“A bibliometric analysis of the economic effects of using artificial intelligence and ChatGPT tools in higher education institutions”

AUTHORS

Anna Vorontsova
Svitlana Tarasenko
Wojciech Duranowski
Arkadiusz Durasiewicz
John Soss
Artem Bilovol

ARTICLE INFO	Anna Vorontsova, Svitlana Tarasenko, Wojciech Duranowski, Arkadiusz Durasiewicz, John Soss and Artem Bilovol (2025). A bibliometric analysis of the economic effects of using artificial intelligence and ChatGPT tools in higher education institutions. *Problems and Perspectives in Management*, *23*(1), 101-114. doi:10.21511/ppm.23(1).2025.08
DOI	http://dx.doi.org/10.21511/ppm.23(1).2025.08
RELEASED ON	Wednesday, 15 January 2025
RECEIVED ON	Wednesday, 06 November 2024
ACCEPTED ON	Thursday, 09 January 2025
LICENSE	This work is licensed under a Creative Commons Attribution 4.0 International License
JOURNAL	"Problems and Perspectives in Management"
ISSN PRINT	1727-7051
ISSN ONLINE	1810-5467
PUBLISHER	LLC “Consulting Publishing Company “Business Perspectives”
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
71	5	4

BUSINESS PERSPECTIVES

LLC "CPC "Business Perspectives"
Hryhorii Skovoroda lane, 10,
Sumy, 40022, Ukraine

www.businessperspectives.org

Anna Vorontsova (Ukraine), **Svitlana Tarasenko** (Ukraine), **Wojciech Duranowski** (Poland), **Arkadiusz Durasiewicz** (Poland), **John Soss** (USA), **Artem Bilovol** (Ukraine)

A BIBLIOMETRIC ANALYSIS OF THE ECONOMIC EFFECTS OF USING ARTIFICIAL INTELLIGENCE AND CHATGPT TOOLS IN HIGHER EDUCATION INSTITUTIONS

Abstract

One of the main challenges in higher education management is the complexity of resource optimization and increasing volumes of data, which limits the efficiency and accuracy of decision-making. The application of artificial intelligence can address these issues.

The present study aims to identify the key trends, knowledge gaps, and opportunities for further research into the economic effects of using artificial intelligence and ChatGPT tools in higher education. For this purpose, a systematic literature review was conducted to identify and screen the scientific articles related to the topic of this study indexed in Web of Science and Scopus from 1986 to 2024. A total of 234 articles were selected, all demonstrating positive growth both in scholarly output and citation count. The study identified the key contributors to scientific research on this topic by region (the United States, China, and India). It concluded that the relevant research centers are still at an early stage of their development. Based on bibliometric clusters formed by co-occurrence relations, three main areas of research were defined: 1) artificial intelligence in education for decision-making; 2) process automation and digital transformation in educational institutions; 3) artificial intelligence technologies and their application in education.

The study highlights the main areas of economic effects of artificial intelligence and ChatGPT tools in higher education, including reducing administrative costs, saving time for teachers and students, and improving the quality and accessibility of educational process.

Keywords automation, chatbot, costs, higher education, management, PRISMA, Scopus, university, Web of Science

JEL Classification D24, I22, O33

Received on: 6th of November, 2024
Accepted on: 9th of January, 2025
Published on: 15th of January, 2025

Anna Vorontsova, Ph.D. in Economics, Senior Researcher, Department of International Economic Relations, Academic and Research Institute of Business, Economics and Management, Sumy State University, Ukraine.

Svitlana Tarasenko, Ph.D. in Economics, Senior Lecturer, Department of International Economic Relations, Academic and Research Institute of Business, Economics and Management, Sumy State University, Ukraine. (Corresponding author)

Wojciech Duranowski, Ph.D. in Economics, Associate Professor, Faculty of Economics, Opole University, Poland.

Arkadiusz Durasiewicz, Dr. of Economics, Associate Professor, Department of Economic Policy and Banking, Faculty of Economics and Finance, Casimir Pulaski Radom University, Poland.

John Soss, Ph.D. in Finance, Associate Professor, Department of Finance, Fox School of Business, Temple University, USA.

Artem Bilovol, Ph.D. Student, Department of International Economic Relations, Academic and Research Institute of Business, Economics and Management, Sumy State University, Ukraine.

Conflict of interest statement:
Author(s) reported no conflict of interest

INTRODUCTION

High competition, migration-related crises, the spread of diseases, and technological changes force higher education institutions to look for new approaches to teaching and learning as well as to rethink the ways of interacting with the participants of educational process. Under such conditions, the use of artificial intelligence (AI) and its tools, such as ChatGPT, are among the ways to adapt and optimize the economic model of higher education institutions' operations.

Throughout the past decades, AI integration in higher education has evolved through multiple stages – from basic expert systems to powerful neural networks – bringing about innovative solutions for personalized learning and automation of educational processes (Bond et al., 2024). Pantelimon et al. (2021) claim that the COVID-19 pandemic played a crucial role in accelerating the implementation of AI tools in

higher education since it forced educational institutions to switch over to distance learning. In other words, the pandemic sped up the digital transformation of universities and boosted the demand for process automation and intelligent technologies to sustain continuous learning (Slimi, 2021; Corea et al., 2022).

According to the 2024 EDUCAUSE Horizon Report, AI tools have the potential to reshape higher education, especially in the context of the recent implementation of ChatGPT (Singh et al., 2023; Pelletier et al., 2024). The application of AI tools extends beyond pure automation of certain administrative processes; it is currently expanding into the realms of teaching and learning, fostering personalized education, enhancing teaching effectiveness, and engaging students (Chu et al., 2022; Fahd et al., 2022; Lindqvist et al., 2023; Segovia-García, 2024; Smerdon, 2024). While AI tools offer potential advantages in higher education, their use also brings a range of ethical and legal challenges that call for solutions (Xu et al., 2021; Markauskaite et al., 2022; Wirtz et al., 2022; Bearman et al., 2023; Ferrara, 2023; Ng et al., 2023; Schön et al., 2023; Stahl, 2023; Saúde et al., 2024).

Thus, an analysis of available research on this topic is necessary to provide information for higher education leaders and policymakers who aim to optimize resource use and deliver quality education by incorporating AI tools into management and teaching practices.

1. LITERATURE REVIEW

According to Zagoruiko and Petkova (2022), firms, not the owners of production factors, determine the technological development horizon. In other words, higher education institutions receive market-tested products created using new technologies.

The economic justification for integrating AI technologies in higher education involves assessing costs, economic effects, and implementation performance indicators, which is relevant given the current challenges universities face in optimizing resources while improving education quality. Numerous studies claim that a positive attitude toward AI contributes to its effective use in education. Exploring the impact of generative intelligence on the knowledge management paradigm, Kaczorowska-Spychalska et al. (2024) demonstrate that AI can enhance knowledge sharing and transform management processes. Discussing the subject domains for AI use in higher education, Crompton and Burke (2023) argue that it is most frequently applied in language learning, coding, and university management. The introduction of artificial intelligence in higher education institutions features the absence of prior practices of substituting teachers' intellectual work with machine algorithms. Accordingly, artificial intelligence undergoes testing and adaptation in the unique context of each higher education institution, potentially resulting in extra costs for technology integration (Nyale et al., 2024; Kamalov et al., 2023). However, the issues of economic benefits of applying this technology, especially in regard to effective university resource management, are still open (Dwivedi et al., 2023; McGrath et al., 2023; Pearce & Chiavaroli, 2023; Chen et al., 2024).

Various models and theories form the theoretical foundation for justifying AI integration in higher education and its effects.

The technology acceptance model (TAM), conceived by Davis (1989), is one of the most popular models for explaining the adoption of technology in various industries. It features two key determinants: 1) measuring perceived usefulness, i.e., how much users believe the new technology will improve their performance, and 2) measuring perceived ease of use, i.e., how easy it is for users to utilize the technology. This model provides insight into how teachers and students accept new technologies based on their expected performance in the educational process (Chatterjee & Bhattacharjee, 2020; Guerrero-Roldán et al., 2021; Lu et al., 2023; Meakin, 2024).

The diffusion of innovation theory, developed by Everett Rogers in 1962, explains how innovation gradually spreads through certain social systems. In particular, it helps explain the step-by-step integration of AI into university systems (Rogers, 2003).

http://dx.doi.org/10.21511/ppm.23(1).2025.08

According to the institutional change theory, new technologies transform not only individual institutions but also institutional practices as a whole by shaping the norms of educational practices, the rules of knowledge transfer, and the organization of education provision (Renz & Hilbig, 2020; Ouyang & Jiao, 2021). Moreover, the introduction of AI in higher education alters the organizational structures of educational institutions and the methods of teaching and interacting with students (Chan, 2023; Lee et al., 2024).

Various models and theories of implementing artificial intelligence suggest a set of strategies for integrating this technology into education. However, in addition to technical issues, it is important to consider the economic rationale for such initiatives.

For example, the economic approach implies analyzing the cost of implementing technologies and their economic effects on the university, students, and society in general. In particular, it considers the cost-sharing between the four principal parties: (1) government or taxpayers, (2) parents, (3) students, and/or (4) individual or institutional donors (Johnstone, 2004). To assess the implementation of AI in business, Kejriwal (2023) suggests using the ROI indicator and emphasizes that the implementation effects of AI may have both short-term and long-term effects.

Integrating AI into educational processes has the potential to optimize operational costs associated with teaching (by reallocating costs across assessment, learning content development, supervision, and student learning trajectory support) and to improve institutional productivity (especially through automating administrative tasks such as student enrollment, scheduling, etc.) (Popenici & Kerr, 2017). Schön et al. (2023) claim that AI assistants substantially transform higher education by shaping the educational processes, assessment approaches, and administrative tasks. They enhance personalized learning and support teachers and students, but at the same time, pose ethical and legal challenges that call for solutions (Zawacki-Richter et al., 2019; Kuleto et al., 2021; Seo et al., 2021; Celik et al., 2022; Kasneci et al., 2023; Schön et al., 2023).

The social approach helps analyze the impact of technologies, particularly AI, on accessibility and quality of higher education, i.e., the level of additional coverage of the population with higher education services as a result of introducing AI technologies (e.g., for people from remote regions, various social groups, and people with special needs). At the same time, technologies give rise to new forms of learning content, reshape the educational process, and improve higher education quality by enhancing the students' engagement and designing a comfortable educational environment (Cavalcanti et al., 2021; Chaudhry & Kazim, 2022; Kumar et al., 2024; Shahzad et al., 2024). Krenn et al. (2022) argue that the AI effects facilitate work with complex dynamic systems, enhance learning from precise and detailed models, and create a heuristic effect whereby algorithms can uncover unexpected data or anomalies that students can leverage for further research and scientific discoveries.

The technological approach involves analyzing possible technological solutions for higher education to improve business processes and infrastructure, i.e., to increase the efficiency of providing higher education services (Schemmer et al., 2023).

Accordingly, the decision to introduce AI into a higher education institution should be economically justified, i.e., based on a cost-effectiveness analysis.

Thus, analyzing the economic aspects of introducing AI in higher education becomes an integral part of any research seeking to optimize resource use and improve higher education quality. The present study aims to identify the key trends, knowledge gaps, and opportunities for further research regarding the economic effects of using artificial intelligence and ChatGPT tools in higher education.

2. METHODOLOGY

This study involved the search, selection, and analysis of scientific articles investigating the economic effects of using AI and ChatGPT tools in higher education. To provide a comprehensive data selection, scientometric databases Web of Science (WoS) by

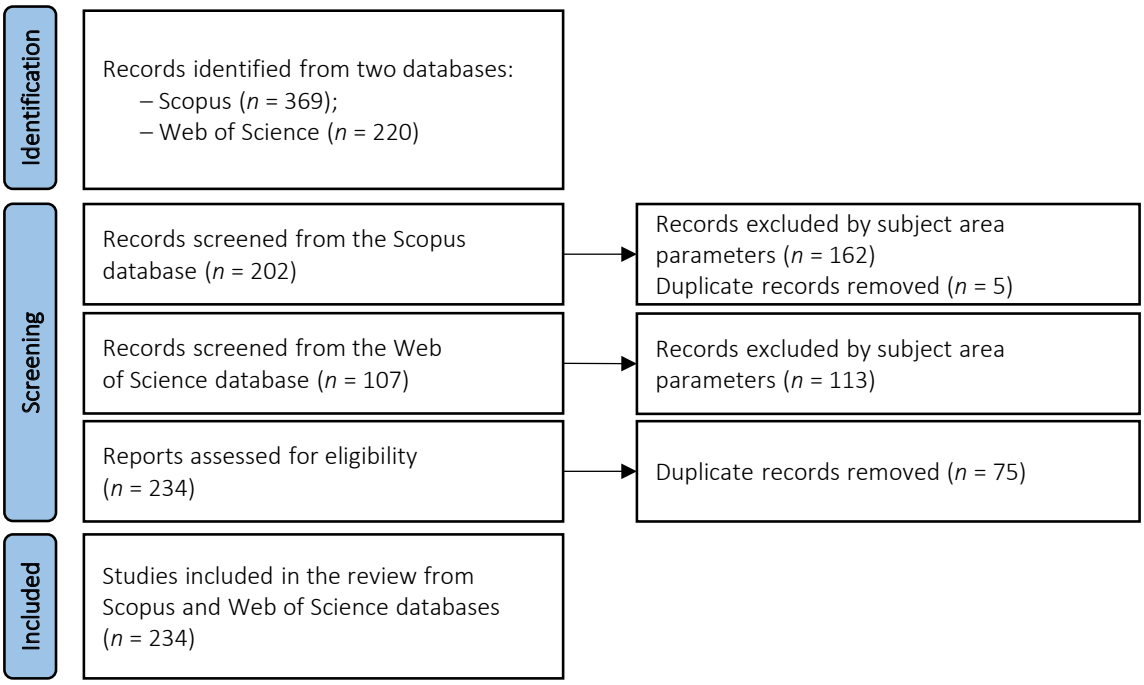

Figure 1. PRISMA flow diagram

Clarivate and Scopus by Elsevier, which provide access to high-quality, peer-reviewed publications across various disciplines, were addressed. The process included the drafting of selection criteria, search for relevant studies, their initial selection or screening with the application of exclusion criteria, a thorough analysis of the selected articles, and synthesis of the results to identify the key trends, gaps, and prospects for further research.

The search query for this study was formulated from the keywords that ensure an optimal selection of publications related to the specified objective:

- higher education;
- university;
- costs;
- expenditure;
- budget;
- artificial intelligence (AI);
- ChatGPT.

The Scopus database syntax, in particular, boolean operators (AND, OR) and field code (TITLE-ABS-KEY), was applied to generate their combinations. To filter off the irrelevant data and focus on economic aspects, the exclusion criterion "subject area" considered only the studies in the fields of Computer Sciences (COMP), Social Sciences (SOCI), Decision Sciences (DECI), Business, Management and Accounting (BUSI), Economics, Econometrics, and Finance (ECON), and Multidisciplinary (MULT) was applied.

Moreover, for selection, screening, compiling, and further analysis of the relevant studies found in databases, the advantage of the in-built Scopus, WoS and SciVal instruments, R package, ShinyApp for making PRISMA2020 flow diagrams (Haddaway et al., 2022), and VOSviewer software were used.

Bibliometric information about the number of publications and citations by year, country, institution, scientific sources of publication, and keywords formed the basis for this analysis. The keywords based on co-occurrence relations were used to build bibliometric clusters.

The data available as of September 30, 2024, were selected for the time period, particularly for the years 1986–2024 in the Scopus and WoS databases and for the years 2014–2024 in the SciVal database. Since ChatGPT by OpenAI was officially launched only in November 2022, some parts of this study emphasized the period 2022–2024.

Figure 1 shows a PRISMA flow diagram describing the main stages of selecting bibliometric data

http://dx.doi.org/10.21511/ppm.23(1).2025.08

from the Scopus and WoS scientometric databases: identification, screening, and final selection for further analysis.

The application of subject area parameters helped to narrow down the search query and filter off the publications with medical or engineering focus. Moreover, a set of duplicates was detected and eliminated occasioned by double indexing of some journals in databases. As a result, the corpus of this research included 234 scientific works that were considered the most optimal and relevant.

3. RESULTS AND DISCUSSION

Figure 2 displays the document and citation dynamics of the selected publications in the Scopus and Web of Science databases. While a few individual publications can be found as early as 1986, they are theoretical and technical, with a focus on the general architecture of AI and its potential applications across various fields (Shaw, 1987; Williams, 1992). Since around 2017, an increase in scholarly interest in the economic effects of AI and ChatGPT in higher education has been evident, with more than 90% of publications between 2017 and 2024 showing high citation rates. For example, Ranoliya et al. (2017) examined the design and functionality of an AI-based chatbot for universities to provide students with interactive FAQ responses.

The keyword frequency analysis method helped study the main thematic vectors of the economic effects of using AI and the ChatGpt tool in higher education. Scholarly output and citation count indicators were used to form the map of the most influential keywords (Figure 3).

Table 1. Main keywords

No.	Keyword	Scholarly Output	Citation Count
1.	Artificial Intelligence	87	644
2.	Deep Learning	30	138
3.	Machine Learning	24	131
4.	Robot	17	45
5.	Internet of Things	14	146
6.	Chatbot	9	353
7.	Graphics Processing Unit	6	64
8.	Intelligence Data	6	40
9.	Quality of Service	5	54
10.	Reinforcement Learning	3	42

The highest frequency of use among the selected keywords showed the term "artificial intelligence," which was quite predictable due to its long-term and wide application in various fields, including education (Table 1). "Deep learning" and "machine learning" are also widely used terms, which indicates a strong interest of researchers in these artificial intelligence training tools. It is interesting to note that many researchers refer to the term "chatbot" in their studies. This emphasizes the growing interest in the tool and its active integration into education. Such terms as "robots," "internet of things," "intelligence data," and "reinforce-

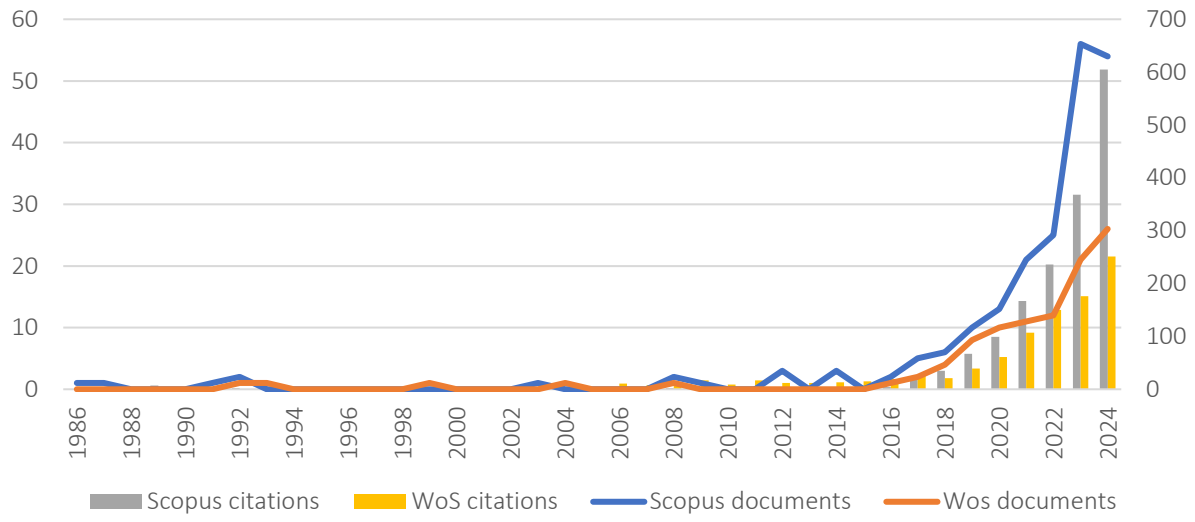

Figure 2. Document and citation dynamics of selected publications

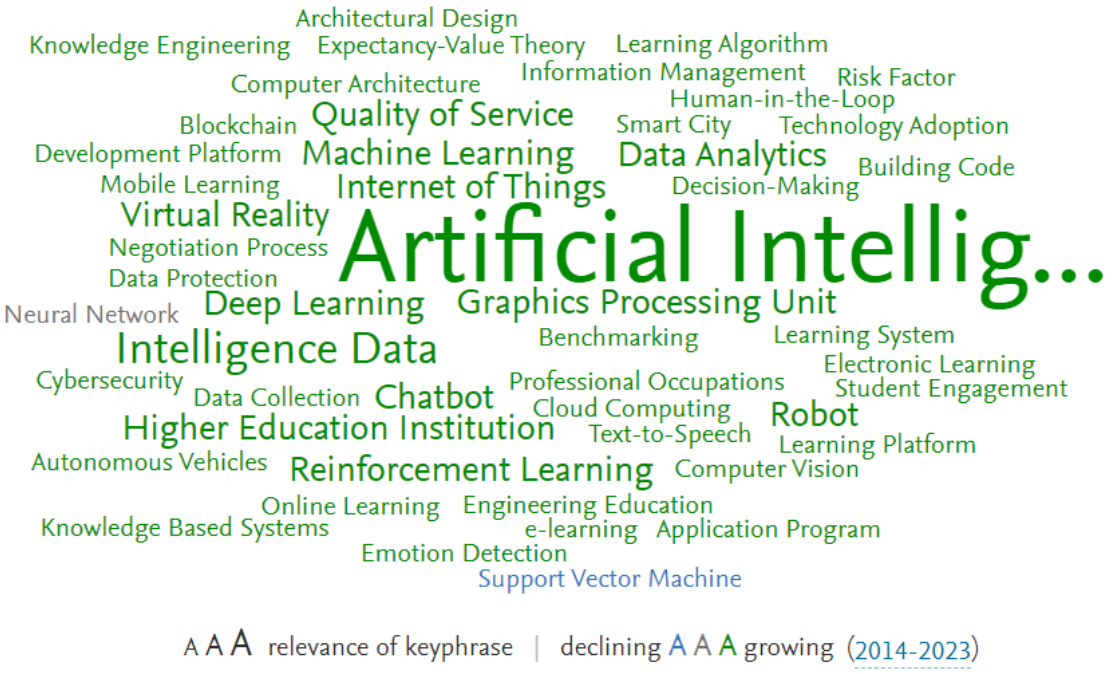

Figure 3. Quantitative characteristics of the main keywords

ment learning" demonstrate a lower scientific performance but still mark important research topics in artificial intelligence in higher education.

Among the key publication contributors to this field, there is a notable diversity in the geographic and institutional distribution (Table 2). The top five countries most actively contributing to the research on the economic effects of AI and ChatGPT in higher education are the United States, China, and India, with India leading in the dissemination of findings.

Institutional leadership, i.e., the number of scientific works on the topic published by the authors from the same institution, primarily share Bucharest University of Economic Studies in Romania, Huazhong University of Science and Technology, and National University of Defense Technology in China, and Polytechnic University of Valencia in Spain. Smaller amounts of publications, however, indicate the novelty of this topic and the emergence of appropriate research centers at the institutional level.

Table 2. Top five key contributors to scientific research by region, institution, and the number of publications in scientific journals from 2014 to 2024

Category	Top five by number of publications	Scholarly Output	Citation Count
Countries	The United States	21	243
	China	16	98
	India	15	447
	Australia	11	209
	The United Kingdom	6	44
Institutions	Bucharest University of Economic Studies (Romania)	3	32
	Huazhong University of Science and Technology (China)	3	22
	National University of Defense Technology (China)	3	43
	Polytechnic University of Valencia (Spain)	3	4
	Manipal Academy of Higher Education (India)	2	113
Scopus sources	Lecture Notes in Networks and Systems	9	4
	Lecture Notes in Computer Science (including subseries Lecture Notes)	7	15
	Advances in Intelligent Systems and Computing	4	16
	Sensors	3	37
	Proceedings - Frontiers in Education Conference, FIE	3	25

http://dx.doi.org/10.21511/ppm.23(1).2025.08

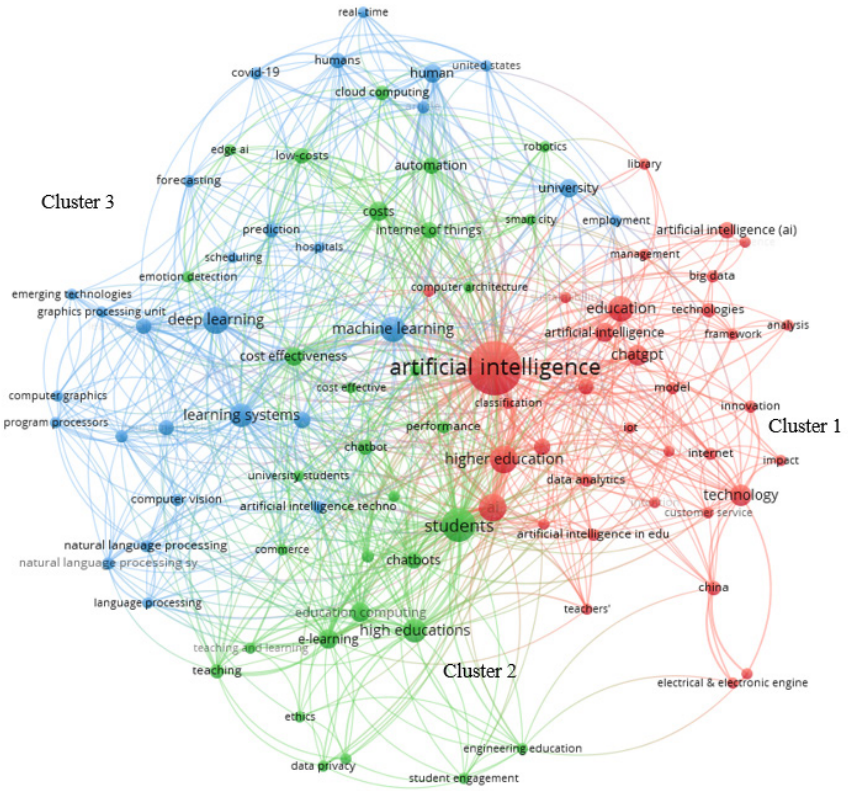

Figure 4. Bibliometric clusters of the main keywords

Examination of the leading scientific journals publishing research in this field revealed that they are predominantly technical, with a focus on Computer Science, Mathematics, and Engineering (e.g., Lecture Notes in Networks and Systems and Advances in Intelligent Systems and Computing). In this regard, the potential for studying the social and, to a greater extent, economic aspects of introducing AI in education should be noted.

A bibliometric keyword map was constructed using the VOSviewer software package based on bibliometric information gathered from the Scopus and WoS databases. The map consists of three clusters, 817 links, and 1,224 total link strengths (Figure 4). Table 3 provides a brief description of the suggested clusters.

The first cluster of the research centralizes the use of AI technologies in education to support decision-making and sustainable practices and to improve the effectiveness of teaching and management. Kumari and Snehalatha (2024) note the revolutionary impact on modern education that AI technologies, particularly OpenAI models, demonstrate and their potential application in streamlining administrative processes and personalizing learning experiences. Driessens and Pischetola (2024) claim that decisions on introducing AI in education should consider not only technological capabilities but also ethical, environmental, and social implications, enabling universities to make more informed and sustainable decisions. A similar perspective on the dual and transformative nature of AI technology in education is observed by Kurban and Şahin (2024) and Mambile and Mwogosi (2025). Boddington (2023) suggests considering AI as a responsible ecosystem of intelligent systems so that the focus shifts to solving a set of ethical and social issues. Han et al. (2024) present a noteworthy study with a focus on the practical financial integration of AI technologies in educational institutions, especially through optimizing financial operations and automating routine tasks. The analysis highlights AI's potential to improve financial productivity and operational efficiency in educational settings.

The second cluster focuses on automation and digital transformation of higher education institutions, which lead to optimizing costs, improving user interaction, and implementing

Table 3. Bibliometric cluster profiles defining research areas in economic effects of using AI and ChatGPT in higher education

No.	Name	General characteristics	Examples of keywords	Links
1	AI in education for decision-making	Focus on the use of AI technologies in education and its effects on decision-making, management, and teaching	artificial intelligence, AI, higher education, sustainability, impact, innovation, decision making, management, teachers, technology, fault detection, framework, customer service	502
2	Automation and digital transformation in educational institutions	Related to digital transformation, process automation, and the use of AI technologies to reduce administrative expenses and improve efficiency	automation, chatbot, cloud computing, commerce, cost-effective, costs, cost-effectiveness, data privacy, digital transformation, e-learning, edge AI, ethical technology, internet of things, low-costs, robotics, student engagement, virtual reality, teaching and learning	580
3	Latest AI technologies and their application in education	Focus on the use of AI technologies in education, deep learning research, computer vision, natural language processing, and their application in various fields	artificial neural network, computer graphics, computer vision, deep learning, emerging technologies, graphics processing unit, language processing, learning algorithms, learning systems, machine learning, natural language processing, neural networks, program processors	552

new technologies in educational settings. Some studies in this field consider the changes in productivity and effectiveness of educational processes through the automated use of specific AI tools. For instance, Noy and Zhang (2023) examined the productivity effects of ChatGPT in the context of mid-level professional writing tasks. Braun et al. (2023) investigated the potential and perceptions of AI-supported assessment of students' tests, showing its potential to speed up feedback delivery and reduce costs. Karam (2023), Gallastegui and Forradellas (2024), and Naseer et al. (2024) highlight the opportunities for personalized student learning, widely recognized as a factor in improving satisfaction with educational services.

The third cluster covers the research into specific educational practices of using certain AI technologies, natural language processing, computer vision and neural networks, deep learning, etc. For example, Asim et al. (2023) studied the application of AI in Pakistan's university libraries, which comprised text-to-speech and reverse technologies, voice command, Radio Frequency Identification (RFID) for checkout and security purposes, etc. Baksh et al. (2024) devoted their investigation to the potential of using open-source learning robots that can help engage students in the educational process and provide an interactive learning experience. Some studies also consider the possibility of innovative learning through a virtual reality environment and AI avatars (van As & Cooke, 2024).

Trends over time (Figure 5) reveal that until 2021, most research centered on basic technological innovations (AI, neural networks, robotics), while between 2022 and 2024, the emphasis shifted toward the practical implementation of these technologies in education, business automation, management, and ethics. In the earlier period, the focus was on innovative computing technologies and AI, such as robotics, computer graphics, computer vision, graphics processors, natural language processing systems, deep learning, and neural networks. Next, 2022–2024 proved researchers' increasing interest in automation, data analytics, and digital transformation. It indicates the tendency to apply technology for business process optimization in education and other industries. At the same time, the focus also shifts to data privacy, information management, and AI ethics, whose relevance grew with the spread of generative AI models such as ChatGPT.

The analysis of collected literature helped summarize the potential economic effects of using AI and ChatGPT in higher education and identify the main directions and key concepts of possible transformations (Table 4). In particular, these include opportunities to reduce costs for administrative processes, optimize the time of teachers and students, and improve the educational process through quality and accessibility.

The economic effects of introducing AI depend on such factors as technology implementation costs, staff training needs, and more. Based on the liter-

http://dx.doi.org/10.21511/ppm.23(1).2025.08

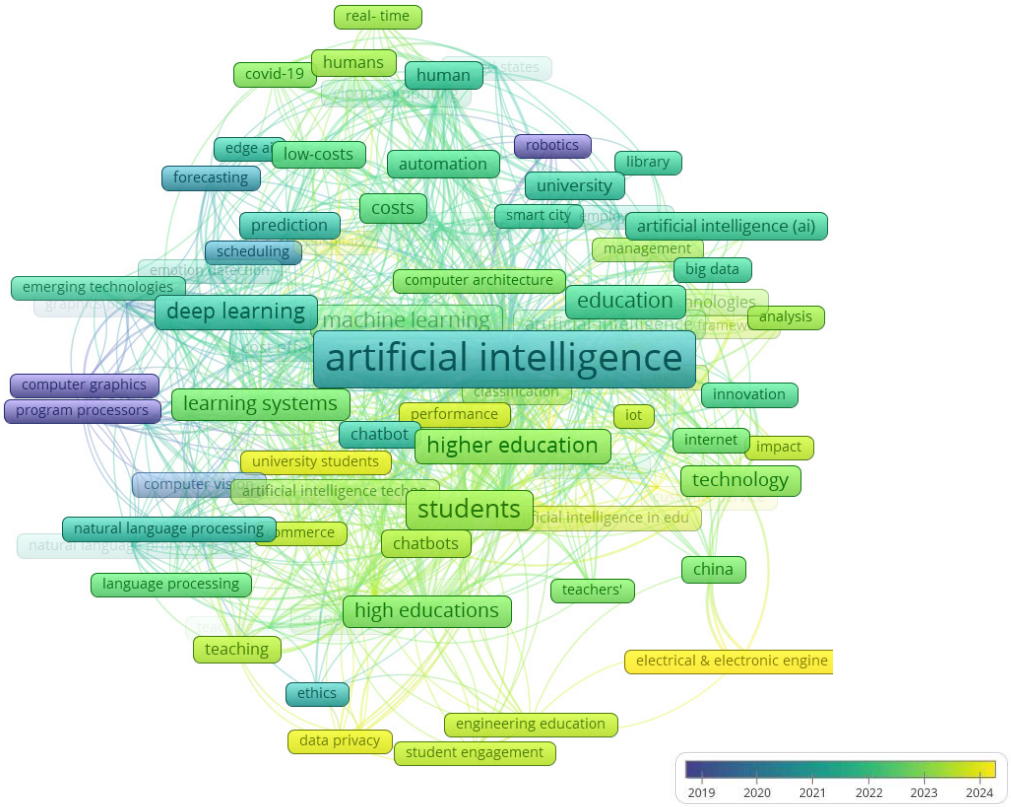

Figure 5. Time-scale distribution of the main keywords

ature review and classical economic theory, costs related to AI and ChatGPT integration and use in higher education can be categorized into two groups: fixed and variable costs.

Fixed costs related to AI and ChatGPT integration and use are independent of the number of students or the extent of AI usage and remain relatively stable over a certain period. These may cover:

1) infrastructure and technical support

- costs of purchasing, configuring, and maintaining servers, software, and databases necessary for AI operation;
- licensing fees for software products, such as ChatGPT and other tools;

Table 4. Systematization of potential economic effects of using AI and ChatGPT in higher education

Directions	Key concepts	Potential economic effects
Reduced administrative costs	1) automating routine administrative tasks; 2) troubleshooting basic technical issues; 3) automating data processing and analysis, including big data; 3) forecasting capabilities; 4) digitalizing document flow.	Cost optimization areas: 1) salaries and social contributions for additional administrative staff; 2) technical support consulting services; 3) rent for paper document storage; 4) office supplies, printer maintenance, etc.
Time savings for faculty and students	1) automating select administrative tasks for instructors; 2) automating the creation of learning content; 3) integrating learning content into digital platforms; 4) assisting the development of distance learning courses; 5) automating assessment and consultancy.	Cost optimization areas: 1) office supplies, printed materials, and textbooks; 2) rent for paper document storage. Revenue growth from increased faculty productivity, enabling reallocation of time to enhance teaching quality, pursue research funding, and explore grant opportunities.
Improving the quality and accessibility of education	1) personalized student learning; 2) adaptive learning; 3) distance learning models.	The same benefits as noted above. Potential reduction in study program duration, allowing universities to serve a larger number of students within the same timeframe, thereby reducing per-student costs.

2) staff training

- costs for developing professional development courses for faculty and administrative staff to facilitate efficient AI integration into the educational process;
- organizing training sessions and workshops for staff;

3) development and adaptation of educational materials

- costs for developing or adapting study programs and materials that leverage AI for personalized learning;
- costs for creating or updating e-textbooks and AI-enhanced resources.

Variable costs related to AI and ChatGPT integration and use depend on the number of students enrolled and the extent of AI usage. These may cover:

4) maintenance and support costs

- operating costs/maintenance of AI systems and software updates;
- costs of maintaining continuous system operation, including the salary of IT staff responsible for system support;

5) licensing fees

- costs of subscriptions to additional services and features needed for different academic disciplines;

6) costs for course customization and personalization

- costs for tailoring learning materials to address specific student needs;
- costs for configuring and personalizing learning trajectories for new cohorts or individual students.

At the initial stages, fixed costs for AI implementation are typically high but can be distributed across a larger number of students over time, thus lowering the per-student cost of AI technologies as the institution reaches the break-even point and benefits from economies of scale.

This approach to cost allocation allows educational institutions to forecast their financial needs and budget for AI and ChatGPT integration and achieve the intended economic effects of technology deployment.

CONCLUSION

This study explores trends, uncovers knowledge gaps, and highlights potential research avenues concerning the economic impact of integrating artificial intelligence and ChatGPT tools into higher education. The paper systematically outlines the potential economic effects of AI and ChatGPT in higher education. First, AI can reduce administrative costs by automating routine tasks, digitizing paperwork, and improving document flows. Second, economic benefits can arise from the time saved by faculty and students through simplified information access and automated learning activities. Third, AI enhances the quality and accessibility of education through personalized learning programs and increased use of AI to improve interaction between education participants.

The results highlighted the economic potential of AI and ChatGPT in higher education through task optimization, time savings, and improved educational quality. At the same time, a set of knowledge gaps, particularly regarding the long-term economic effects of AI in higher education and its impact on the higher education labor market, were identified.

Accordingly, artificial intelligence technologies will reshape the structure and cost distribution of higher education institutions in the short term. In the long term, through savings achieved from economies of scale, a potential transition to a new production possibilities curve in the higher education sector could be realized.

http://dx.doi.org/10.21511/ppm.23(1).2025.08

AUTHOR CONTRIBUTIONS

Conceptualization: Anna Vorontsova, Svitlana Tarasenko, Artem Bilovol.
Data curation: Wojciech Duranowski, Arkadiusz Durasiewicz, Artem Bilovol.
Formal analysis: Anna Vorontsova, Svitlana Tarasenko.
Funding acquisition: Svitlana Tarasenko.
Investigation: Svitlana Tarasenko, Arkadiusz Durasiewicz, John Soss, Artem Bilovol.
Methodology: Anna Vorontsova, John Soss.
Project administration: John Soss, Artem Bilovol.
Resources: Wojciech Duranowski, Arkadiusz Durasiewicz, Artem Bilovol.
Software: Anna Vorontsova, Wojciech Duranowski.
Supervision: Svitlana Tarasenko, Wojciech Duranowski, John Soss.
Validation: Arkadiusz Durasiewicz.
Visualization: Anna Vorontsova.
Writing – original draft: Anna Vorontsova, Svitlana Tarasenko, Wojciech Duranowski, Arkadiusz Durasiewicz, John Soss, Artem Bilovol.
Writing – review & editing: Anna Vorontsova, Svitlana Tarasenko.

ACKNOWLEDGMENTS

The publication is part of the research topic "Economic Basics of Technology Diffusion into the National Economy of Ukraine Considering Best International Practices" (№0124U003482).

REFERENCES

1. Asim, M., Arif, M., Rafiq, M., & Ahmad, R. (2023). Investigating applications of artificial intelligence in university libraries of Pakistan: An empirical study. *Journal of Academic Librarianship, 49*(6), Article 102803. https://doi.org/10.1016/j.acalib.2023.102803.
2. Baksh, F., Zorec, M. B., & Krusamäe, K. (2024). Open-source robotic study companion with multimodal human–robot interaction to improve the learning experience of university students. *Applied Sciences, 14*(13), Article 5644. https://doi.org/10.3390/app14135644.
3. Bearman, M., Ryan, J., & Ajjawi, R. (2023). Discourses of artificial intelligence in higher education: A critical literature review. *Higher Education, 86*(2), 369-385. https://doi.org/10.1007/s10734-022-00937-2
4. Boddington, P. (2023). The rise of AI ethics. In AI ethics. *Artificial intelligence: Foundations, theory, and algorithms* (pp. 35-89). Singapore: Springer. https://doi.org/10.1007/978-981-19-9382-4_2
5. Bond, M., Khosravi, H., De Laat, M., Bergdahl, N., Negrea, V., Oxley, E., Pham, P., Chong, S. W., & Siemens, G. (2024). A meta systematic review of artificial intelligence in higher education: A call for increased ethics, collaboration, and rigour. *International Journal of Educational Technology in Higher Education, 21*(1), Article 4. https://doi.org/10.1186/s41239-023-00436-z.
6. Braun, D., Rogetzer, P., Stoica, E., & Kurzhals, H. (2023). Students' perspective on AI-supported assessment of open-ended questions in higher education. In *Proceedings of the 15th International Conference on Computer Supported Education (CSEDU 2023)* (Vol. 2, pp. 73-78). https://doi.org/10.5220/0011648900003470
7. Cavalcanti, A. P., Barbosa, A., Carvalho, R., Freitas, F., Tsai, Y.-S., Gašević, D., & Mello, R. F. (2021). Automatic feedback in online learning environments: A systematic literature review. *Computers and Education: Artificial Intelligence, 2,* Article 100027. https://doi.org/10.1016/j.caeai.2021.100027
8. Celik, I., Dindar, M., Muukkonen, H., & Järvelä, S. (2022). The promises and challenges of artificial intelligence for teachers: A systematic review of research. *TechTrends, 66,* 616-630. https://doi.org/10.1007/s11528-022-00715-y
9. Chan, C. K. Y. (2023). A comprehensive AI policy education framework for university teaching and learning. *International Journal of Educational Technology in Higher Education, 20*(1), Article 38. https://doi.org/10.1186/s41239-023-00408-3
10. Chatterjee, S., & Bhattacharjee, K. K. (2020). Adoption of artificial intelligence in higher education: A quantitative analysis using structural equation modelling. *Education and Information Technologies, 25,* 3443-3463. https://doi.org/10.1007/s10639-020-10159-7
11. Chaudhry, M. A., & Kazim, E. (2022). Artificial Intelligence in

Education (AIEd): A high-level academic and industry note 2021. *AI and Ethics, 2,* 157-165. https://doi.org/10.1007/s43681-021-00074-z

12. Chen, K., Tallant, A. C., & Selig, I. (2024). Exploring generative AI literacy in higher education: Student adoption, interaction, evaluation and ethical perceptions. *Information and Learning Sciences*. https://doi.org/10.1108/ILS-10-2023-0160
13. Chu, H., Tu, Y., & Yang, K. (2022). Roles and research trends of artificial intelligence in higher education: A systematic review of the top 50 most-cited articles. *Australasian Journal of Educational Technology, 38*(3), 22-42. https://doi.org/10.14742/ajet.7526
14. Corea, F., Fossa, F., Loreggia, A., Quintarelli, S., & Sapienza, S. (2022). A principle-based approach to AI: The case for European Union and Italy. *AI & SOCIETY, 38,* 521-535. https://doi.org/10.1007/s00146-022-01453-8
15. Crompton, H., & Burke, D. (2023). Artificial intelligence in higher education: The state of the field. *International Journal of Educational Technology in Higher Education, 20,* Article 22. https://doi.org/10.1186/s41239-023-00392-8
16. Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319-340. http://dx.doi.org/10.2307/249008
17. Driessens, O., & Pischetola, M. (2024). Danish university policies on generative AI: Problems, assumptions, and sustainability blind spots. *MedieKultur: Journal of Media and Communication Research*, *40*(76), 31-52. https://doi.org/10.7146/mk.v40i76.143595
18. Dwivedi, Y. K., Kshetri, N., Hughes, L., Slade, E. L., Jeyaraj, A., Kar, A. K., Baabdullah, A. M., Koohang, A., Raghavan, V., Ahuja, M., Albanna, H., Albashrawi, M. A., Al-Busaidi, A. S., Balakrishnan, J., Barlette, Y., Basu, S., Bose, I., Brooks, L., Buhalis, D., … Wright, R. (2023). Opinion Paper: "So what if ChatGPT wrote it?" Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy. *International Journal of Information Management, 71,* Article 102642. https://doi.org/10.1016/j.ijinfomgt.2023.102642
19. Fahd, K., Venkatraman, S., Miah, S. J., & Ahmed, K. (2022). Application of machine learning in higher education to assess student academic performance, at-risk, and attrition: A meta-analysis of literature. *Education and Information Technologies, 3,* 3743-3775. https://doi.org/10.1007/s10639-021-10741-7
20. Ferrara, E. (2023). Should ChatGPT be biased? Challenges and risks of bias in large language models. *First Monday, 28*(11). https://doi.org/10.5210/fm.v28i11.13346
21. Gallastegui, L. M. G., & Forradellas, R. R. (2024). Optimization of the educational experience in higher education using predictive artificial intelligence models. *Revista de Gestão Social e Ambiental, 18*(5), Article e07111. https://doi.org/10.24857/rgsa.v18n5-104.
22. Guerrero-Roldán, A.-E., Rodríguez-González, M. E., Bañeres, D., Elasri-Ejjaberi, A., & Cortadas, P. (2021). Experiences in the use of an adaptive intelligent system to enhance online learners' performance: A case study in Economics and Business courses. International *Journal of Educational Technology in Higher Education, 18*(1), Article 36. https://doi.org/10.1186/s41239-021-00271-0
23. Haddaway, N. R., Page, M. J., Pritchard, C. C., & McGuinness, L. A. (2022). PRISMA2020: An R package and Shiny app for producing PRISMA 2020-compliant flow diagrams, with interactivity for optimised digital transparency and Open Synthesis. *Campbell Systematic Reviews, 18*(2), Article e1230. https://doi.org/10.1002/cl2.1230
24. Han, X., Xiao, S., Sheng, J., & Zhang, G. (2024). Enhancing efficiency and decision-making in higher education through intelligent commercial integration: Leveraging artificial intelligence. *Journal of the Knowledge Economy*. https://doi.org/10.1007/s13132-024-01868-2
25. Johnstone, D. B. (2004). The economics and politics of cost sharing in higher education: Comparative perspectives. *Economics of Education Review, 23*(4), 403-441. https://doi.org/10.1016/j.econedurev.2003.09.004
26. Kaczorowska-Spychalska, D., Kotula, N., Mazurek, G., & Sułkowski, Ł. (2024). Generative AI as source of change of knowledge management paradigm. *Human Technology, 20*(1), 131-154. https://doi.org/10.14254/1795-6889.2024.20-1.7
27. Kamalov, F., Calonge, D. S., & Gurrib, I. (2023). New era of artificial intelligence in education: Towards a sustainable multifaceted revolution. *Sustainability, 15*(16), Article 12451. https://doi.org/10.3390/su151612451
28. Karam, J. (2023). Reforming higher education through AI. In N. Azoury & G. Yahchouchi (Eds.), *Governance in Higher Education: Global Reform and Trends in the MENA Region* (pp. 275-306). Cham: Palgrave Macmillan. https://doi.org/10.1007/978-3-031-40586-0_12
29. Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günnemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T., Nerdel, C., Pfeffer, J., Poquet, O., Sailer, M., Schmidt, A., Seidel, T., … Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences, 103,* Article 102274. https://doi.org/10.1016/j.lindif.2023.102274
30. Kejriwal, M. (2023). AI in practice and implementation: Issues and costs. In *Artificial Intelligence for Industries of the Future. Future of Business and Finance* (pp. 25-45). Cham: Springer. https://doi.org/10.1007/978-3-031-19039-1_2
31. Krenn, M., Pollice, R., Guo, S. Y., Aldeghi, M., Friederich, P., Häse,

http://dx.doi.org/10.21511/ppm.23(1).2025.08

F., Jinich, A., Nigam, A., & Yao, Z. (2022). On scientific understanding with artificial intelligence. *Nature Reviews Physics, 4*(12), 761-769. https://doi.org/10.1038/s42254-022-00518-3

32. Kuleto, V., Ilić, M., Dumangiu, M., Ranković, M., Martins, O. M., Păun, D., & Mihoreanu, L. (2021). Exploring opportunities and challenges of artificial intelligence and machine learning in higher education institutions. *Sustainability, 13*(18), Article 10424. https://doi.org/10.3390/su131810424

33. Kumar, S., Rao, P., Singhania, S., Verma, S., & Kheterpal, M. (2024). Will artificial intelligence drive the advancements in higher education? A tri-phased exploration. *Technological Forecasting and Social Change, 201,* Article 123258. https://doi.org/10.1016/j.techfore.2024.123258

34. Kumari, R. K., & Snehalatha, M. (2024). AI and OpenAI in education: Unveiling the future of learning and teaching. In Ş. Demir & M. Demir (Eds.), *Enhancing Higher Education and Research With OpenAI Models* (pp. 176-205). IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3693-1666-5.ch008

35. Kurban, C. F., & Şahin, M. (2024). *The impact of ChatGPT on higher education: Exploring the AI revolution*. Emerald Group Publishing. https://doi.org/10.1108/9781837976478

36. Lee, D., Arnold, M., Srivastava, A., Plastow, K., Strelan, P., Ploeckl, F., Lekkas, D., & Palmer, E. (2024). The impact of generative AI on higher education learning and teaching: A study of educators' perspectives. *Computers and Education: Artificial Intelligence, 6,* Article 100221. https://doi.org/10.1016/j.caeai.2024.100221

37. Lindqvist, M. H., Mozelius, P., Jaldemark, J., & Innes, M. C. (2023). Higher education transformation towards lifelong learning in a digital era – A scoping literature review. *International Journal of Lifelong Education, 43*(1), 24-38. https://doi.org/10.1080/02601370.2023.2279047

38. Lu, K., Pang, F., & Shadiev, R. (2023). Understanding college students' continuous usage intention of asynchronous online courses through extended technology acceptance model. *Education and Information Technologies, 28,* 9747-9765. https://doi.org/10.1007/s10639-023-11591-1

39. Mambile, C., & Mwogosi, A. (2025). Transforming higher education in Tanzania: Unleashing the true potential of AI as a transformative learning tool. *Technological Sustainability, 4*(1), 51-76. https://doi.org/10.1108/TECHS-03-2024-0014

40. Markauskaite, L., Marrone, R., Poquet, O., Knight, S., Martinez-Maldonado, R., Howard, S., Tondeur, J., De Laat, M., Buckingham Shum, S., Gašević, D., & Siemens, G. (2022). Rethinking the entwinement between artificial intelligence and human learning: What capabilities do learners need for a world with AI? *Computers and Education: Artificial Intelligence, 3,* Article 100056. https://doi.org/10.1016/j.caeai.2022.100056

41. McGrath, C., Cerratto Pargman, T., Juth, N., & Palmgren, P. J. (2023). University teachers' perceptions of responsibility and artificial intelligence in higher education – An experimental philosophical study. *Computers and Education: Artificial Intelligence, 4,* Article 100139. https://doi.org/10.1016/j.caeai.2023.100139

42. Meakin, L. (2024). Exploring the impact of generative artificial intelligence on higher education students' utilization of library resources: A critical examination. *Information Technology and Libraries, 43*(3). https://doi.org/10.5860/ital.v43i3.17246

43. Naseer, F., Khan, M. N., Tahir, M., Addas, A., & Aejaz, S. M. H. (2024). Integrating deep learning techniques for personalized learning pathways in higher education. *Heliyon, 10*(11), Article e32628. https://doi.org/10.1016/j.heliyon.2024.e32628

44. Ng, D. T. K., Lee, M., Tan, R. J. Y., Hu, X., Downie, J. S., & Chu, S. K. W. (2023). A review of AI teaching and learning from 2000 to 2020. *Education and Information Technologies, 28*(7), 8445-8501. https://doi.org/10.1007/s10639-022-11491-w

45. Noy, S., & Zhang, W. (2023). Experimental evidence on the productivity effects of generative artificial intelligence. *Science, 381*(6654), 187-192. https://doi.org/10.1126/science.adh2586.

46. Nyale, D., Karume, S., & Kipkebut, A. (2024). A comprehensive analysis of the role of artificial intelligence in aligning tertiary institutions academic programs to the emerging digital enterprise. *Education and Information Technologies, 29,* 22407-22426. https://doi.org/10.1007/s10639-024-12743-7

47. Ouyang, F., & Jiao, P. (2021). Artificial intelligence in education: The three paradigms. *Computers and Education: Artificial Intelligence, 2,* Article 100020. https://doi.org/10.1016/j.caeai.2021.100020

48. Pantelimon, F.-V., Bologa, R., Toma, A., & Posedaru, B.-S. (2021). The evolution of AI-driven educational systems during the COVID-19 pandemic. *Sustainability, 13*(23), Article 13501. https://doi.org/10.3390/su132313501

49. Pearce, J., & Chiavaroli, N. (2023). Rethinking assessment in response to generative artificial intelligence. *Medical Education, 57*(10), 889-891. https://doi.org/10.1111/medu.15092

50. Pelletier, K., McCormack, M., Muscanell, N., Reeves, J., Robert, J., & Arbino, N. (2024). *2024 EDUCAUSE Horizon Report, teaching and learning edition*. EDUCAUSE. Retrieved from https://library.educause.edu/-/media/files/library/2024/5/2024hrteachinglearning.pdf

51. Popenici, S. A. D., & Kerr, S. (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. *Research and Practice in Technology Enhanced Learning, 12*(1), Article 22. https://doi.org/10.1186/s41039-017-0062-8

52. Ranoliya, B.R., Raghuwanshi, N., & Singh, S. (2017). Chatbot for

university related FAQs. *2017 International Conference on Advances in Computing, Communications and Informatics (ICACCI)* (pp. 1525-1530).

53. Renz, A., & Hilbig, R. (2020). Prerequisites for artificial intelligence in further education: Identification of drivers, barriers, and business models of educational technology companies. *International Journal of Educational Technology in Higher Education, 17*(1), Article 14. https://doi.org/10.1186/s41239-020-00193-3

54. Rogers, E.M. (2003). *Diffusion of innovations* (5th ed.). New York: The Free Press.

55. Saúde, S., Barros, J. P., & Almeida, I. (2024). Impacts of generative artificial intelligence in higher education: Research trends and students' perceptions. *Social Sciences, 13*(8), Article 410. https://doi.org/10.3390/socsci13080410

56. Schemmer, M., Kuehl, N., Benz, C., Bartos, A., & Satzger, G. (2023). Appropriate reliance on AI advice: Conceptualization and the effect of explanations. *Proceedings of the 28th International Conference on Intelligent User Interfaces*, 410-22. https://doi.org/10.1145/3581641.3584066

57. Schön, E.M., Neumann, M., Hofmann-Stölting, C., Baeza-Yates, R., & Rauschenberger, M. (2023). How are AI assistants changing higher education? *Frontiers in Computer Science, 5,* Article 1208550. https://doi.org/10.3389/fcomp.2023.1208550

58. Segovia-García, N. (2024). Optimización de la atención estudiantil: una revisión del uso de chatbots de IA en la educación superior [Optimizing student support: A review of the use of AI chatbots in higher education]. *European Public and Social Innovation Review, 9,* 1-20. (In Spanish). https://doi.org/10.31637/epsir-2024-324

59. Seo, K., Tang, J., Roll, I., Fels, S., & Yoon, D. (2021). The impact of artificial intelligence on learner–instructor interaction in online learning. *International Journal of Educational Technology in Higher Education, 18*(54), Article 54. https://doi.org/10.1186/s41239-021-00292-9

60. Shahzad, M.F., Xu, S., & Zahid, H. (2024). Exploring the impact of generative AI-based technologies on learning performance through self-efficacy, fairness & ethics, creativity, and trust in higher education. *Education and Information Technologies*. https://doi.org/10.1007/s10639-024-12949-9

61. Shaw, D. E. (1987). On the range of applicability of an artificial intelligence machine. *Artificial Intelligence, 32*(2), 151-172. https://doi.org/10.1016/0004-3702(87)90010-5

62. Singh, H., & Singh, A. (2023). ChatGPT: Systematic review, applications, and agenda for multidisciplinary research. *Journal of Chinese Economic and Business Studies, 21*(2), 193-212. https://doi.org/10.1080/14765284.2023.2210482

63. Slimi, Z. (2021). The impact of AI implementation in higher education on educational process future: A systematic review. *Research Square.* https://doi.org/10.21203/rs.3.rs-1081043/v1

64. Smerdon, D. (2024). AI in essay-based assessment: Student adoption, usage, and performance. *Computers and Education: Artificial Intelligence, 7,* Article 100288. https://doi.org/10.1016/j.caeai.2024.100288

65. Stahl, B. C. (2023). Embedding responsibility in intelligent systems: From AI ethics to responsible AI ecosystems. *Scientific Reports, 13,* Article 7586. https://doi.org/10.1038/s41598-023-34622-w

66. van As, J., & Cooke, R. (2024). Immersive virtual community engagement: Unleashing the potential of AI avatars and virtual reality in education to enhance learning excellence. In K. Chee & M. Sanmugam (Eds.), *Integrating cutting-edge technology into the classroom* (pp. 162-183). IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3693-3124-8.ch009

67. Williams, N. (1992). The artificial intelligence applications to learning programme. *Computers & Education, 18*(1-3), 101-107. https://doi.org/10.1016/0360-1315(92)90042-4

68. Wirtz, B. W., Weyerer, J. C., & Kehl, I. (2022). Governance of artificial intelligence: A risk and guideline-based integrative framework. *Government Information Quarterly, 39*(4), Article 101685. https://doi.org/10.1016/j.giq.2022.101685

69. Xu, Y., Liu, X., Cao, X., Huang, C., Liu, E., Qian, S., Liu, X., Wu, Y., Dong, F., Qiu, C-W., Qiu, J., Hua, K., Su, W., Wu, J., Xu, H., Han, Y., Fu, C., Yin, Z., Liu, M., … Zhang, J. (2021). Artificial intelligence: A powerful paradigm for scientific research. *The Innovation, 2*(4). https://doi.org/10.1016/j.xinn.2021.100179

70. Zagoruiko, I., & Petkova, L. (2022). Model of world technological and economic efficiency frontiers. *Journal of International Studies, 15*(2), 174-198. https://doi.org/10.14254/2071-8330.2022/15-2/12

71. Zawacki-Richter, O., Marín, V.I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – Where are the educators? *International Journal of Educational Technology in Higher Education 16*(1), Article 39. https://doi.org/10.1186/s41239-019-0171-0

http://dx.doi.org/10.21511/ppm.23(1).2025.08