

УДК 378.245/56;31

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ВЕКТОРИ ВИКОРИСТАННЯ АДАПТИВНИХ СИСТЕМ У ЗАКЛАДАХ ВИЩОЇ ОСВІТИ: ЗАРУБІЖНИЙ ДОСВІД

У статті проаналізовано деякі напрями використання адаптивних систем навчання в закладах вищої освіти зарубіжних країн. Виявлено, що педагогічною основою проектування адаптивної системи навчання в електронному середовищі зарубіжних ЗВО є поліпарадигмальний підхід, що акумулює відкритий несуперечливий кластер підходів до навчання, комплексне використання яких має синергетичний ефект. Вивчення та аналіз поточної ситуації у розвитку засобів і методів електронного навчання продемонстрував, що саме персоналізація стає світовим трендом в електронному навчанні. Зарубіжний досвід застосування систем адаптивного навчання дав змогу резюмувати, що що персоналізація професійної підготовки реалізується у кількох формах: на основі диференційованого навчання, через розширення автономності студентів, через варіювання змісту навчання. В загальному тлумаченні, адаптивне навчання визначається аналітиками освіти і як концепція, і як інструмент і передбачає можливість надання студенту відповідних інструментів навчання, вибору обсягу отримуваних знань та індивідуальної траєкторії навчання. До адаптивних навчальних платформ за версією дослідників *Eduventure* у 2015 році можна віднесено такі платформи: *2U, Wiley, Canvas, Loud Cloud, Blackboard, Knewton, RealizeIT, Adaptcourseware, Anewspring*, до компаній, що виробляють адаптивний контент – *Adaptcourseware, Wiley, Pearson Education, Jones & Bartlett Learning, sixRedMarbles, Smart Sparrow, Acrobatiq, Cengage Learning, Toolwire*. Виокремлено три рівні навчальних систем адаптивного навчання: системи, які забезпечують «пасивну», «активну» та «розумну» адаптивність. Підсумовано, що цифровізація вищої освіти детермінує виникнення нових технологій реалізації змістовної складової підготовки студентів до професійної діяльності. В світовому педагогічному континуумі нині зосереджується увага на виявленні та використанні можливостей адаптивного навчання студентів як векторів реалізації особистісно-зорієнтованого підходу, забезпечення персоналізації освіти та активізації діяльності студентів. В практиці зарубіжних ЗВО ідея адаптивного навчання корелює з засадами парадигми конструктивізму в педагогіці. Тобто кристалізується активна роль студентів у процесі засвоєння знань і формуванні свого власного розуміння світу. Згідно з цією концепцією в адаптивному навчанні студент не лише пасивно поглинає інформацію, а активно взаємодіє з навчальним матеріалом, створюючи нові знання на основі власного досвіду, рефлексії та взаємодії з навколишнім середовищем. У контексті адаптивного навчання окреслена платформа ініціює створення освітніх середовищ, які стимулюють активну участь студентів. Для цього застосовують різні моделі адаптації. Адаптивні системи навчання надають студентам можливості для самостійної пізнавальності.

Ключові слова: освіта, цифровізація, майбутні фахівці цифрових технологій, професійна підготовка, адаптивні системи, адаптивне навчання.

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VECTORS OF USING ADAPTIVE SYSTEMS IN HIGHER EDUCATION INSTITUTIONS: FOREIGN EXPERIENCE

The article analyzes some areas of adaptive learning systems in higher education institutions of foreign countries. It has been found that the pedagogical basis for designing an adaptive learning system in the electronic environment of foreign higher education institutions is a polyparadigmatic approach that accumulates an open, non-contradictory cluster of learning approaches, the integrated use of which has a synergistic effect. The study and analysis of the current situation in the development of e-learning tools and methods has shown that personalization is becoming a global trend in e-learning. The foreign experience of using adaptive learning systems has made it possible to summarize that personalization of professional training is realized in several forms: on the basis of differentiated learning, through the expansion of student autonomy, through the variation of learning content. In general terms, adaptive learning is defined by educational analysts as both a concept and a tool, and provides for the possibility of providing students

with appropriate learning tools, choosing the amount of knowledge they receive, and an individual learning trajectory. According to Eduventure researchers in 2015, adaptive learning platforms include the following: 2U, Wiley, Canvas, Loud Cloud, Blackboard, Knewton, RealizeIT, Adaptcourseware, Anewspring, and companies producing adaptive content – Adaptcourseware, Wiley, Pearson Education, Jones & Bartlett Learning, sixRedMarbles, Smart Sparrow, Acrobatiq, Cengage Learning, Toolwire. Three levels of adaptive learning systems are distinguished: systems that provide "passive", "active" and "smart" adaptability. It is summarized that the digitalization of higher education determines the emergence of new technologies for the implementation of the content component of students' preparation for professional activities. The world pedagogical continuum is now focusing on identifying and using the possibilities of adaptive learning of students as vectors for the implementation of a personality-oriented approach, ensuring the personalization of education and activation of students' activities. In the practice of foreign higher education institutions, the idea of adaptive learning correlates with the principles of the constructivism paradigm in pedagogy. That is, the active role of students in the process of acquiring knowledge and forming their own understanding of the world is crystallized. According to this concept, in adaptive learning, students not only passively absorb information but actively interact with the learning material, creating new knowledge based on their own experience, reflection, and interaction with the environment. In the context of adaptive learning, the outlined platform initiates the creation of educational environments that stimulate active student participation. Various adaptation models are used for this purpose. Adaptive learning systems provide students with opportunities for independent cognition.

Key words: education, digitalization, future digital specialists, professional training, adaptive systems, adaptive learning.

The relevance of the problem. The current trends in higher education in the global space of pedagogical knowledge are its digitalization and personalization. This concept is relevant for all levels of education around the world, as it helps to solve the problem of student involvement in the educational process, their motivation, and thus improves the quality of education. The process of student learning in higher education institutions is now closely linked to the digital educational environment, where educational programs are implemented through e-learning and distance learning technologies. The use of digital technologies, in turn, is closely related to the approach of personalization of learning.

Digitalization and personalization of education are interconnected and complement each other. It is no coincidence that personalization of education is seen as the "core" of the digital transformation of professional training systems around the world. In higher education, along with the widespread use of digital technologies in the educational process, the presence of personalized learning is currently small. However, there is already progressive experience in the use of adaptive systems in higher education in foreign countries.

Analysis of recent research and publications. The study of information about the specifics of the use of adaptive learning systems in higher education (Smaliukh, 2018) shows a significant interest of researchers in this problem. The works of S. Gerasymenko and O. Parkhomenko reveal the historiography of the integration of adaptive learning into the higher education system in general, with an emphasis on foreign experience in the use of adaptive technologies and their impact on the educational process (Gerasymenko, Parkhomenko,

2020). Whereas V. Hryniova analyzed the benefits of using these technologies in the education systems of countries around the world (Hryniova, 2020). V. Kukharenko systematized the technologies that support adaptive learning systems, emphasizing the importance of integrating these technologies into modern higher education to ensure the flexibility of learning processes (Kukharenko, 2012).

Foreign researchers (Anderson, McCormick, 2015) outlined the boundaries of the use of adaptive systems in higher education in terms of providing personalized learning in the digital era in the distance learning system (Red, 2010); identified (Anderson, Schmidt, 2023) modern achievements in the field of adaptive learning to improve the learning environment in higher education institutions; considered adaptive systems as a prospect for personalized learning in education (Baker, Siemens, 2023); studied the specifics of the implementation of adaptive systems of higher education (Fedoruk, 2010; Huang, Shui, 2012 etc.), based on the use of artificial intelligence to improve educational interaction and involvement of students in the learning process (Johnson, Garcia, 2023; Thompson, Zhao, 2023, etc.); implementation of adaptive learning in university programs (Wilson, Taylor, 2023). However, digital technologies are currently developing very rapidly, offering new opportunities for the development of adaptive learning systems. Foreign higher education institutions are actively using such opportunities, presenting positive results in the quality of student training. In Ukraine, adaptive learning is only gaining popularity, so it is advisable to identify the key vectors of its development in foreign countries in order to adapt and implement it in the domestic educational realities.

The purpose of the article is to identify the directions and features of the use of adaptive learning

systems in higher education institutions in foreign countries.

Presentation of the main material. The development of e-learning in the academic environment takes place through the creation of e-learning courses based on a learning management system that provide ample opportunities for both teachers and students. Teachers use eLearning environments to develop educational content and test materials, communicate with students, and organize the learning process, including the use of active learning methods. Such an environment allows students to interact with each other and with the teacher, and to participate in joint activities.

The concept of adaptive learning in higher education has gained wide popularity in parallel with the introduction of distance learning technologies. It is due to the fact that first-year students have different levels of mastery of specialized disciplines, different preferences in choosing an individual educational trajectory, and cognitive abilities. Over time, trends in higher education are increasingly focused on individualized approach to students. Traditional e-learning platforms have a significant drawback – very often, all students are offered the same content and activities, without taking into account the needs of the student and his or her unique characteristics. Instead, adaptive systems are designed to tailor the learning content to the needs and capabilities of each future professional.

The pedagogical basis for designing an adaptive learning system in the electronic environment of foreign higher education institutions is a polyparadigmatic approach that accumulates an open, non-contradictory cluster of learning approaches, the integrated use of which has a synergistic effect. The leading role in this cluster is assigned to the competency-based approach. The contextual, interdisciplinary, subject-information, and personality-oriented approaches are of great didactic importance. In fact, the latter methodological platform is the key idea of promoting adaptive learning systems in higher education.

The study and analysis of the current situation in the development of e-learning tools and methods demonstrates that personalization is becoming a global trend in e-learning. The growing popularity of personalization in higher education can be explained, on the one hand, by a reflection of the natural human desire for an individual approach to students' personal requests, and, on the other hand, by the growing need for people to be even more productive and comfortable in acquiring new competencies due to technological advances. Therefore, teachers of global universities are turning to electronic personalization tools, on the

one hand, to meet the growing market demand, and on the other hand, to intensify the learning process.

Foreign experience in the use of adaptive learning systems suggests that the personalization of professional training is realized in several forms: through differentiated learning, through expanding student autonomy, through varying the content of learning. In general terms, adaptive learning is defined by educational analysts as both a concept and a tool, and provides for the possibility of providing students with appropriate learning tools, choosing the amount of knowledge they receive, and an individual learning trajectory.

According to Eduventure researchers, adaptive learning platforms in 2015 included *2U, Wiley, Canvas, Loud Cloud, Blackboard, Knewton, RealizeIT, Adaptcourseware, Anewspring*, and companies producing adaptive content – *Adaptcourseware, Wiley, Pearson Education, Jones & Bartlett Learning, sixRedMarbles, Smart Sparrow, Acrobatiq, Cengage Learning, Toolwire* (Thompson, Zhao, 2023: 245).

Adaptive learning system, "tutorielle assistive systeme", "Intelligent Tutoring Systems" is a system that reflects some student characteristics in a "student model" and uses this model to adapt various aspects of programmed learning and knowledge control. Three levels of adaptive learning systems can be distinguished: systems that provide "passive", "active", and "intelligent" adaptability. Such a classification is given as a well-established one in online dictionaries of European countries on psychology and pedagogy (Wilson, Taylor, 2023: 102). In systems that provide "passive adaptability," the active role is delegated to the student: taking into account the recommended set of parameters, the student, in his or her own interests, plans the trajectory of his or her learning material, the timing of studying a particular content. Such systems use passive schemes "if... → then..." and simple hypertext systems.

Systems that provide "active adaptability" are designed in such a way that the system itself determines the trajectory of further learning based on the educational material already completed by students and their answers to test questions. Such systems use active schemes "if... → then..." and apply programming.

Obviously, adaptive technologies are currently widely used in various fields of education, including vocational education, corporate training, distance learning, and self-education. With the development of cloud computing, virtual reality, and artificial intelligence, new opportunities are opening up for the creation of innovative adaptive systems. The latter can be classified according to various criteria.

The most common classifications used in higher education institutions in the Euripro countries are based on the types of data used for adaptation, student characteristics, and learning objectives. Here are some of the main types:

1. Adaptation based on data about the student:

- use of data analytics – includes analyzing data on student performance and behavior to determine their individual needs and abilities;

- feedback and evaluation – using feedback from students and the results of their assessments to adjust and adapt the material and teaching methods.

2. Content-based adaptation:

- individualization of content – provides different content for each student, depending on their level of knowledge and preferences;

- task selection – the systems can offer tasks of different complexity and types depending on the level of training and performance.

3. Adaptation by teaching methods:

- individualized methods – this approach uses different techniques and strategies based on the needs and preferences of the student;

- self-study – providing an opportunity to choose the method and pace of learning.

4. Adaptation by time and pace:

- time management – the student manages the pace and schedule of learning according to their individual capabilities;

- accelerated or decelerated learning – learning systems can automatically accelerate or decelerate the pace of learning depending on the student's performance.

In this context, the opinion of V. Hrynova is valuable, as she notes that the idea of adaptation in higher education can be traced to the use of electronic tests. They are based on a dynamic change in the levels of complexity of test questions in accordance with the previous and current indicators of student's educational performance (Hrynova, 2020: 55). That is, foreign universities are actively implementing adaptive tests. According to Y. Smaliukh, an adaptive test is a computer-implemented system of test tasks of various types, the condition of which can be presented in different forms: graphic, analytical, verba (Smaliukh, 2018). This system allows you to present tasks of a certain level of difficulty depending on the results of the previous task, that is, after each correct answer, the level of difficulty of the following tasks increases, and after the wrong answer, it decreases.

In the practice of higher education in Europe, three types of computer-based testing are used:

- *testing, in which the options and the order of submission of tasks are fixed;*

- *testing, in which variants are generated automatically from the existing set of tasks according to the rules set by the developer;*

- *adaptive testing, in which an individual set of tasks is formed for each test subject during the testing process, and their choice is based on the results of the student's answers to previous tasks (Hrynova, 2020).*

The study of the practice of using adaptive learning systems in foreign higher education institutions has made it possible to group the methods used in designing tasks and content of such systems. Here are some of them:

- Clustering – allows you to group students based on their characteristics or behavioral data;

- classification – the definition of the category or class to which each applicant belongs is applied;

- regression – used to predict numerical values based on available data;

- Natural Language Processing (NLP) – allows you to analyze and understand the natural language used by students during their studies;

- Reinforcement Learning – this method is used to train algorithms to make a sequence of decisions in order to maximize a certain numerical reward;

- Convolutional Neural Networks (CNN) is a type of neural network specialized for processing structured data such as images;

- Recurrent Neural Networks (RNNs) can process sequential data, such as text or sound; in adaptive learning, they can be used to analyze students' sequential responses to learning tasks and provide personalized feedback;

- Deep Learning – an approach to machine learning that uses multi-layer neural networks to extract high-level features of data; it is used to create complex models that can adapt to a wide range of educational data and tasks;

- Genetic Algorithms are used to evolve optimal solutions based on the principles of natural selection. In particular, they can be used to optimize the parameters of training models and adaptation strategies based on empirical data;

- Association Rules identify relationships and dependencies between different data elements.

Conclusions. The digitalization of higher education determines the emergence of new technologies for the implementation of the content component of students' preparation for professional activities. The world pedagogical continuum is now focusing on identifying and using the possibilities of adaptive learning of students as vectors for the implementation of a personality-based approach, ensuring the personalization of education and activation of students' activities. In the practice of foreign higher education

institutions, the idea of adaptive learning correlates with the principles of the constructivism paradigm in pedagogy. That is, the active role of students in the process of acquiring knowledge and forming their own understanding of the world is crystallized. According to this concept, in adaptive learning, students not only passively absorb information but actively interact with the learning material, creating new knowledge based

on their own experience, reflection, and interaction with the environment. In the context of adaptive learning, the outlined platform initiates the creation of educational environments that stimulate active student participation. Various adaptation models are used for this purpose. Adaptive learning systems provide students with opportunities for independent cognition.

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