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Integration of artificial intelligence technologies into the management system of agrotechnical education

Abstract. Introduction*. Integrating AI into the learning management system enhances student engagement by providing a more interactive and personalised learning experience. In the context of teaching, it improves the efficiency of content creation, gives feedback and facilitates assessment processes. Furthermore, AI can help students to develop critical thinking and modern digital skills, both of which are essential for professionals in the field of agricultural engineering. AI can also enhance our ability to analyse complex data and model technical processes, thereby enriching students' practical understanding and simplifying administrative processes.*

Purpose*. The article explores ways to integrate artificial intelligence technologies into agrotechnical education management systems.*

Results*. Integrating artificial intelligence tools into the educational system enables us to adapt learning to the individual needs of students and automate routine tasks, freeing up time to focus on research and innovation in the curriculum. The study of integrating artificial intelligence technologies into the management system of technical agricultural education involved comparing the effectiveness of two approaches: a combined approach, which uses a wide range of AI tools to implement the educational and management processes of higher education institutions; and a differentiated approach, in which AI technologies are divided into three groups to perform the following specialised tasks: creating visual and media content; modelling, calculations and 3D visualisation; and chatbot assistants for planning, consultation and support during the educational process. To assess this, criteria were developed for the integration of AI technologies into the management system of agricultural education. These criteria include compliance with the intended purpose, moderation of the educational process, accessibility, quality of the created content, and technical support. A statistical evaluation based on the Spearman criterion determined that preliminary differentiation of AI tools according to the expected results of their application is a more effective approach.*

Conclusions*. The integration of AI technologies into agrotechnical education management systems can transform the role of educators, shifting the focus from content provision to facilitating deeper learning and critical analysis. However, strengthening the mentoring and guidance of students on the ethical and effective use of AI and issues of academic integrity shuld be adressed. In the context of applying AI technologies to improve education management systems for higher education students majoring in agriculture, it is clear that teaching becomes more dynamic, effective and responsive to their individual needs.*

Keywords*: artificial intelligence, education management system, agricultural education, technical disciplines*

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Інтеграція технологій штучного інтелекту в систему управління агротехнічною освітою

Анотація. *Інтеграція штучного інтелекту в систему управління освітою підвищує залученість студентів, забезпечуючи інтерактивний та персоналізований навчальний досвід. В контексті викладацької діяльності відбувається підвищення ефективності у створенні контенту, наданні зворотного зв'язку та процесах оцінювання. Крім того, штучний інтелект допоможе студентам розвивати критичне мислення та сучасні цифрові навички, які є важливими для фахівців в галузі агроінженерії. Використання штучного інтелекту також може підвищити нашу здатність здійснювати складний аналіз даних та моделювання технічних процесів, збагачуючи практичне розуміння студентів та спрощуючи адміністративні процеси.*

У статті досліджено способи інтеграції технологій штучного інтелекту в систему управління агротехнічною освітою.

Залучення інструментів штучного інтелекту дозволяє адаптувати навчання до індивідуальних потреб студентів та звільнити час, автоматизуючи рутинні завдання, що надає можливість присвятити більше зусиль дослідженням та інноваціям у навчальній програмі. Дослідження інтеграції технологій штучного інтелекту в систему управління технічною аграрною освітою полягало в порівнянні ефективності двох підходів: комбінованого, тобто застосування широкого спектру засобів ШІ для реалізації освітніх та управлінських процесів закладів вищої освіти та диференційованого, тобто коли технології ШІ поділені на три групи та реалізують наступні спеціалізовані завдання: створення візуального та медіа контенту; здійснення моделювання, розрахунків та 3Д візуалізації; чат-бот асистенти для планування, консультування та підтримки навчального процесу. З метою оцінки розроблено критерії інтеграції технологій штучного інтелекту в систему управління агротехнічною освітою, до яких відносяться: відповідність цільовому призначенню; модерація освітнього процесу; доступність; якість створеного контенту та технічна підтримка. Здійснено статистичну оцінку на основі критерія Спірмена і визначено, що попередня диференціація засобів ШІ в залежності від очікуваних результатів їх застосування є більш ефективним підходом.

Інтеграція технологій штучного інтелекту в систему управління агротехнічною освітою може трансформувати роль викладача, змістивши фокус з о надання контенту на сприяння глибшому навчанню та критичному аналізу. Але треба звернути увагу на необхідність посилення наставництва та керівництва студентами щодо етичного та ефективного використання штучного інтелекту, питань академічної доброчесності. В контексті застосування технологій ШІ для покращення системи управління освітою, що спрямована на підготовку здобувачів вищої освіти агротехнічного напрямку визначено, що викладання стає більш динамічним, ефективним та реагує на індивідуальні потреби здобувачів вищої освіти.

Ключові слова*: штучний інтелект; система управління освітою; аграрна освіта; технічні дисципліни.*

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Formulation of the problem. Using AI tools can improve the clarity and accuracy of technical writing, lab reports and design documentation, all of which are critical for communicating engineering concepts. AI tools facilitate the creation of visually appealing presentations and dynamic explanations, enabling the structured and engaging demonstration of designs, mechanisms, or material behaviour. In practical design work, AI tools provide an intuitive environment for 3D modelling of components, equipment and object schematics, enabling the exploration of mechanical concepts in a highly visual way. AI tools can transform text descriptions into functional interface designs or schematic layouts, which is useful for rapid prototyping or conceptual visualisation in system planning. Embedding these AI tools in technical education can increase engagement, streamline complex processes, and develop the skills needed for higher education students to work effectively at the intersection of engineering and agriculture.

Integrating AI technologies into the management system of technical agricultural education enables the development of innovative, practical solutions through the effective use of AI tools throughout the educational process. Integrating technical knowledge with research, ideas, design and communication using AI promotes critical thinking and transparency in assessing the work of higher education students. Integrating AI technologies into the management system of agricultural education optimises administrative and educational-methodological processes, fosters entrepreneurial skills and digital competencies in higher education students, and encourages collaboration in agricultural engineering innovation and industry. It also simplifies learning management, assessment, and counselling processes.

Analysis of recent research and publications. Educators often struggle to articulate their ideas clearly in design reports, project documentation and research summaries [1]. Motivating students in technically complex subjects, particularly when they cannot see the

immediate practical applications, can be challenging [3]. Authors [2, 4] point out that passive learning formats further reduce engagement in the learning process. Researchers [7, 8] argue that, although students may be able to master theoretical models or textbook examples, they often find it difficult to apply these principles to real-world design scenarios, particularly in the absence of industry case studies or simulation environments.

Identifying real-world problems and generating creative, viable solutions by combining technical knowledge with AI-powered idea generating tools encourages critical thinking and adaptability, as students evaluate AI-driven insights and refine their ideas based on data and feedback. The authors outline technologies that enable students to develop practical design and prototyping skills using AI-powered modelling software, allowing them to quickly develop and test innovative concepts. Graduate students will gain experience in articulating the value and feasibility of their solutions through clear presentations and AI-powered business modelling, thereby improving their communication and presentation skills [11].

In addition, students develop digital literacy and ethical awareness by integrating AI tools responsibly into their work processes, thereby preparing themselves to navigate technological developments [12]. The integration of AI technologies into the management system of technical agricultural education fosters an entrepreneurial mindset centred on innovation, problem-solving, collaboration and the capacity to translate ideas into tangible, effective outcomes within the agricultural sector [10]. However, researchers agree that a successful strategy for using AI tools in educational management should be based on the ethical use of AI principles, ensuring transparency regarding AI's contribution and the originality of the work [11, 13].

Appropriately selected AI tools should meet the technical requirements of agricultural engineering disciplines, as well as promoting practical understanding, clear communication and student-centred learning [17]. Providing visually appealing educational content complements the need for detailed explanations of engineering concepts such as facility design or systems analysis, transforming them into accessible formats that facilitate better understanding and the development of professional skills [15]. Accurate and clear documentation is critical in agricultural engineering, and this tool helps students to improve their reports and project descriptions, ensuring that they can articulate engineering solutions clearly and accurately [18].

Researchers have noted that AI tools enable students to intuitively visualise and model structures, mechanical components and process flows. This bridges the gap between theoretical knowledge and practical application, as user-friendly interfaces encourage experimentation and iterative learning [14, 16]. These AI tools increase engagement, support diverse learning styles and prepare students for the evolving technological landscape in agricultural engineering.

Formulation of research goals. Development and experimental verification of the effectiveness of integrating artificial intelligence technologies into the management system of technical agricultural education.

Outline of the main research material. The rapid development of artificial intelligence (AI) is transforming the transmission and acquisition of technical knowledge in agricultural universities. For example, the integration of practical design, spatial thinking and analytical skills is crucial in training future agricultural engineers. A number of free or easily accessible AI-based tools can support this by making technical education more interactive, visual and student-centred. In the context of development, it is proposed that a number of AI tools be implemented to support the management and implementation of the educational process for future agricultural engineers. AI technologies are conventionally divided into three groups: those for creating visual and media content; those for modelling, calculations and 3D visualisation; and chatbot assistants for planning, consulting and supporting the educational process. Examples of tools in the first group include: Lucidchart, Canva AI, Power BI with Copilot, Pictory and Gamma. AI tools that provide modelling, calculations and 3D visualisation include Shapr3D, Uizard, Autodesk Fusion 360 + Generative Design, SolidWorks + AI plug-ins and Unity 3D. Educational planning and consulting functions can be partially automated using Perplexity AI, Copilot, Turnitin Feedback Studio, the GPT-4 API and Gradescope.

A questionnaire was conducted to assess the effectiveness of implementing the above-mentioned tools. According to the previously outlined criteria, the questionnaire assessed the effectiveness of implementing artificial intelligence technologies in the management system of technical agrarian education. Two groups participated in the study: the first used a combination of the outlined technologies, while the second used AI technologies in isolation from the tasks they were designed for. Five criteria for assessing effectiveness were developed and are presented in Table 1. During the questionnaire, compliance with the implementation of AI-powered innovation in technical agrarian education was assessed on a scale of 1 to 10 for each criterion.

Table 1 **Criteria of implementation of AI-powered innovation in technical agrarian education**

Tool/Criteria	**Visual AI tools**	**Graphical AI tools**	**Supportive AI tools**
1. Realization of primary function	AI-driven presentation and content creation tool	3D modeling or rapid prototyping and wireframing tools	AI-powered writing assistant for paraphrasing, grammar, and clarity improvement
2. Use in education and moderating the educational process	Creates visually engaging presentations and project reports. Templates, visual design suggestions, interactive elements. Enhances engagement and communication skills	Supports hands-on design and visualization of livestock facilities, machinery, and processes. Intuitive 3D modelling, CAD compatibility; drag-and-drop design, sketch conversion. Develops spatial understanding and practical design skills	Enhances technical writing, report drafting, and academic communication. Paraphrasing, grammar correction, multiple writing modes. Improves writing clarity and academic professionalism.
3. Accessibility	Free tier available, user-friendly interface	Free educational licenses available, requires initial training	Free version with essential features, simple interface
4. Use Format	Synchronous sessions and assignments	Synchronous guided sessions plus independent projects	Independent study and assignments
5. Support Needed	Workshops on presentation design	Training sessions, tutorials, ongoing support	Introductory tutorials, writing guidelines

Source: authors' development

The study examined the integration of artificial intelligence technologies into the management system of technical agricultural education, surveying participants in the educational process. A total of 48 participants took part in the study, including higher education students, teachers, and management staff from a higher education institution. The first research group comprised 20 experts who used a combination of AI tools without differentiating between them depending on the type of application. The second group of 20 experts relied on the differentiated use of AI tools depending on the ultimate goal: creating visual and media content; performing modelling, calculations and 3D visualisation; and developing chatbot assistants for planning, consulting and supporting the educational process.

The last stage of the study was a statistical verification of the effectiveness of integrating artificial intelligence technologies into the management system of technical agricultural education by surveying participants of the educational process before and after their implementation, taking into account the assessment of each of the 20 experts, which is presented in Table 2.

The Spearman criterion was applied to the statistical calculation of the effectiveness of integrating artificial intelligence technologies into the management system of technical agricultural education, which involved surveying participants in the educational process before and after the implementation of the proposed technologies. The critical values selected from a typical two-sided table for a sample size of n=20 are: $\rho \leq 0.05 = 0.447$ and $\rho \leq 0.01 = 0.587$. Table 2 shows the criterion score on a 10-point scale for a combined approach to using AI tools (group X) and a differentiated approach to using AI tools (group U). To calculate Spearman's rank correlation, two series of values that can be ranked are required. Such a series of values can be two individual hierarchies of signs revealed in two subjects with one and the same set of signs. First, the indicators are ranked separately for each indicator. Typically, a smaller value of the attribute is assigned a lower rank. The difference between ranks X and Y is calculated, each difference d is squared, and the sum of squares is calculated.

Table 2 **Estimation of implementation of AI-powered innovation in technical agrarian education**

№	Combined approach (X)	Differentiated approach (Y)	Rank X	Rank Y	d = Rank X – Rank Y	d^2
1	5	7	9	12	3	9
2	5	8	9	12	3	9
3	6	9	16	18	2	4
4	4	6	4	1	3	9
5	6	7	16	5	11	121
6	5	8	9	12	3	9
7	5	8	9	12	3	9
8	3	6	1	1	0	0
9	3	7	1	5	4	16
10	6	8	16	12	4	16
11	5	8	9	12	3	9
12	4	6	4	1	3	9
13	5	6	9	1	8	64
14	4	7	4	5	1	1
15	5	7	9	5	4	16
16	6	8	16	12	4	16
17	4	9	4	18	14	196
18	6	10	16	20	4	16
19	4	7	4	5	1	1
20	3	7	1	5	4	16
Total	94	149	166	174	82	546

Source: authors' development

The Spearman rank correlation method enables you to determine the strength and direction of the correlation between two features or feature profiles. In the context of this study, the effectiveness of two approaches was tested: a combined approach, involving the use of a wide range of AI tools to implement educational and management processes in higher education institutions; and a differentiated approach, involving dividing AI technologies into three groups to perform the following specialised tasks: creating visual and media content; modelling, calculations and 3D visualisation; and chatbot assistants for planning, consulting and supporting the educational process. The rank correlation coefficient rs = 0.589 was calculated; therefore, the correlation between the research groups is statistically significant. We can therefore conclude that using a differentiated approach to integrate artificial intelligence technologies into the management system of agricultural education is effective.

In the context of the study, the ethical and legal restrictions on the use of AI were taken into account. In particular, all participants in the experiment were informed of the need to observe academic integrity and the transparency of the algorithms used for the outlined tools. They were also informed that substituting intellectual activity was not permitted.

Conclusions. In the era of digital transformation, integrating artificial intelligence (AI) into agricultural engineering education is transforming how students learn, think and create. AI-based tools enhance the quality of learning and enable students to gain a deeper understanding of complex agricultural engineering systems. By combining automation, personalisation and creativity, these tools bridge the gap between theoretical knowledge and its practical application. When strategically integrated into agricultural engineering training, these tools promote innovation, improve academic performance and prepare students for the

demands of today's agricultural engineering industries. The following table provides a comparative analysis of these tools based on their usefulness in key engineering disciplines.

This study evaluates combined and differentiated approaches to implementing AI tools in technical agricultural education management systems. The criteria for implementing innovations based on artificial intelligence in technical agricultural education were developed and subjected to expert assessment; the expert groups included participants in the educational process. Statistical calculations determined that the differentiated approach, oriented towards variable application of AI tools depending on educational goals, the level of applicants and the type of activity, is the most effective.

An important aspect of the outlined problem is gaining the administration's approval to include AI tools in the curriculum, including allocating time for training sessions and securing funding for workshops or resource development. Collaborating with colleagues to share best practice, develop educational materials jointly and provide mutual assistance in effectively implementing and integrating AI technologies will help ensure a smooth process and maximise the educational benefits of AI tools for tutors, students and administrators.

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