(knowledge of SEN), motivational-value (attitude to inclusion) and operational-activity (proficiency in methods, techniques and skills for adapting educational materials). The study revealed significant variability in the level of teacher readiness. At the same time, the majority of respondents supported the inclusive approach and recognized its importance for modern education, but a lack of specialized knowledge regarding the psychophysiological characteristics of children with SEN was noted. Teachers also often experience difficulties in implementing individual approaches, changing educational materials and organizing interaction with teacher assistants and parents. The article outlines areas for improving the professional development of teachers: the introduction of specialized training programs in the field of inclusive education, regular supervision, the development of interdisciplinary interaction in school support groups, and the inclusion of mandatory courses in inclusive pedagogy and psychology in the curricula of teacher training universities. Regular supervision by experienced specialists in inclusive education can provide invaluable guidance. Particular attention is paid to the need to develop a sustainable professional identity of the teacher as an active agent of the inclusive educational process.

Key words: *inclusive education, special educational needs, pedagogical readiness, questionnaire, professional training.*

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Reshnova S., Vasylieva N., Popovych T., Pylypchuk L., Solona Yu.

ANALYSIS AND ASSESSMENT OF ARTIFICIAL INTELLIGENCE POTENTIAL FOR IMPROVING AND AUTOMATING THE DEVELOPMENT OF METHODOLOGICAL SUPPORT FOR THE EDUCATIONAL PROCESS IN DISTANCE LEARNING

This article analyzes the potential of artificial intelligence (AI) to enhance and partially automate the development of methodological support for distance education. The growing demand for quality digital content and the rapid integration of AI in education underline the relevance of this research. Special focus is placed on AI-generated educational materials, particularly glossaries and explanatory resources in biochemistry.

The study highlights both advantages and limitations of AI in generating definitions of biochemical terms. For instance, the AI-generated definition of glucose lacks essential scientific details, such as its molecular structure and role in metabolism. Similarly, the description of monosaccharides omits key chemical characteristics, limiting their academic value. These examples raise concerns about the scientific adequacy of AI-generated content.

Nevertheless, the article emphasizes the benefits of AI in expediting initial content creation, aiding information synthesis, and reducing educator workload. However, mandatory expert review is required to ensure high academic quality. The analysis of glossaries also revealed significant gaps, particularly the absence of terms related to the classification of carbohydrates, enzymatic activity, metabolic processes, and other key concepts of biochemical relevance.

In conclusion, the study advocates for a hybrid approach that combines AI's efficiency with expert oversight to produce accurate and pedagogically valuable materials. Based on the findings, practical recommendations are provided for effectively integrating AI tools into the development of methodological resources for scientific distance learning.

Key words: *distance learning, artificial intelligence, bioorganic chemistry, methodological support of the educational process*

(*статтю подано мовою оригіналу*)

The role of AI is being studied in many areas of social life, including the development of sustainable business models, sustainable development, and automated learning [15]. However, in today's world of digital technologies and remote education, the use of AI has become an integral part of the educational process. This is particularly true in sciences such as bioorganic chemistry and biochemistry, where the volume and complexity of information are continuously increasing, AI can serve as an essential tool for creating methodological materials and enhancing the learning experience [1].

AI has tremendous potential to transform the educational process by providing more efficient and personalised approaches to learning. It enables the automation of various tasks such as assessing students' knowledge, analysing large volumes of data, and even managing learning processes [10]. AI can also assist in conducting laboratory work by analysing experimental results and providing recommendations for further actions. Furthermore, through its personalised approach, AI can adapt learning materials for students with different levels of preparation, helping them better understand the material and achieve higher academic results.

One of the main advantages of AI is its ability to create educational materials based on the analysis of large volumes of data, allowing educators to more effectively allocate their time and focus on individualised work with students. For example, AI can assist in developing adaptive learning programmes that take into account each student's knowledge level, progress, and unique needs [3]. These capabilities of AI form the basis for the relevance of our research.

In Ukraine, researchers from various fields are actively engaged in studying the use of AI in education. Among them are Nataliia Bobro [1], Serhii Yahodzinskyi [2], and Maya Maryenko [3]. Their research focuses on the application of AI for the individualisation of learning, which includes automating the collection and analysis of student performance data, thereby contributing to the improvement of the quality of the educational process.

Between 2011 and 2020, Ouyang, F., Zheng, L., & Jiao, P. (2022) demonstrated that the functions of artificial intelligence applications in online higher education include predicting learning status, success, or satisfaction, resource recommendations, automated assessment, and enhancing the learning experience. The study noted that traditional AI technologies are commonly applied, while more advanced methods (such as genetic algorithms and deep learning) are still rarely used. It was indicated that the effects created by AI programmes include high-quality predictions with AI support involving multiple input variables, high-quality recommendations based on student characteristics, improved academic performance, and enhanced online interaction and participation [12].

Other researchers, such as Tang, K. Y., Chang, C. Y., & Hwang, G. J. (2021), in their study covering the period from 1998 to 2019, demonstrated that most research focused on the development and application of intelligent learning systems, followed by the use of AI to facilitate assessment and evaluation in the context of e-learning [13].

Colchester, Khalid, et al. (2017) present a review of topics in the field of AI methods used for adaptive educational systems within e-learning, discussing their advantages and disadvantages, as well as the importance of using these methods to achieve more intelligent and adaptive e-learning environments [4].

The analysis of the literature sources allowed to systematise the advantages of using AI: automation of educational material creation, individualisation of learning, automation of assessment, modelling and visualisation. Creating educational materials for bioorganic chemistry and biochemistry courses usually requires a lot of time, as it involves not only preparing lectures but also creating laboratory assignments, interactive exercises, and assessments. AI allows for the automation of a significant part of this process through:

– *Content generation*: modern AI algorithms, such as GPT-4, are capable of creating high-quality educational texts, explaining complex concepts, and generating examples and questions for testing.

– *Updating information*: since biochemistry and bioorganic chemistry are constantly developing, it is important to update educational materials in a timely manner. AI can automatically update texts according to the latest scientific discoveries.

– *Analysis of scientific data*: to prepare lecture materials, it is important to analyse new research. AI can quickly process large volumes of scientific articles and provide teachers with a brief overview of the most recent discoveries [4].

Despite all the advantages, the use of AI in education also presents challenges. It is important to ensure the ethical use of such technologies, taking into account issues of student data privacy and ensuring equal access to learning opportunities. The implementation of such solutions requires technical training for both teachers and students, as well as the availability of appropriate software and infrastructure [5].

However, given the rapid development of technologies and the growing demand for distance learning, the use of AI in methodological support for bioorganic chemistry and biochemistry has great potential to enhance the quality of education.

The aim of the work is to develop methodological support for bioorganic chemistry and biochemistry based on the analysis of AI potential, for effective use in the context of distance learning.

The capabilities of AI ChatGPT-4 in creating educational and methodological support for distance learning in bioorganic chemistry, using the topic “Carbohydrates” as an example, are analysed in four directions:

1) generation of lecture plans;
2) selection of lecture material;
3) development of test assignments;
4) creation of a glossary.

Results. The result generated by AI in response to the request for the development of a lecture plan on the topic “Carbohydrates” demonstrated that the content is well-structured. The first lecture is dedicated to the general characteristics and monosaccharides, while the second focuses on oligosaccharides and polysaccharides, allowing students to progressively learn the material, moving from simpler to more complex molecules. This approach promotes a systematic study of the topic. The depth of coverage of the material ensures a thorough understanding of the chemical structures and functions of carbohydrates. In the first lecture, emphasis is placed on monosaccharides such as glucose and fructose, with knowledge of their composition, structure, and properties serving as the foundation for understanding biochemical processes (carbohydrate metabolism). The second lecture covers the composition, structure, and properties of oligosaccharides and polysaccharides. The selection of representatives is justified by their significance in the biochemical reactions of the body.

Special attention is given to the practical application of knowledge: the lecture questions emphasise the biological role of carbohydrates in metabolism and energy processes in the body. This enhances the significance of bioorganic chemistry for biology students, enabling them to connect theoretical knowledge with biochemical processes. At the same time, the lecture plan generated by artificial intelligence contains excessive information, namely several definitions of terms. Overall, the lecture plan meets the requirements of the bioorganic chemistry course and provides students with sufficient information on the topic “Carbohydrates”.

The result generated by AI in response to the request for selecting lecture material did not meet our expectations. Instead of providing lecture content. AI provided us with an expanded outline rather than lecture material, which included a lot of biology and very little chemistry. The selected lecture material lacks structural and spatial formulas, as well as chemical reactions, which are essential for understanding the properties of carbohydrates and their role in complex biochemical processes. Adding such elements would make the material more scientific and visual, facilitating a better understanding of the composition, structure, and properties of carbohydrates.

The experience of developing test assignments using artificial intelligence was interesting and successful (Table 1).

Table 1

Analysis of the content of test tasks developed by artificial intelligence

Positive aspects	Negative aspects
Variety of task formats	The absence of chemical formulas and equations
Coverage of new information by the tasks	The reproductive level of most test tasks
Focus on biochemical processes	The low complexity level of most test tasks
Clear formulation of tasks	

Let's take a closer look at the obtained result. First of all, the analysis of the test assignments selected by artificial intelligence for the "Carbohydrates" test revealed several positive aspects:

1. *Coverage of new information through the tasks*. The tasks cover the main new concepts of the lecture and align with the key learning objectives. This allows students to assimilate new information and transform it into knowledge.
2. *Variety of task formats*. The test includes tasks of two types (multiple-choice questions and yes/no questions), which allows for assessing different levels of understanding of the material.
3. *Focus on biochemical processes*. The test includes questions that help students understand the role of carbohydrates in biochemical processes.
4. *Clear formulation of tasks*. The test questions are formulated clearly and concisely, which simplifies the process of solving them for students.

Suggestions for improving the test:

1. *Addition of chemical formulas and equations*. The test does not include tasks involving the depiction of chemical structures or reactions. It would be useful to add tasks on identifying or comparing the structures of monosaccharides (e.g., glucose and fructose), recognising the chemical bonds between them, and drawing chemical reaction schemes.
2. *Increasing the productivity and complexity of tasks*. Most of the questions focus on basic understanding of the topic. To enable deeper analysis, it would be beneficial to add more productive-type questions as well as tasks of a higher level of difficulty.

The possibilities of AI in developing a glossary for the proposed topic were also analysed. AI has several positive aspects in creating a glossary: it quickly generates basic definitions, structures the material, and provides an overall understanding of the key concepts of the topic. The definitions of concepts are concise. However, in many cases, these definitions are incomplete, do not describe the composition, structure, and properties of compounds, and therefore require significant refinement to ensure a deep understanding needed in the context of the bioorganic chemistry course (Table 2).

Table 2

Analysis of the glossary developed by artificial intelligence

The result generated by artificial intelligence based on the request for the development of a glossary	Definitions of concepts in scientific literature
Glucose is a hexose monosaccharide that serves as the primary source of energy for the cells of the body	Glucose is grape sugar, a monosaccharide, an aldose hexose, a reducing sugar, and the primary source of energy for the cells of the body
Monosaccharides are the simplest carbohydrates that cannot undergo further hydrolysis. They are the basic building blocks for oligosaccharides and polysaccharides	Monosaccharides are polyhydroxy aldehydes or polyhydroxy ketones that do not undergo hydrolysis
Fructose is a ketose monosaccharide found in fruits and honey, which easily converts to glucose in the body	Fructose is a monosaccharide, a ketohexose, found in fruits and honey, which easily converts to glucose in the body
Deoxyribose is a pentose monosaccharide that is a component of DNA	Deoxyribose is a monosaccharide, an aldopentose, which lacks an oxygen atom at the second carbon atom and is a component of DNA

For example, the definition of glucose proposed by AI – "Glucose is a hexose monosaccharide that is the primary energy source for the body's cells" – is incomplete as it does not consider the composition, structure, and properties of the substance. Let's compare it with a more comprehensive definition that covers these aspects: "Glucose is grape

sugar, a monosaccharide, an aldohexose, a reducing sugar, and a primary energy source for the body’s cells”. The definition generated by AI requires correction.

Another example is the definition of monosaccharides. AI describes them as “the simplest carbohydrates that cannot undergo further hydrolysis and serve as basic building blocks for oligo- and polysaccharides”. However, a more complete definition should include information about their chemical nature: “Monosaccharides are polyoxyaldehydes or polyoxyketones that do not undergo hydrolysis”. Such detailed information is critically important for students studying carbohydrate chemistry.

The developed glossary does not cover all the essential concepts related to carbohydrates and their role in biological processes. For instance, terms such as glycosidic group, pentoses, hexoses, sucrose, and D-sugars etc., are missing. The inclusion of biochemical concepts such as glycolysis, gluconeogenesis, and the pentose phosphate pathway in the “Carbohydrates” glossary is a topic of discussion.

Conclusions. AI can significantly automate the process of developing lecture plans by effectively creating structured and meaningful materials based on well-formulated prompts. Thanks to its ability to analyse provided data and textbook excerpts, AI can generate logical and coherent lecture plans that cover essential topics, key concepts, and examples. This allows educators to save time on preparing teaching materials while ensuring a high level of quality and compliance with curriculum requirements. However, as noted by Holmes, W. (2020), AI applications in education have a relatively short history of implementation and possess immense potential for transformation [7].

Recent research on the integration of AI in education by Nikolopoulou, K. (2025) indicates that incorporating AI in higher education can lead to advancements in sustainability. This includes improvements in educational practices (such as personalised learning, automated assessments and feedback, and professional development for educators), optimisation of resource usage (including digital learning resources and efficient energy management), and support for inclusive and accessible education [11].

Additionally, teacher can easily modify the suggested plan by submitting new prompts to expand or reduce specific sections, thereby integrating creative and technological approaches to teaching. Despite its numerous advantages, AI cannot replace the human element in crafting a comprehensive lecture. Its capabilities are limited to automating the development of extended lecture outlines based on specific prompts. AI can assist teachers in structuring information, highlighting key topics and concepts, and organising material in a convenient and well-structured format. However, teaching complex and multifaceted disciplines like chemistry requires the involvement of a teacher who can not only incorporate relevant examples, chemical formulas, and reactions into the lecture but also provide additional explanations to foster a deeper understanding of complex processes.

The teacher holds the responsibility for adapting lecture material to the knowledge level and needs of students, considering their questions and reactions during the learning process. This interaction provides an opportunity to make education personalised and engaging. Therefore, AI serves as a powerful tool to support teachers by facilitating the preparation of materials and optimising time for course organisation. However, it cannot replace the educational experience that only specialists possess and apply. Thus, AI is an assistant, not a substitute, when it comes to creating high-quality and informative lectures for various learning formats.

AI, based on uploaded materials for analysis, can automate the development of test tasks and adapt them to various formats, enhancing the interactivity of lessons and ensuring a personalised approach for each student. Thanks to AI’s ability to quickly process and structure information, it can generate a variety of test types, including multiple-choice questions and yes/no tasks. This significantly eases the preparation of educational materials, allowing teachers to save time and focus on improving the learning process. This capability is particularly useful for distance learning, where the rapid adaptation of lesson plans and assignments is crucial for effective education. It is true that more than half of the definitions generated by AI require significant additions and clarifications to achieve a full understanding of the topic, which is essential in the learning process, especially in complex disciplines like bioorganic chemistry. While AI is capable of generating basic, structured definitions that can be useful for initial familiarisation, it often overlooks the nuances of terminology that are crucial for a correct and deep understanding of the material.

Thus, AI can only provide a preliminary foundation for the glossary, which requires further refinement and correction by a specialist. For creating high-quality educational materials for a subject, artificial intelligence can only be a helpful tool in the initial stages, while the final result depends on the competence of the teacher, who adapts the material to the level and needs of the students, ensuring scientific accuracy and logical consistency of the educational content. We share the opinion of researchers García-Martínez, I., Fernández-Batanero, J.M., Fernández-Cerero, J. et al. (2023), who, despite the numerous advantages, highlight that the implementation of AI technologies in the educational process poses serious educational and ethical challenges for teachers regarding their development and implementation. However, the results of the study confirm the positive impact of AI on student success, revealing an increase in their attitude towards learning and motivation, especially in STEM fields (Science, Technology, Engineering, and Mathematics) [6]. These conclusions align with our results in teaching bioorganic chemistry to higher education students.

AI is also an important tool for distance learning, allowing for the prompt adjustment of lesson plans and assignments, which increases the flexibility of the learning process and makes it easier for teachers to respond to changes. Such statements are mentioned in the article by Mouta, A., Torrecilla-Sánchez, E.M., & Pinto-Llorente, A.M. (2024), where it is shown that the integration of ethical AI in education contributes to the continuous professional development of teachers by equipping them with scenarios that can be used as resources for learning objectives [10].

However, AI is not capable of fully replacing the teacher in the process of creating educational materials. This is especially true for complex subjects like bioorganic chemistry, where accurate definitions and explanations are needed to provide deep understanding, including terminological and structural nuances. Most definitions generated by AI are simplified and often require substantial additions and corrections from specialists, as they do not account for the subtleties and critical characteristics necessary for forming a deep understanding of the topic for students. Specialists Cope, B., Kalantzis, M., & Searsmith, D. (2020) also note that artificial intelligence will never "take over" the role of the teacher. This statement implies that AI is fundamentally different from human intelligence. However, AI offers the potential for transforming education: it makes education more humane, rather than diminishing its value [5].

Therefore, AI serves as a tool for preliminary material preparation, but the main role in creating high-quality educational content remains with the teacher. A competent specialist is capable of adapting the material to the level and needs of the students, ensuring scientific accuracy, logical consistency, and the depth of information required for effective learning.

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Решнова С. Ф., Васильєва Н. О., Попович Т. А., Пилипчук Л. Л., Солона Ю. О. Аналіз і оцінка потенціалу штучного інтелекту для вдосконалення та автоматизації розробки методичного забезпечення освітнього процесу в дистанційному навчанні

У статті розглядається потенціал штучного інтелекту (ШІ) у вдосконаленні та частковій автоматизації створення методичного забезпечення для дистанційної освіти. Зростаюча потреба в якісному цифровому навчальному контенті та швидка інтеграція ШІ в сучасні освітні процеси підкреслюють актуальність проведеного дослідження. Особливу увагу приділено матеріалам, створеним за допомогою ШІ, зокрема глосаріям та пояснювальним ресурсам у галузі біохімії.

У дослідженні окреслено як переваги, так і обмеження застосування ШІ для визначення біохімічних термінів. Наприклад, визначення глюкози та моносахаридів, згенеровані ШІ, не містять важливих наукових деталей, таких як молекулярна будова чи хімічні властивості, що суттєво знижує їхню академічну цінність. Це викликає обґрунтоване занепокоєння щодо точності створеного автоматизованого контенту.

Отже, штучний інтелект виявляється корисним інструментом для пришвидшення створення навчальних матеріалів, підтримки інформаційного синтезу та зменшення навантаження на викладачів, що особливо актуально в умовах зростаючої кількості інформації. Проте необхідна обов’язкова експертна перевірка для забезпечення високої академічної якості. Аналіз глосаріїв також показав суттєві прогалини, зокрема відсутність термінів, пов’язаних із класифікацією вуглеводів, ферментативною активністю, метаболічними процесами та іншими ключовими поняттями біохімічного змісту.

Автори підтримують доцільність використання гібридного підходу, що поєднує ефективність ШІ з фаховим контролем для створення точних, науково обґрунтованих і педагогічно цінних навчальних матеріалів. У результаті дослідження наведено практичні рекомендації щодо інтеграції інструментів ШІ у процес розробки ресурсів для науково орієнтованого дистанційного навчання.

Ключові слова: *дистанційне навчання, штучний інтелект, біоорганічна хімія, методичне забезпечення освітнього процесу.*