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The role of GenAI in transforming the educational process in HEIs

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Abstract

Higher education plays a critical role in shaping competent citizens and professionals globally. The emergence of generative AI (GenAI) has introduced both opportunities and challenges to traditional educational models. In response to these challenges, this paper explores the interaction of AI and educational technology (EdTech), clarifying the potential and the challenges associated with integrating AI within the educational process. The study starts with an overview of GenAI, followed by a discussion on the application of GenAI in HEIs. The study is based on a bibliometric analysis of terms related to "artificial intelligence" and "educational technology", employing a conceptual framework derived from a systematic literature review. Findings suggest that higher education must adapt to prepare students for a GenAI-driven society, emphasising AI literacy, interdisciplinary and transformative learning, and intelligent tutoring systems.

Key words:

Artificial intelligence (AI), Generative AI (GenAI), Educational process, Educational technology (EdTech), Higher education (HE), ChatGPT.

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1. Introduction

In an era where the world is transitioning towards a digital future, Industry 4.0 technologies, such as artificial intelligence (AI), are increasingly seen as instrumental to this transformative shift (Kumar et al., 2021). AI has emerged as an essential tool in problem-solving, offering high accuracy and speed in processing large amounts of input data (Dirican, 2015). It is commonly understood as the implementation of computational systems for processes such as logical reasoning, pattern recognition, experiential learning, and the comprehension of particular behaviours. Currently, AI solutions are dominant in many user-facing interactions. AI has become deeply integrated into our routines, enhancing convenience, personalisation, and efficiency in various aspects of daily life, e.g. virtual assistants, curation of personalised content feeds, real-time traffic updates in navigation apps, chatbots handling customer inquiries and troubleshooting problems, etc.

Educational technology in universities has changed a lot in the past few decades. We've moved from old-school blackboards to high-tech learning management systems (LMS) and interactive digital platforms. The early stuff like PowerPoint and online course websites are old news now. These days, we're using fancier educational technology, like virtual classrooms and tools to learn from home. Cloud computing has made it easy to use platforms like Moodle and Canvas everywhere giving the academic staff flexible ways to manage education and get students involved. As we've got better at using data and algorithms, we've created smart learning platforms that adjust to how each student learns best. Many universities are now using virtual and augmented reality to make learning more immersive in fields like medicine, engineering, and art (Yusuf, et al. 2024). The current education scene includes AI-powered innovations like digital tutors' systems that grade automatically, and ways to give personalised feedback. AI-powered learning analytics give teachers useful insights into how students are doing. As schools adopt these new technologies important questions come up about ethics protecting data and making sure everyone has fair access to technology in education.

The aim of the paper is to explore generative AI applications in university education and particularly in the educational process. Taking the abovementioned context into consideration, the following research questions were posed by this study:

- Which are the most popular AI tools and methods influencing educational technology?
- How can GenAI enhance teaching, learning, and administration in HEIs?
- Which are the areas and subareas of GenAI demanding further investigation?

2. Literature Review

2.1. Overview of Generative AI (GenAI)

Generative AI (GenAI) is a branch of artificial intelligence (AI) that focuses on autonomously creating new content, data, or solutions by learning from existing information. It utilizes machine learning techniques, particularly deep learning and neural networks, to produce outputs that mimic real-world examples. The definition provided in the Generative AI Market Report 2023-2030 (IoT Analytics, 2024) states that GenAI is a deep learning technique that is capable of generating text, images, or other media, using models that learn the patterns and structure of their input training data and then generate new data that has similar characteristics. According to Lim et al. (2023:2) GenAI could be defined as "a technology that (i) utilizes deep learning models to (ii) produce human-like content (e.g., text, images) in response to (iii) diverse and complex prompts (e.g., questions, instructions, languages)". As GenAI continues to advance at a rapid pace, it is expected to drive innovation and enhance higher education in the coming years while simultaneously introducing numerous challenges (Dwivedi et al., 2023; Kasneci et al., 2023). A prominent example is ChatGPT (Chat Generative Pre-Trained Transformer), a chatbot powered by GenAI, which has garnered significant attention and sparked ongoing debates about its potential adverse impacts on teaching and learning. ChatGPT describes itself as a large language model (LLM) designed to "generate human-like text based on a given prompt or context. It can

be applied to various natural language processing tasks, including text completion, conversation generation, and language translation" (Baidoo-Anu & Owusu Ansah, 2023:4).

This technology has diverse applications, including generating art, designing realistic game environments, augmenting data, discovering new drugs, and enhancing privacy through synthetic datasets. By enabling more creative and varied solutions, GenAI has significantly advanced AI across numerous fields. Prominent models in this domain include Generative Adversarial Networks (GANs), Variational Autoencoders (VAEs), and Transformer-based language models like ChatGPT (Figure 1).

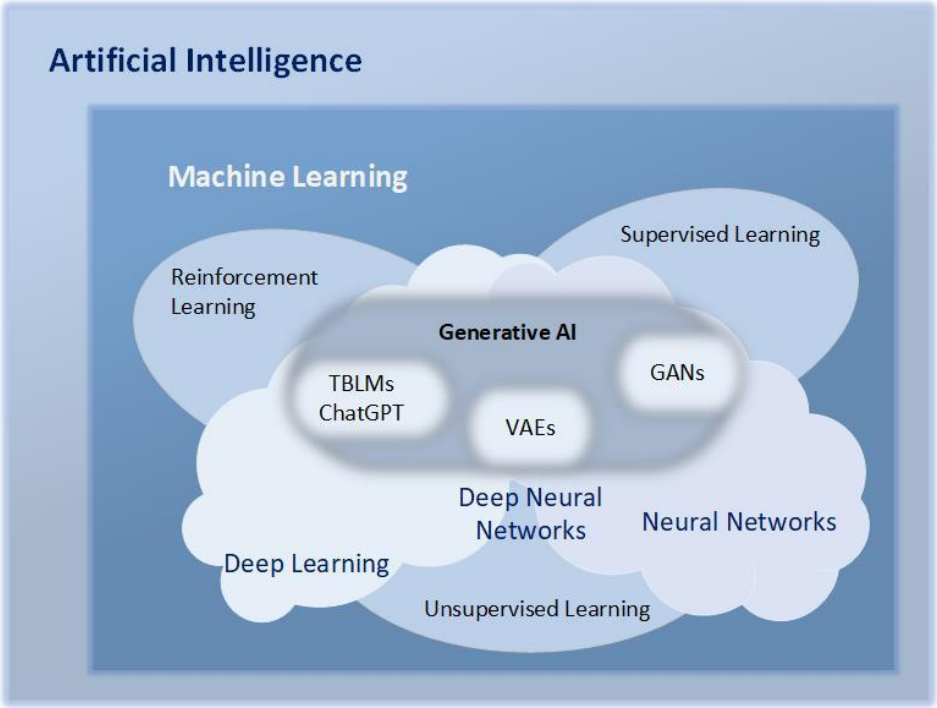


Fig. 1. The interrelation GenAI-DL-ML-AI
Source: Adapted by https://bit.ly/3DIaIYn; https://bit.ly/45bWEjv [Accessed 26th December 2024]

Transformer-based language models such as GPT-4 fall under the category of generative AI which is built on the transformer architecture to deliver solutions to natural language processing problems. These models employ a self-attention mechanism to capture the complex inter-dependency between sequences of texts, and therefore are capable of producing plausible responses. The transformer models are first pre-trained on large text corpora after which they are able to pick out the language's general structural characteristics such as the pattern, grammar, syntax and semantics. Thereafter, they can be further adjusted for certain NLP tasks, for instance, for text generation. These models write responses given an input or a prompt. Some of the most well-known transformer models are the ones from OpenAI, for example the GPT series models (GPT, GPT-2, GPT-3, GPT-4, and ChatGPT), and from Google, for instance BERT, which have achieved state-of-the-art results in both generative and discriminative language modelling.

According to the data provided by IoT Analytics (2024) the market for foundational models and GenAI platforms is highly fragmented. OpenAI currently leads with a 39% market share, closely followed by its partner and investor, Microsoft, at 30%. In 2023, spending in this sector reached $3 billion and is projected to grow significantly, reaching $92 billion by 2030. In 2023, many companies worked to establish their GenAI strategies, while GenAI service providers generated $3.2 billion in revenue. Accenture emerged as a leader in this space, capturing a 6% market share. The company aims to solidify its position as a key GenAI service

provider with a planned investment of $3 billion.

2.2. Applications of GenAI in HEIs

Despite AI not being a novel field of study (Huin et al., 2003), its range of applications has only recently been appreciated (Min, 2010), making significant steps in diverse areas, including educational technology (EdTech). Current discussions are largely shaped by expert opinions and educators' experiences, focusing primarily on policy development and assessment (Chiu, 2024:4). However, there is a significant gap in research addressing the future direction of higher education in the context of recent technological developments. As GenAI continues to evolve, disrupt, and integrate into existing systems, it creates opportunities to reshape and advance higher education (Table 1) to better prepare the future workforce and enhance learning outcomes (Jensen et al., 2024).

Table 1

Summary of the role of GenAI in higher education

Author(s)	Role of Generative AI in Higher Education
Hashmi, N. & Bal, A.S., 2024	Emphasises preparing students for AI-integrated work environments by enhancing their understanding and engagement with generative AI.
Michel-Villarreal, R. & Vilalta-Perdomo, E., 2023	Explores the challenges and opportunities of using ChatGPT for critical thinking and analysis in educational settings.
Chan, C.K.Y. & Tsi, L.H.Y., 2024	Highlights the use of generative AI in improving learning outcomes while assessing its role alongside teachers in higher education.
Walczak, K. & Cellary, W., 2023	Discusses the transformative potential of generative AI in providing access to tailored and widespread educational resources.
Jensen, L.X. et al., 2024	Reviews early claims of generative AI's potential in education, emphasising optimism about its integration despite societal challenges.
Dai, Y., Liu, A. & Lim, C.P., 2023	Positions ChatGPT as a student-driven innovation capable of transforming education quality and enhancing active learning approaches.
Tariq, M.U., 2024	Examines the integration of generative AI in curriculum development, fostering innovation in pedagogy and resource design.
Aad, S. & Hardey, M., 2024	Investigates the evolving roles of faculty in higher education as influenced by generative AI technologies and their implementation.
Lee, D. et al., 2024	Focuses on generative AI's impact on teaching practices, including modifications to assessments and integration into pedagogy.
Chiu, T.K.F., 2024	Proposes future directions for integrating generative AI in education, including improving AI literacy and advancing institutional support.

Source: Authors' compilation

The recent research report of Global Market Insights Inc. (2023) estimates the AI in education market size to reach $30 billion by 2032. One of the main conclusions based on research results shows that AI and ML are transforming educational models and drastically modifying teaching and learning methods from the elementary level to higher education, K12, and lifelong learning. Pioneering technologies nowadays assist the administrative activities of HEIs such as identifying and attracting students to universities, forecasting enrolment, predicting outcomes, and recognising at-risk students. Regarding teaching activities the focus is placed on personalisation such as developing personalised learning material, customisation of teaching, and

supporting in AI-enabled teaching assistants and tutors. Due to the fast penetration of AI-based tools, HEIs are facing a lot of challenges in the educational ecosystem. They have a responsibility both to provide their students with up-to-date efficient & relevant learning tools and to respond to the rapidly changing technological landscape, including AI (Lee et al., 2024). Based on conducted systematic literature review (Bearman et al., 2023; Lee et al., 2024; Zhai et al., 2021) the following key GenAI applications in HE are proposed by the authors and grouped by the core business processes of higher education with regard to teaching excellence (Venkatraman, 2007:103).

- Active learning to enhance student involvement.

The focus here is placed on personalised learning and tutoring supported by generative AI-powered adaptive learning platforms such as ChatGPT as a virtual tutor providing custom explanations and study aids. Interactive and immersive learning contributes a lot to active student involvement. For example, AI-generated virtual labs and environments are suitable for STEM subjects. Role-playing scenarios using generative models can be applied for humanities and social sciences.

- Mastery of content and the ability to communicate it.

Content generation for teaching and learning takes a substantial part of academic staff's time and efforts. A variety of AI-based tools are available for creating realistic simulations, case studies, and other forms of content to stimulate active learning. AI-generated lecture notes, presentations, quizzes, and assignments could be used as well.

- Assessment and other means of feedback about student learning.

Within this area, GenAI application vary from automated grading of essays and open-ended questions to generating detailed, personalised feedback for students. Diverse AI tools can be used for automating email responses and generating schedules. AI-supported real-time feedback platforms have been demonstrated to produce sustainable growth in collaborative, communication, problem solving, creativity, and self-regulated learning skills (Porter & Grippa, 2020).

Table 2

Key GenAI tools influencing higher education

AI tool	Developer	Release
ChatGPT	OpenAI	November 2022 (initial release)
Midjourney	David Holz	July 2022
Bing AI Chat	Microsoft	February 2023
BARD	Google	February 2023
Dall-E	OpenAI	January 2021
Synthesia	Synthesia	December 2022 (stable release)
Amper Music	Amper Music, acquired by Shutterstock in November 2020	January 2019 (stable release)

Source: Authors' compilation based on Lee et al., 2024

- Concern for students' learning and progress, including research assistance.

Students are the most important stakeholders in higher education, thus it is essential to involve them in research projects that seek to comprehend how GenAI will alter higher education (Chiu, 2024). Students' motivation and engagement are key learning outcomes. Human-robot interactions, for example, made low-achieving students feel more secure and valuable (Xia et al., 2022). Generative AI tools for literature review, summarisation, and hypothesis generation are particularly useful for students' progress.

3. Methodology

3.1. Conceptual framework

Conceptual models provide a structured framework to understand, represent, and analyse complex phenomena (Bozlu & Demirörs, 2008). By abstracting key elements and their interrelationships, conceptual models facilitate a systematic exploration of theoretical constructs and empirical observations (Fettke, 2009). This methodology is particularly valuable in fields where direct experimentation is challenging or where multiple interacting variables need to be synthesised into a coherent explanation (Grenier & Dudzinska-Przesmitzki, 2015; Hallinger, 1999). Conceptual maps as an element of the conceptual models are an effective methodological tool for visually organising and representing knowledge.

This study is to suggest how GenAI is transforming the educational process in HEIs. The proposed conceptual framework is based on a systematic literature review of AI in HE conducted by the authors. It considers the four major educational domains – learning, teaching, assessment and administration (Chiu, et al., 2023) with a focus on educational process and EdTech. The review study selected 30 articles from 1125 articles in three academic databases - ProQuest, Web of Science, and Scopus. The methodological framework developed by Chiu, et al. (2023) and Chiu (2024) was used for the screening process of the selected articles. Content analysis was applied to investigate both the benefits and challenges presented by AI in the educational process in HEIs. A conceptual map (Figure 2) was used to facilitate the identification of relationships between AI tools and the stages of the educational process thus providing a clear and structured framework for their understanding. The authors consider this methodology particularly valuable in research requiring the synthesis of diverse ideas, as it helps to uncover underlying patterns, clarify ambiguities, and foster critical thinking.

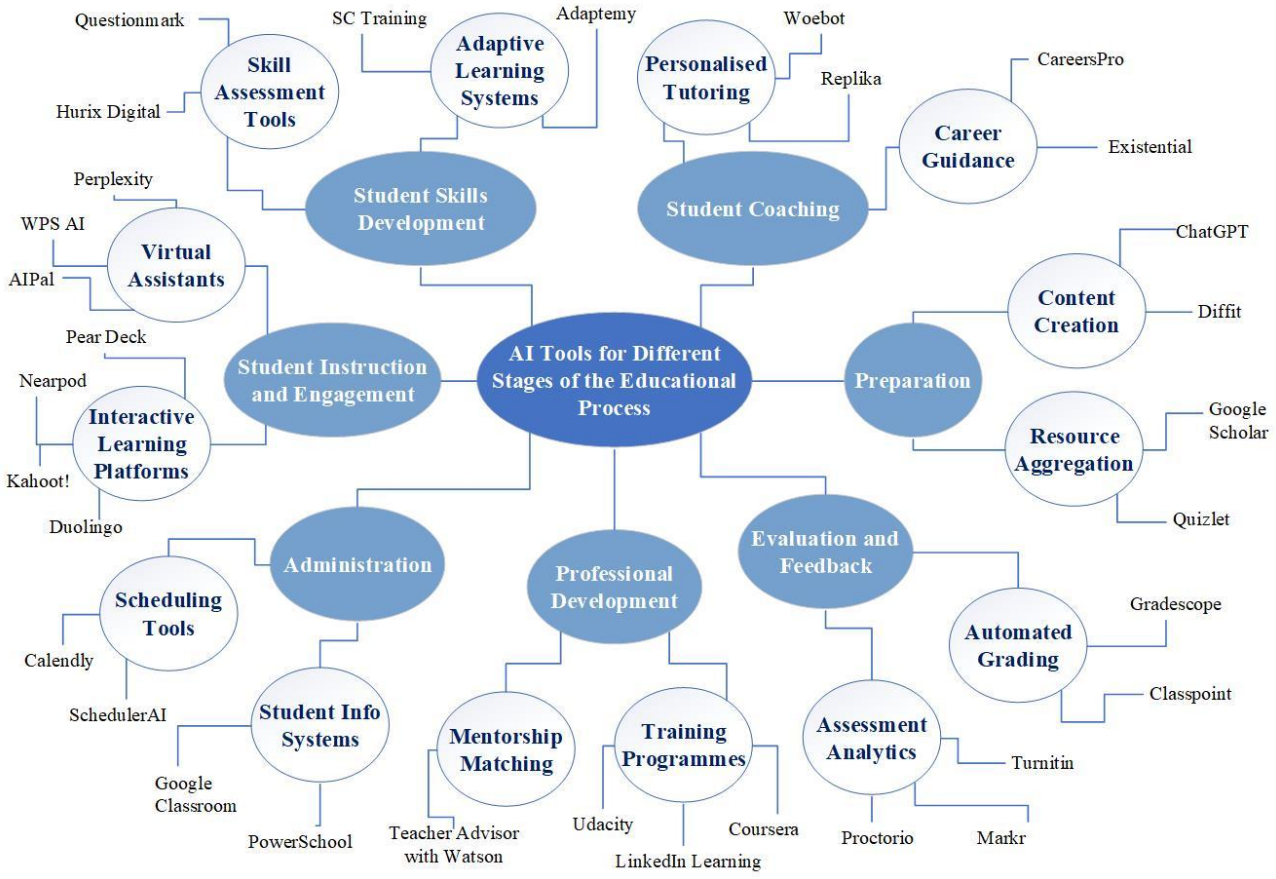


Fig. 2. Conceptual map of AI tools by stages of the educational process

Source: Authors' work

The first stage of the educational process is preparation, consisting of content creation and resource aggregation. During this stage AI-powered tools like OpenAI's ChatGPT can assist in generating educational content and lesson plans. Tools such as Google Scholar and AI-driven educational resource platforms can gather relevant study materials and research papers. The second stage - evaluation and feedback, includes automated grading and assessment analytics. Tools like Gradescope can automatically grade assignments and provide feedback. AI-driven platforms can analyse student performance data to give detailed insights into their learning progress. During the stage of professional development training programmes are developed. AI-based training platforms like Coursera and LinkedIn Learning can provide customised professional development courses. This stage includes mentorship matching as well where AI tools can match educators with mentors and peer networks for professional growth. Administration is an important phase since it comprises student information systems and scheduling tools. AI-integrated systems like PowerSchool help in managing student data and administrative tasks, while AI-driven scheduling software can optimise class schedules and resource allocation. The stage of student instruction and engagement includes interactive learning platforms and virtual assistants. For example, tools like Khan Academy use AI to provide personalised learning experiences. AI-powered chatbots can assist students with queries and support outside classroom hours. Student skills development requires implementation of skill assessment tools and adaptive learning systems. Within this stage AI can evaluate student competencies and suggest areas for improvement. Platforms like DreamBox adapt to student learning styles and pace to enhance skill development. The stage of student coaching comprises personalised tutoring and career guidance. It is advisable to apply AI tutors which can provide one-on-one coaching based on individual student needs and AI tools which can analyse student profiles to suggest suitable career paths and opportunities as well.

From a strategic point of view the integration of artificial intelligence (AI) in higher education represents a transformative shift that aligns with and expands upon established theories of learning and pedagogy. AI-driven tools, such as intelligent tutoring systems, adaptive learning platforms, and natural language processing technologies, embody principles from constructivist, behaviorist, and cognitivist theories. For example, adaptive learning systems leverage behaviorist ideas by providing immediate feedback and reinforcement, while also incorporating constructivist elements by tailoring content to individual learners' needs, fostering active engagement and personalized knowledge construction. AI also enhances metacognitive practices by encouraging reflection and self-regulation, aligning with social-cognitive theory. Tools like chatbots and virtual assistants support collaborative learning, drawing on Vygotsky's theory of social constructivism (Kalina & Powell, 2009) by facilitating interaction and scaffolding in group work or peer learning contexts. Moreover, AI systems enable educators to adopt a data-driven approach to pedagogy. By analyzing large datasets on student performance, AI can identify learning patterns, predict at-risk students, and inform instructional strategies, embodying principles of evidence-based teaching. However, the implementation of AI in higher education also necessitates a critical evaluation of ethical considerations, equity, and the balance between automation and human-centered learning design. This intersection of AI with pedagogy emphasizes a paradigm shift where technology not only supports traditional teaching methods but also redefines the learning experience in line with evolving educational theories.

3.2. Bibliometric analysis

Bibliometric analysis is a popular and rigorous method for exploring and analysing large volumes of scientific data (Donthu et al., 2021). Its popularity can be attributed both to the availability and accessibility of bibliometric software such as Gephi, Leximancer, VOSviewer, and scientific databases such as Scopus and Web of Science. Bibliometric methodology is crossdisciplinary by nature which makes it suitable for application from information science to business research. Visualisation is considered as a powerful approach to analyse a large variety of bibliometric networks, ranging from networks of citation relations between publications or journals to networks of co-authorship relations between researchers or networks of co-occurrence relations between keywords (Van Eck & Waltman, 2014).

3. Results and discussion

The relationships between AI tools and the stages of the educational process depicted in Figure 2 was further analysed through mapping on two aspects: with a focus on AI tools and with a focus on the stages of the educational process (Figure 3).

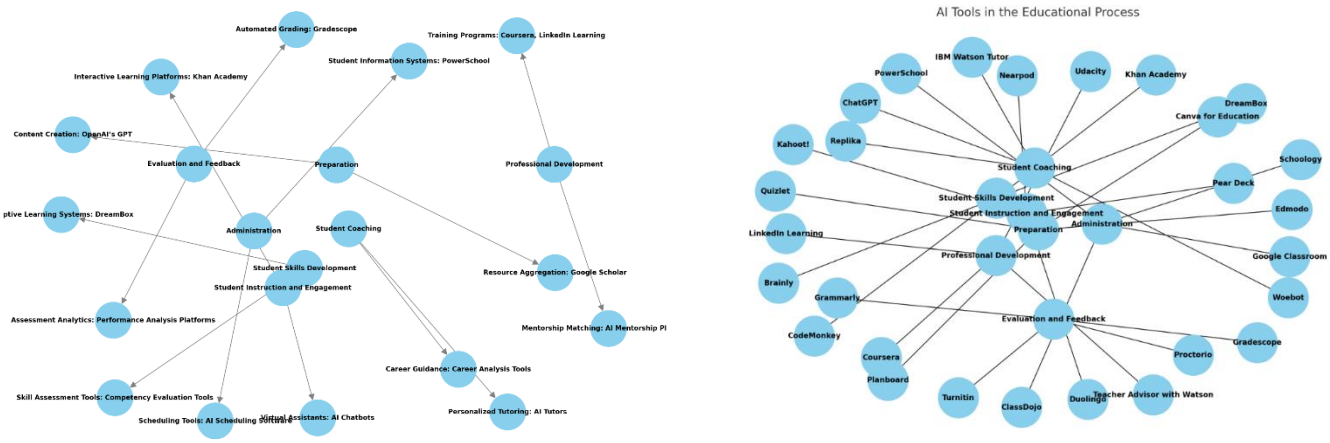


Fig. 3. Mapping AI tools to different stages of the educational process

Source: Authors' work

It is obvious that these results confirm the relationships presented on the conceptual map (Figure 2) and explained above.

In this study the authors apply VOSviewer to create a bibliometric network the results of which are used further in their analysis. VOSviewer is a software tool for constructing and visualising bibliometric networks (Waltman et al., 2010). VOSviewer offers text mining functionality that can be used to construct and visualise co-occurrence networks of important terms extracted from a body of scientific literature. To construct a map, VOSviewer uses the VOS mapping technique (Van Eck and Waltman 2007), where VOS stands for visualisation of similarities.

The Scopus database is used as a source of information. The keywords "artificial intelligence" and "educational technology" are extracted from the title, abstract and keywords of the publications. The publications included in the data collection cover the period from 1960 to present. The generated file is uploaded as a csv file in the VOSviewer software. As a result, a co-occurrence bibliometric network of terms is designed (Figure 4).

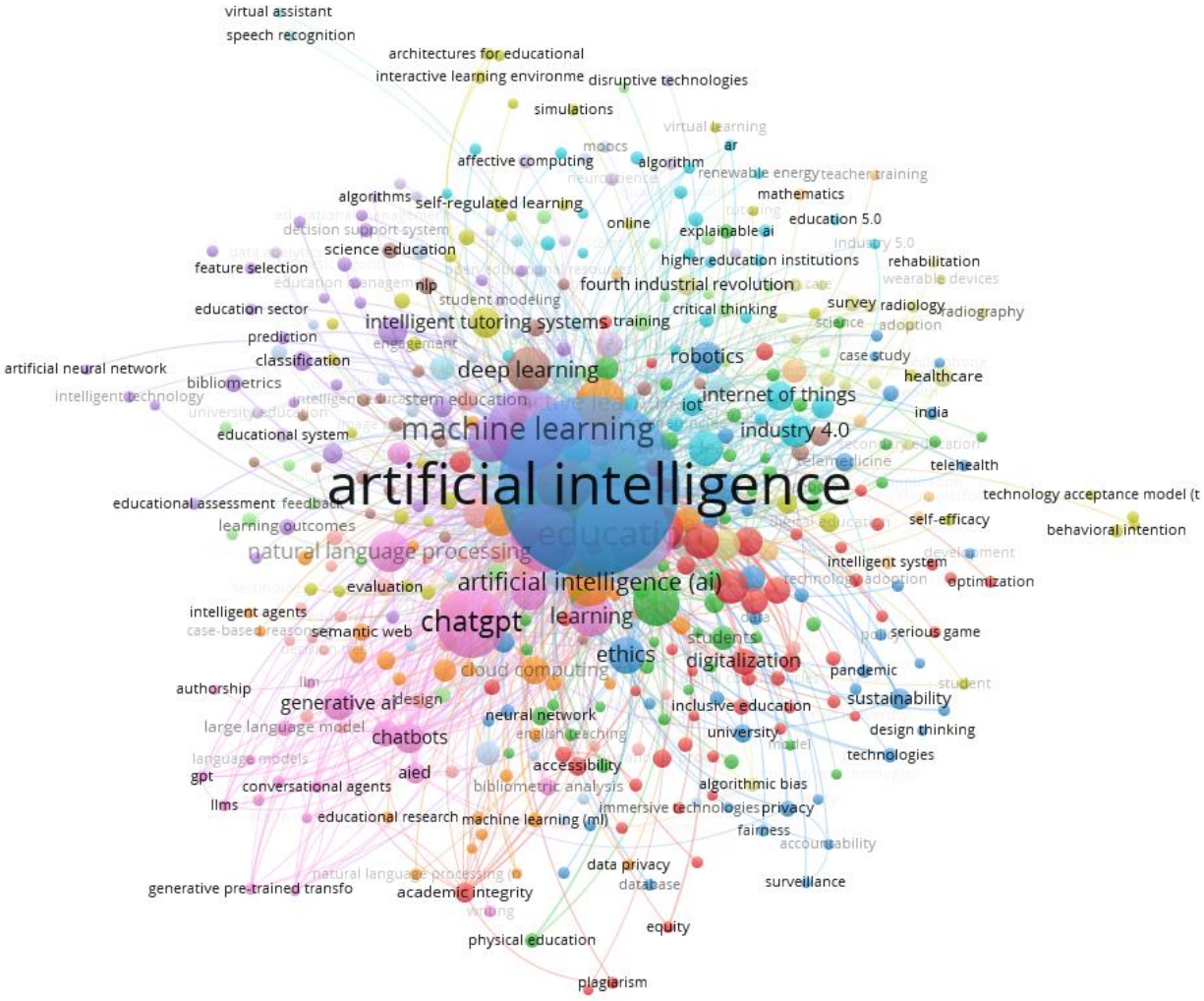


Fig. 4. Co-occurrence bibliometric network of terms related to "artificial intelligence" and "educational technology"

Source: Authors' work

The VOSviewer software is applied to create a distance-based map. Distance-based maps are maps in which the distance between two items reflects the strength of the relation between the items (total link strength is shown in parentheses in Table 3). A smaller distance typically signifies a stronger relationship. However, in distance-based maps, items are often distributed unevenly. While this uneven distribution helps in identifying clusters of related items, it can also pose challenges in labelling all items clearly, as overlapping labels may occur in densely packed areas. In the visualisation presented in Figure 4, each circle represents a term. The size of a circle indicates the number of publications that have the corresponding term in their title, abstract or keyword. Terms that co-occur a lot tend to be located close to each other in the visualization. The association strength method is used for normalizing the strength of the links between items.

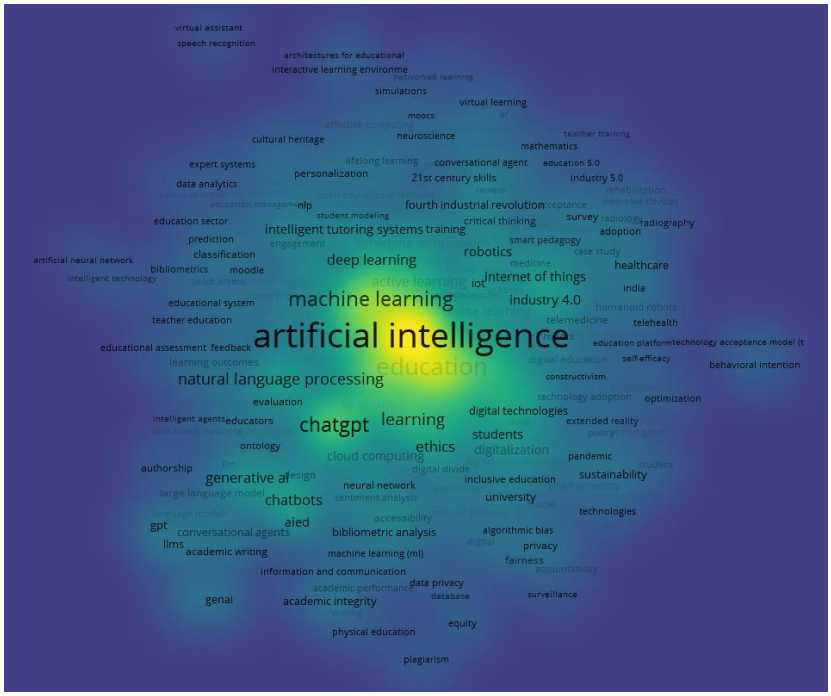


Fig. 5. Co-occurrence bibliometric network: Density visualisation
Source: Authors' work

The co-occurrence bibliometric network map (Figure 4) provides an overview of the structure of the terms related to "artificial intelligence" and "educational technology". Within the bibliometric network 470 items and 5928 links are found altogether. Total link strength is calculated as 11476. Association strength is applied as a method of analysis and small clusters are merged. Clusters of related terms can be identified in the map, and these clusters can be linked to specific field of AI. Clusters that are located close to each other in the map indicate closely related fields. VOSviewer has grouped the terms into sixteen clusters, of which two (Table 3) are of a significant size.

Cluster 1	55 items	Cluster 9	27 items
Cluster 2	52 items	Cluster 10	25 items
Cluster 3	42 items	Cluster 11	23 items
Cluster 4	38 items	Cluster 12	22 items
Cluster 5	32 items	Cluster 13	20 items
Cluster 6	32 items	Cluster 14	17 items
Cluster 7	32 items	Cluster 15	16 items
Cluster 8	28 items	Cluster 16	9 items

Table 3

Bibliometric analysis of terms related to "artificial intelligence" and "educational technology": cluster 1 and cluster 2

Cluster	# of Items	Items			
1	55	academic integrity (41/72/18) accessibility (35/48/15) adaptation (14/14/7) adaptive learning systems (18/20/5)	digital skills (17/21/7) digital technologies (41/65/31) digital transformation (72/131/49) digital twin (19/26/9)	fuzzy logic (26/31/11) game-based learning (42/56/14) gamification (59/88/35)	plagiarism (14/19/6) serious game (8/9/7) serious games (37/51/16) smart classroom (15/25/11)

		ambient intelligence (11/15/8) architecture (6/6/6) augmented reality (87/190/56) autism spectrum disorder (13/13/5) collaborative learning (15/18/14) constructivism (10/10/7) cyber-physical systems (16/19/5) cybersecurity (12/12/6) digital competencies (26/31/10) virtual learning environments (7/8/6)	digitalization (45/78/31) digitalization of education (11/14/7) distance education (19/21/10) education system (18/24/9) educational environment (9/9/6) educational process (29/35/15) equity (19/27/7) extended reality (16/24/6) framework (15/17/8) virtual worlds (16/17/6) digital divide (15/16/5) usability (27/37/10)	immersive learning (27/37/8) immersive technologies (10/13/6) inclusion (9/10/5) inclusive education (24/29/11) intelligent classroom (6/7/6) interactive learning (28/36/19) metaverse (48/101/30) mixed reality (29/58/17) optimization (8/13/7)	smart education (63/93/64) smart technologies (10/10/6) smart university (15/16/5) sustainable development (17/23/8) systematic literature review (20/28/10) technology adoption (16/22/8) transformation (13/14/5) user experience (21/28/10) virtual reality (111/243/76)
2	52	5G (16/18/7) AI ethics (13/16/9) AI in education (35/61/26) artificial intelligence education (10/10/12) artificial intelligence literacy (10/11/5) automation (29/45/18) cognition (20/25/7) computer science education (22/26/9) content analysis (10/11/6) curriculum design (12/12/6) curriculum development (12/14/7) data science (24/42/18) digitization (14/18/9) engineering (29/41/10)	educational application (9/11/6) educational applications (14/16/8) educational robots (16/19/6) emotional intelligence (14/14/5) english teaching (12/17/8) ethical issues (14/15/5) expert system (9/10/5) explainable AI (18/22/10) future (26/34/8) generative artificial intelligence (34/54/29) human-computer interaction (13/18/9) human-robot interaction (6/8/5)	humanoid robots (18/29/6) information (19/22/7) information and communication technologies (22/23/9) innovative technologies (10/12/5) internet (25/26/14) knowledge (25/29/7) leadership (16/17/6) learning systems (8/11/5) machine learning algorithms (8/9/5) medicine (19/25/8) model (12/13/5) MOOC (30/46/16)	new technologies (12/12/5) physical education (7/16/10) problem solving (10/14/7) project-based learning (15/17/9) research (24/35/10) robots (22/32/11) science (11/22/6) skills (30/39/10) social robotics (8/9/10) students (56/87/24) technology (113/258/91) universities (23/26/7) neural network (22/32/16) neural networks (33/55/19)

Note: Links/Total link strength/Occurrences

Based on the data provided by the bibliometric analysis the authors reached a set of findings, the most prominent of which are:

AI as a term is closely related to high strength of the links with ChatGPT, natural language processing (NLP), machine learning, learning ethics, GenAI, chatbots, intelligent tutoring systems, and deep learning. The terms with the highest total links strength within Cluster 1 include academic integrity, augmented reality, virtual reality, mixed reality, digital technologies, digital transformation, digitization, gamification. Technology appears to be the term with the highest total links strength not only compared to the rest of the terms in Cluster 2 but compared to all terms in the bibliometric network. Ethics (Cluster 3) is tightly related not only to the terms from the same cluster (e.g. accountability, privacy, robotics) but also to technology, ChatGPT, educational technology, learning analytics, teaching, algorithmic bias. It is evident, that currently online learning is associated not simply with the online type of communication, but with machine learning, deep learning, intelligent tutoring systems, and artificial intelligence.

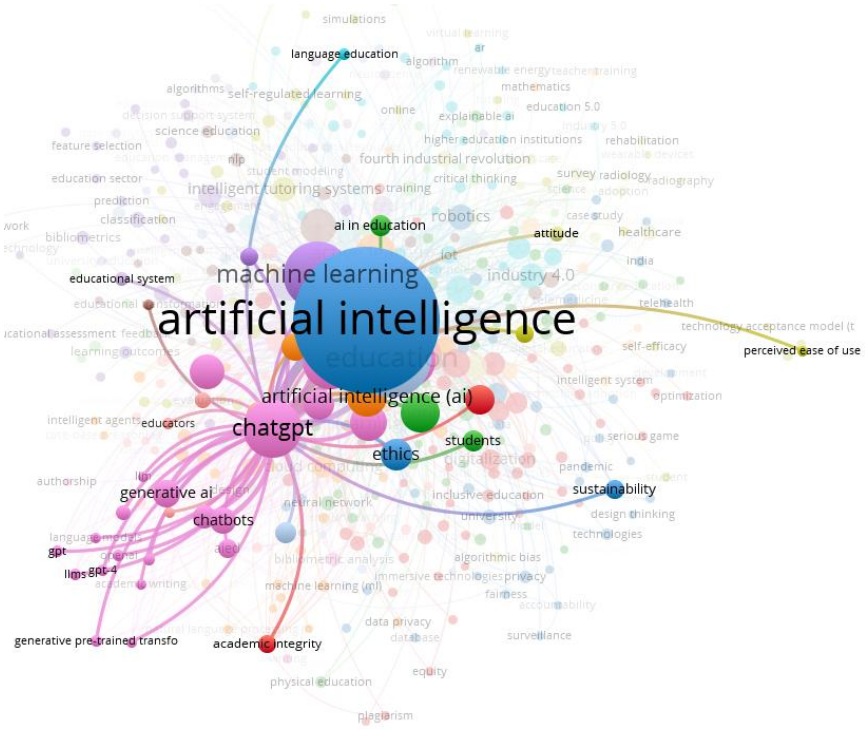


Fig. 6. Co-occurrence bibliometric network: ChatGPT as a focal point
Source: Authors' work

An interesting situation in the bibliometric network presents ChatGPT (Cluster 9, Figure 6). It is linked with terms from different clusters, e.g. language education (Cluster 6), perceived ease of use (Cluster 4), academic integrity (Cluster 1), machine learning (Cluster 5), ethics and sustainability (Cluster 3), educational system (Cluster 14), educators (Cluster 10). We can conclude that ChatGPT affects almost every aspect of the educational process and its actors. It seems that it will serve as a change agent triggering the transformation of teaching and learning as the most important part of the educational process.

4. Conclusions and Implications for Future Research

University leaders and academic staff have not previously been exposed to GenAI. Research into GenAI applications in higher education is an ongoing process but there is still a severe lack of research that is pertinent to the question of what the future of higher education should be like.

Findings of this study suggest that higher education must adapt to prepare students for a GenAI-driven society, emphasizing AI literacy, interdisciplinary and transformative learning, and intelligent tutoring systems. GenAI is a pioneering and transformative technology. As such, it should be used in ethical and responsible way. The benefits of implementing GenAI in the educational process include (1) increased efficiency in content creation, (2) greater accessibility through personalised learning, and (3) enhanced creativity of teaching materials and engagement in learning. But there are challenges as well. Ethical issues (bias in generated content, copyright concerns, etc.) are raised as a significant problem. There are certain risks of misinformation or inaccuracies in AI-generated output as well. In a long term we might face a dependency on AI and loss of human oversight in educational processes. Taking into account the abovementioned benefits and the challenges, two key recommendations for universities are suggested. Firstly, universities should develop strategies for integrating generative AI responsibly. Secondly, academic staff and students should be taught in using AI tools effectively.

Several countries have already responded to AI penetration in education. For example, Singapore is

focused on becoming a world leader in AI by 2030, helping teachers better personalise and enrich the student experience. South Korea aims to have AI coursework in its national curriculum by 2025. The United Kingdom adopts new principles for universities such as adapting teaching and assessment to embrace the ethical use of generative AI, ensure integrity, and continue to collaborate and share best practices as technology evolves (Lee et al., 2024).

This study should be regarded as a preliminary stage of a more complex research project. Based on the presented conceptual model and the results from bibliometric analysis, a qualitative study using thematic analysis will be conducted with both students and academic staff. The research objective will be to get an insight of both students and faculty viewpoints. The main topics for focus group discussions will be derived from existing results. As a next step, a survey among students and academic staff will be organised. It is expected to attain a complete understanding of what is essential for making sense of the impact that GenAI will have on universities in the future with regard to learning, teaching, assessment, and administration.

Although this review does propose some valued insights and potential research directions for AI in education, there exist several limitations. Firstly, the papers reviewed in this study were derived from three academic databases. The bibliometric analysis was based on data provided by Scopus. The initial search could be extended using more keywords such as adaptive learning and smart education. Secondly, since the current review was not attempted in order to be inclusive but to provide a systematic overview of AI in education, the analysis in the former may provide a framework for future research integration. A conceptual map and bibliometric network could be used for further analysis, generating research hypotheses and conducting quantitative research. The emerging trends in GenAI for education represent an interesting topic for further investigation. For example, swarm intelligence has become a vital development direction of AI, where the roles of teachers and students will be disruptively changed (Zhai et al., 2021). Swarm intelligence may change teachers' duties from knowledge transmission to knowledge organization. Recent advancements in multimodal models (e.g., combining text, image, and audio) comprise another emerging trend as well as the potential for AI-generated 3D simulations and augmented reality.

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