру, функціональні можливості та аксіологічно-інституційний потенціал цифрових аватарів у межах екосистеми цифрового університету. Акцент зроблено на визначенні ролі аватара як автономного учасника освітнього процесу, здатного до когнітивної адаптації, емоційного зворотного зв'язку та моделювання педагогічних практик.*

***Методологічну** основу дослідження становить поєднання елементів системного, структурно-функціонального та інтерпретативного аналізу. Застосовано аналітичну реконструкцію технологічних рішень у сфері EdTech, контент-аналіз актуальних міжнародних досліджень, нормативно-правовий аналіз кейсів авторського права в освітньому середовищі, а також елементи компаративного підходу до цифрових стратегій провідних університетів. Запропоновано трикомпонентну модель цифрового аватара, яка об'єднує джерела знань, сервісно-аналітичні модулі та блоки потреб користувачів.*



Результати дослідження засвідчили, що цифрові аватари виступають ефективним інструментом гіперперсоналізованого навчання, що базується на інтеграції NLP-моделей нового покоління, біометричного зворотного зв'язку, систем емоційної аналітики та симуляційної візуалізації. У статті визначено переваги використання цифрових аватарів у професійній підготовці, зокрема в контексті інженерії, медицини та права. Продемонстровано ефективність адаптивних навчальних сценаріїв, побудованих на аналізі когнітивних моделей студентів, а також можливість демократизації доступу до провідних освітніх практик. Окрему увагу приділено ризикам, пов'язаним із ефектом «моторошної долини», правовими колізіями щодо авторського права та етичними викликами використання автономних цифрових агентів у вищій освіті.

У **висновках** наголошено на необхідності подальшого нормативного, етичного та технологічного осмислення впровадження цифрових аватарів як нового типу цифрової присутності у вищій освіті. Обґрунтовано, що цифрові аватари здатні не лише підтримувати навчальний процес, а й брати участь в управлінні освітніми процесами, трансформуючи архітектуру взаємодії між усіма учасниками цифрового університету.

Ключові слова: цифровий аватар, цифровий університет, персоналізація навчання, EdTech, штучний інтелект, діджиталізація, когнітивна адаптація, імерсивне навчання, цифрова трансформація.

Problem statement. In the context of the digital transformation of higher education, which is becoming increasingly widespread in a post-industrial society and the globalization of knowledge, we are witnessing not only the integration of the latest technologies into traditional educational practices, but also a radical restructuring of the educational landscape, in which intelligent digital systems are beginning to play a key role. This process leads to the emergence of a new paradigm of interaction between all participants in the educational environment - students, teachers, administration, and



technical platforms, where digital agents, including avatars, become active participants in educational communication. The concept of a digital avatar in this context appears as an interdisciplinary construct that combines elements of personalized digital representation, functional autonomy, adaptive analytics, and cognitive-behavioral modeling. The digital avatar can be either a simple virtual assistant or a complex digital twin capable of simulating teaching activities, automated assessment of learning achievements, discussion moderation, and feedback. At the same time, this complexity raises a number of controversial issues, from the technological implementation and reliability of the reproduction of emotional and behavioral reactions to the change in the roles and professional identity of the teacher in the digital environment.

The relevance of this research is due to the need to rethink educational architectonics in the era of Industry 4.0 and the transition to the concept of Industry 5.0, in which the humanization of technological development, focus on values, and sustainable development are becoming increasingly important. The introduction of digital avatars is not only a response to the technological challenges of our time, but also a means of implementing the key principles of modern higher education: inclusiveness, personalization, adaptability, mobility, and flexibility. Digital avatars allow creating an environment in which individual student characteristics - their cognitive styles, motivation, emotional state, and previous experience - are taken into account systematically and integrated into the pedagogical strategy. In addition, avatars as intelligent agents are able to automatically adapt learning content, recognize and interpret student non-verbal signals, and perform predictive analytics of academic performance, which contributes to early detection of difficulties and a reduction in dropout rates. Nevertheless, a significant number of related challenges - psychological barriers in interacting with hyper-realistic models, ethical dilemmas of digital agent autonomy, legal conflicts of copyright for pedagogical methods - indicate that the theoretical and normative understanding of the phenomenon of digital avatar is incomplete.



In this scientific context, a holistic study of the digital avatar as a systemic object that combines the technical component (algorithms, platforms, machine learning models), social and communicative function (support for pedagogical interaction), axiological potential (formation of educational values), and legal regulation (data protection, copyright, liability) becomes especially relevant. There is an urgent need to develop a conceptual model of a digital avatar in the educational environment that would cover not only technical parameters but also take into account organizational, socio-cultural, and axiological factors of its integration. In particular, it is important to define the status of the digital avatar as a possible educational actor that influences the formation of the content of educational material, assessment, feedback, and even ethical modeling of behavior. Thus, this article is aimed at the theoretical and methodological substantiation of the digital avatar as a complex multilevel tool for educational transformation, which requires a systematic study taking into account the humanitarian, technological, and legal dimensions of its functioning.

Analysis of recent research and publications. The issue of digital avatars as elements of intelligent educational systems is increasingly being developed in the interdisciplinary scientific space, covering the areas of pedagogy, artificial intelligence, cognitive psychology, information technology, and law. Of fundamental importance is the concept of a digital twin, developed by M. Grieves, who interprets it as a set of virtual information constructs that fully describe a physical or logical object and are capable of dynamic interaction with it in the digital environment [1]. The provisions of this approach are also laid down in the international standard ISO 23247-1:2021 [2], which formalizes the principles of two-way synchronization of digital twins and real objects. Reports by McKinsey, Gartner, and Yahoo Finance [3;4:5] show a steady trend toward the transformation of digital duplicates into a strategic tool for managing processes, including educational ones.

The example of the ETH Zurich educational environment (ETHEL project) demonstrates how digital avatars are integrated into the learning process using artificial



intelligence, speech generation, recognition of student intentions, and management of individual learning trajectories [6]. Planit Teachers emphasizes the significant impact of digital avatars on the formation of vocabulary and communication skills in a professional context, in particular through cognitive-oriented analysis of individual progress [7]. The work of Kortemeyer et al. [8] discusses the post-pandemic transformation of educational formats and the role of digital avatars as intermediaries in blended or distance learning. Particularly noteworthy are examples of the practical use of avatars in gamified virtual environments, such as Neuroject, where the educational process is modeled through immersion in professional simulations [9].

The results of some studies show the economic feasibility of introducing avatars as elements of EdTech ecosystems in higher education [10]. At the same time, researchers M. Seymour, K. Riemer, and J. Kay [11] raise the problem of psychological discomfort of users when interacting with hyper-realistic avatars, which is caused by the “uncanny valley” effect. A separate area of scientific inquiry focuses on the legal aspects of the digitalization of education: M. Lemley analyzes the contradictions between the copyright of teachers and the rights to algorithmized products created on the basis of artificial intelligence, formulating the problem of protecting the “digital pedagogical handwriting” [12]. The works of N. Bobro, R. Hyshchuk, A. Strunhar, O. Bukovskyi, V. Alekseiko [13], as well as A. Krap, S. Bataiev, N. Bobro, V. Kozub, N. Hlevatska [14] outline the role of artificial intelligence in the transformation of the educational process and modern management models, with an emphasis on the need to adapt digital avatars to hybrid learning as one of the effective mechanisms for supporting an individualized educational environment.

At the same time, despite the active study of the phenomenon of digital avatars, several fundamental issues remain open. For example, there is no integrated conceptual model that takes into account the structural complexity, functional multidimensionality, and ethical limitations of a digital avatar as a subject of the educational process. Also, the use of biometric feedback in higher education is not



sufficiently developed, which is especially important in the context of adaptive learning. Thus, this article aims to overcome these gaps by building a structural model of a teacher's digital avatar that takes into account both educational functions and technological and psychological parameters of its functioning in the digital university of the future.

Identification of previously unresolved aspects of the general problem.

Despite a significant body of academic work on digital avatars and their implementation in education, several critical aspects remain underexplored. Notably, there is a lack of comprehensive analysis of digital avatars as complex, integrative systems within the architecture of higher education institutions. The functional potential of digital avatars as agents of personalized and value-oriented educational environments has not been sufficiently conceptualized, particularly in the context of hybrid learning models where the interplay between human cognition and algorithmic logic creates new educational and socio-psychological dynamics. Furthermore, a clear theoretical distinction between digital avatars as instrumental technologies supporting pedagogical processes and as quasi-subjects capable of influencing the structure, content, and value orientation of educational interactions remains underdeveloped. The methodological foundations for designing adaptive, empathic, and epistemologically dynamic digital avatars are also fragmented or nascent.

This study seeks to address these gaps by offering a conceptual and methodological framework for understanding the digital avatar not merely as a technical tool, but as a multidimensional actor within the educational ecosystem. The proposed approach highlights the socio-technological, axiological, and cognitive dimensions of digital avatar deployment, aiming to systematize its educational functions and to formulate the principles of its ethical and institutional integration into higher education.

Formulation of the article's objectives (task statement). The aim of this article is to build a conceptual model of a teacher's digital avatar as a key element of



the educational and organizational ecosystem of the digital university. Within the framework of this aim, the achievement of the following specific objectives is envisaged: first, to identify the structural and functional components of a digital avatar in the context of the digitalization of education; second, to characterize the technological architectonics of a digital avatar, taking into account modern AI solutions, speech synthesis systems, NLP models, and emotional intelligence algorithms; third, to analyze the potential of digital avatars for hyper-personalization of the learning process, taking into account biometric feedback and adaptive scenarios; fourth, to identify the risks associated with the use of digital avatars in higher education, including ethical and psychological aspects.

In this way, the author seeks to fill existing gaps in the scientific literature and contribute to the formation of a holistic approach to introducing digital avatars as innovative tools for the digital university of the future.

Presentation of the main research material. At the current stage of digital transformation in higher education, the integration of advanced Industry 4.0 technologies is not only a tool for innovative renewal but also a key factor in the formation of a competitive educational space. Among such technologies, the concept of digital avatars is becoming increasingly important, demonstrating powerful potential for application in education, in particular as representatives of educational process participants, tools for personalizing learning, and virtualized management of the educational environment.

Digital avatars are becoming an integral part of modern intelligent systems. Despite the relative novelty of the concept and the lack of an established terminology system, they are already being actively implemented in the practice of transforming educational processes. Among the advantages of using digital avatars in higher education are reducing the workload on teachers, accelerating the adaptation of content to student needs, improving learning efficiency, and enabling the creation of individual educational trajectories.



According to the definition proposed by Michigan University professor M. Greaves, a digital avatar (twin) is “a set of virtual information constructs that fully describe a potential or actual physical object – from the micro level to the macro geometric representation” [1, p. 3]. This gives grounds to interpret a digital avatar in higher education as a complex digital model of a subject or process capable of interaction, self-learning, data processing, and supporting feedback in learning.

In the international standard ISO 23247-1:2021, the relevant technology is defined as a digital representation of an element that is observed with two-way synchronization [2, p. 16]. This characteristic allows considering a digital avatar as an element of an interactive digital ecosystem that supports value-oriented management of the educational process.

The digital avatar is an integrative technology that combines components of sensor networks, artificial intelligence, virtual and augmented reality technologies, cloud services, and platform solutions. In higher education, such a system can be used to create a virtual representation of a teacher or student, which not only represents the personality but also performs the functions of analytics, recommendations, communication, and learning progress management.

Analytical reports from leading consulting companies (including Gartner and McKinsey) show that digital avatars maintain consistently high positions among the key tools of digital transformation. According to forecasts, by 2026, up to 91% of Internet of Things (IoT) platforms will be capable of implementing digital duplicate functions [3;4] – opening up new horizons for the introduction of digital avatars in the field of educational management and learning.

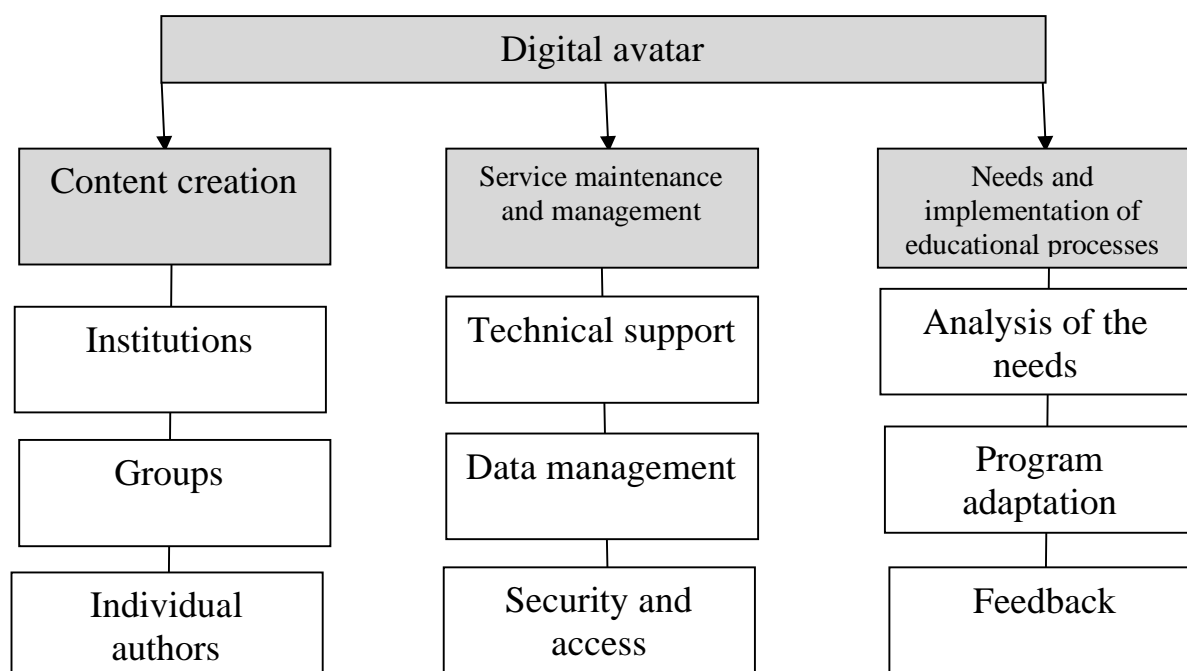
In the next three years (by 2028), digital avatars could become a basic feature of digital education platforms. Among the main ways they could be used in education, it is worth highlighting the modeling of educational roles, the digital duplication of teacher functions, the adaptation of the learning environment, and the simulation of learning scenarios. This opens up opportunities for building a digital avatar not only as

an auxiliary tool, but as an active participant in the educational process at various levels – from educational to organizational and managerial.

To illustrate the architecture of a digital avatar in higher education, its model can be divided into three interrelated blocks (Figure 1).

Figure 1

Conceptual architecture of a digital avatar in higher education



Source: author's own development

The first block covers sources of educational content: institutions, groups, and individual authors. Group initiatives often spark innovation, while individual creators generate unique knowledge that others can't replicate.

According to the areas of activity, this block covers:

- academic and applied research;
- technological innovations and EdTech solutions;
- analytical models and business developments;
- activities of scientific centers.

The second – service and analytical block – includes:



- knowledge repository;
- analytical module;
- taxonomy generator;
- integration module.

The digital avatar adapts content to individual user requests using machine learning algorithms to analyze knowledge, update it, and predict obsolescence.

The third block – “needs and implementation” – is responsible for identifying the requests of users: students, teachers, institutions, and companies. These needs are formed according to the context, goals, and time.

It should be noted that the following elements are lacking for the full implementation of the concept:

- an intelligent avatar capable of self-learning;
- stable connections between system components;
- high-precision modeling of the educational environment.

In turn, modern educational platforms using artificial intelligence open up new opportunities for digital avatars in creating immersive learning environments. In particular, the ETHEL (ETH E-Learning) project from ETH Zurich demonstrates how digital avatars are integrated into the university's educational process. Using artificial intelligence, the teacher's avatar is able to simulate real-life scenarios of interaction with students: conducting consultations, moderating discussions, answering questions, and providing feedback. The system analyzes students' speech, corrects their use of terminology, and adapts the complexity of tasks in real time depending on their individual needs and level of knowledge.

As part of the project, the digital avatar supports personalized interaction with students, providing the opportunity to work individually on complex learning situations, cases, or theoretical concepts. This approach allows for better adaptation of the learning process to the educational needs of each student, enhancing the efficiency and quality of training for specialists in various fields of knowledge [6].



Digital avatars provide hyper-personalization of learning by analyzing not only typical mistakes and the speed of knowledge acquisition, but also the emotional state of the student through the recognition of intonation and facial expressions. Research by Planit Teachers confirms that the use of digital avatars in education can reduce the time needed to learn specialized terminology by up to 40% by adapting the learning process to students' individual cognitive models [7].

Another advantage is the democratization of access to leading experts. For example, a digital avatar of a Harvard professor or SpaceX chief engineer can simultaneously teach thousands of students, replicating their unique pedagogical techniques and author-developed methods [8, p. 94]. This removes geographical and financial barriers, allowing access to the best global experience.

The transformation of the educational process through gamification and immersive scenarios is also important. Platforms such as Neuroject create virtual reality environments in which medical students can practice communicating with digital patients in the operating room, and future engineers explain technological processes on a virtual construction site using professional terminology [9]. This not only promotes the rapid development of language skills, but also the integration of professional competencies into the learning process.

Particular attention will be paid to the technological base that underpins the functioning of digital avatars in higher education. So, modern digital avatars are the result of the integration of several breakthrough technologies, with a key role played by modern NLP models of the new generation, such as GPT-4 and LaMDA, which provide deep semantic analysis of context.

An important aspect of digital avatars is their emotional intelligence. Modern speech synthesis technologies, such as Deepfake Text-to-Speech, are capable of conveying not only content but also paralinguistic characteristics of speech: pauses, intonations, regional accents. In combination with platforms such as TextToVideoAI, which generate avatars with context-dependent facial expressions, this creates the



effect of live communication. Observations show that when students use complex terms correctly (e.g., “quantum entanglement”), the avatar displays positive emotions through facial expressions, while pronunciation errors (e.g., “electrophoresis”) activate additional visual cues [10, p. 8].

The adaptability of digital avatars is ensured by the use of modern machine learning algorithms, which allow the system to respond to typical user errors and dynamically adapt training scenarios. If difficulties are encountered in mastering specific concepts or terms, the digital avatar can offer visual explanations, interactive hints, or a change in the format of the material presentation. Based on an analysis of the user's previous actions, the system is able to predict potential difficulties in acquiring knowledge and adapt the learning trajectory according to individual cognitive characteristics.

The use of biometric feedback in the operation of digital avatars deserves special attention. Systems that integrate artificial intelligence with technologies for analyzing micro-expressions of the face and paralinguistic characteristics of speech (in particular, timbre, rhythm, intonation) can dynamically respond to changes in the user's emotional state. If signs of psycho-emotional stress are detected, the system can adapt the level of academic load by simplifying the content or changing the format of the material presentation. In particular, the study of complex technical concepts can be accompanied by examples from everyday life or real-life contexts, which promotes better understanding and reduces academic stress.

At the same time, the introduction of digital avatar technologies into the educational process is accompanied by a number of challenges. Research shows that hyper-realistic avatars, despite their technological perfection, can cause psychological discomfort. For example, in an experiment by M. Seymour, K. Riemer, and J. Kay, about 34% of respondents reported anxiety when interacting with digital representations of teachers, which can be explained by the “uncanny valley” effect [11].



Intellectual property issues are becoming particularly relevant. Court precedents from 2024, in particular the high-profile case of EdTech vs. Stanford University, demonstrate the complexity of determining copyright for “digital pedagogical handwriting” — algorithmic teaching methods developed by real teachers [12]. An equally significant problem is the risk of semantic distortions in educational content created by AI [13;14].

It can be stated that digital avatars in the educational sphere are intelligent assistants based on artificial intelligence, capable of modeling pedagogical practices, analyzing professional competencies, and accompanying the learning process of students. They are particularly effective when learning foreign languages in highly specialized fields, such as medicine, law, and engineering [15, c.53].

The main advantage of using digital avatars in higher education is their ability to provide deep, multi-level personalization of the educational process. Due to the integration of modern artificial intelligence technologies, in particular neural network data analysis models, digital avatars not only take into account typical student errors but also perform complex analytics of their cognitive profile. This includes recognizing thinking styles, learning speed, abstract thinking levels, memory types, and current psycho-emotional characteristics. As a result, digital avatars are able to dynamically adapt learning tasks, change the pace of material presentation, and apply appropriate examples and formats for presenting information that correspond to the individual characteristics of each student. This not only increases learning efficiency but also significantly reduces the risks of cognitive overload, stress, and loss of motivation to learn. In addition, by constantly monitoring changes in behavioral responses and engagement levels, digital avatars can predict learning difficulties before they arise, initiating timely adjustments to the educational trajectory.

Another key advantage of digital avatars is their potential to democratize access to quality education. Through the use of cloud technologies and platform distribution, digital avatars that replicate the teaching style of leading professors from world



universities or engineers from multinational companies can function simultaneously for a large number of users in any region of the world. This means that students from remote areas, economically less developed regions, or those who are unable to study offline, gain access to authentic methods, unique cases, original approaches, and the best global practices that were previously only available at elite educational institutions. In this way, digital avatars not only expand the reach of educational services but also serve to equalize educational opportunities and create a global educational space with a high level of inclusivity.

In addition, digital avatars contribute to the transformation of the very essence of educational interaction, the transition from a linear model of knowledge transfer to a flexible, dialogical structure of the learning process, in which the avatar acts as an adaptive intermediary between information, the platform, and the student. Due to built-in gamification mechanisms, simulation of professional situations, and multimodal presentation of knowledge, the digital avatar becomes a tool with a high level of student engagement in the educational process, which positively affects motivation, level of interactivity, and depth of material assimilation. Considering these advantages, digital avatars have the potential to become one of the most effective tools for institutional modernization of higher education in the era of digital transformation.

The technological basis of digital avatars includes modern NLP models, powerful speech synthesis systems, and algorithms for generating interactive characters with adaptive facial expressions. Due to the application of machine learning algorithms, predictive analytics is implemented, which allows identifying potential difficulties of students in advance and preventing them through personalized recommendations. An important feature is the integration of biometric feedback, which allows the system to respond quickly to changes in students' psychological state, reducing cognitive load in real time.

The practical efficiency of digital avatars is confirmed by the successful implementation of immersive scenarios, especially in virtual environments. In



particular, through gamification and the use of virtual reality technologies, medical students train in communicating with virtual patients, and future engineers master professional vocabulary in simulated real-life production situations.

Thus, digital avatars in higher education are not just a tool for technological improvement, but a holistic socio-technological model that combines the functions of teaching, analytics, communication, and management. Their implementation will transform the architecture of the educational process, enhance the individualization of learning, and create conditions for ensuring the sustainable development of the digital university. Despite the existing risks and regulatory challenges, the potential of digital avatars to improve the accessibility, quality, and adaptability of education is undeniable and deserves further research and institutional support.

Conclusions. As a result of the conducted research, the set aim was achieved – a conceptual model of a teacher's digital avatar as an element of the educational and organizational ecosystem of the digital university was formed. Within this model, key structural blocks were identified that ensure the collection, processing, and personalized presentation of educational content, as well as the adaptation of interaction to the cognitive and emotional characteristics of the student. In particular, the architectonics of a digital avatar as an integrative object combining artificial intelligence tools, speech recognition technologies, emotional state recognition, and visual simulation was outlined.

An analysis of the technological, pedagogical, and cognitive aspects of digital avatars has demonstrated their high efficiency in personalizing the educational process. It has been established that digital avatars not only optimize the learning process but also contribute to improving its quality through the possibility of continuous feedback, modeling complex educational scenarios, and taking into account the individual needs of students. This opens up new perspectives for the development of flexible educational trajectories that correspond to the concepts of sustainable and inclusive learning.



At the same time, the research confirmed the existence of a number of challenges associated with the use of digital avatars in higher education. These include the need to regulate copyright issues, the risks of psychological discomfort when interacting with hyper-realistic models, and the need to develop ethical standards for the functioning of digital agents. These aspects require further scientific consideration, especially in the context of the development of autonomous educational systems based on artificial intelligence.

Further research should focus on empirical studies of the efficiency of digital avatars in various educational contexts, particularly in interdisciplinary and intercultural environments. Another promising area is the development of standards for interaction between digital avatars and users, including aspects of trust, identity, and learning autonomy. Thus, the digital avatar emerges not only as a technological solution but as a new pedagogical paradigm for the digital university.

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