

The Impact of Generative Artificial Intelligence on University Information Literacy Education: A Systematic Review from Challenges to Changes

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Abstract: The rapid development of generative AI is transforming university information literacy education by reshaping how students access and process information. This study systematically reviews 49 research papers published between 2020 and 2024, using the PRISMA framework and thematic analysis to explore the applications, impacts, and pedagogical changes associated with generative AI in the field of information literacy education. Results show that generative AI has a wide range of applications in information literacy education, mainly in student learning support, learner-oriented personalized learning, academic research assistants, academic writing assistance, information literacy skills development, and curriculum design and teaching assistance. Generative AI has promoted students' information retrieval, evaluation skills and critical thinking, but also brought the challenge that over-reliance on AI may weaken students' critical thinking and information evaluation skills. Important changes in curriculum design and teaching methods are needed to introduce instruction in prompt engineering and computational thinking. The role of the teacher has shifted from knowledge transmitter to learning facilitator, emphasizing the importance of professional basic knowledge and ethical education. Through the results it is found that Generative AI can significantly enhance student learning outcomes and skills development in university information literacy education. However, its application requires caution and must fully consider potential challenges and risks. Through reasonable curriculum design, innovative teaching methods, and policy support, educators can leverage the advantages of Generative AI to cultivate high-quality talent with critical thinking, innovation, and a sense of moral responsibility. As AI technology continues to develop, information literacy education will usher in more innovations and opportunities, bringing new vitality and possibilities to higher education.

Keywords: Generative AI, ChatGPT, Information Literacy, Education, Challenges, Changes.

I. Introduction

The wider and even more influential domain of education requires a deeper investigation into the changes that generative AI integration has caused in the context of university information literacy instruction. As AI becomes more integrated into the educational landscape, comprehension of its influence on information literacy is vital for graduating students who can effectively engage with the increasingly complex and fluid information environment of today (AlAli & Wardat, 2024). As generative AI tools are changing the scope of information literacy, educators are responding with alternative teaching in order to put the transformative force of her generative AI technology while creating the right learning (Bitzenbauer, 2023; Dinçer, 2024). Such a shift necessitates rebuilding educational practices existing at large as well as creating new frameworks including—but not limited to—the aspect of AI literacy, but perhaps timelier building in the ethics axis (J. Lee et al., 2021).

Information literacy is the cornerstone of academic success and lifelong learning and its importance is magnified in the context of university education. Research results show that information literacy can help students to find, assess and use information effectively (Bradley, 2013; Yebowaah & Sanche, 2021). The relationship between information literacy and academic performance has shown a huge positive relationship (Adhikari, 2018). However, the emergence of generative AI has further shaped the information landscape, which has prompted a shift in the traditional information literacy paradigm (Ng et al., 2024). While generative AI provides information, it also brings new challenges that relate to information assessment and credibility judgments (Ng et al., 2021).

Along with the introduction of generative AI technologies, information literacy education has seen dramatic changes in curriculum design and implementation. The use of AI technologies has led to higher education curricula that are more focused on integrating theoretical knowledge with practical applications (Aldosari, 2020; ÇAYIR, 2023). These changes improve students' practical skills while also providing them with a stronger foundation for their future (Vafadar & Moradi Amani, 2024). At the same time, the use of AI raises ethical questions about data privacy, algorithmic bias, responsible use of AI, and academic integrity. Educators and policymakers need to resolve these issues to ensure that AI technologies are used in an ethical way. (Kazantsev, 2023).

While generative AI has the power to redefine information literacy education, it still faces many challenges that limit its ability to be effectively integrated with pedagogical practices. One of the challenges to the use of generative AI technologies is the lack of knowledge and skills among educators and librarians with respect to emerging technologies such as generative AI (Bakiri et al., 2023; Yoon et al., 2022). This is important because it will ensure that students are able to leverage the advancements in AI technology while advancing core assessment abilities and ethical conduct. According to Ng et al. (Page et al., 2021), Advanced digital literacy skills, such as AI literacy, need to be developed in educators and students if generative AI is to be utilized as a tool to improve information literacy education.

In this systematic review we will examine the effect of generative AI on university information literacy education in depth, highlighting the challenges and changes that it brings. More specifically, this review sets out to address these research questions:

RQ1: What are the main applications of generative AI in university information literacy education?

RQ2: How does generative AI impact the development of information literacy skills in university students?

RQ3: What changes has the introduction of generative AI brought to the design and teaching methods of information literacy courses?

This study attempts to answer the above questions, therefore, it includes a systematic literature review to inquire the implications of generative AI practices in university information literacy instructions, to characterize the reformations of information literacy education by generative AI, to discover its opportunities, challenges and research gaps, and to provide implications on how artificial intelligence technologies could be suitably embedded in educational practices via steps for individual educators and by facilitators for policymakers.

II. Methodology

2.1 PRISMA Framework

This systematic review uses the PRISMA framework. This framework is a systematic review guideline that guides researchers in literature searching, screening, data extraction, quality assessment, and reporting, to ensure the transparency and rigor of the review (Page et al., 2021). This study aims to provide a scientific and systematic evaluation of the impact of generative AI on information literacy education in universities.

2.2 Search Strategy:

The literature for this review is from WOS (Web of Science), Scopus, and ERIC (Educational Resources Information Center). These three databases were chosen to cover high-quality research on the impact of generative AI on information literacy in higher education. To ensure the data's newness and academic quality, the detailed search setup was as follows:

Retrieve field: default.

Retrieved: (("generative AI" OR "generative artificial intelligence" OR "ChatGPT" OR "GPT-3" OR "GPT-4" OR "large language model*" OR "LLM*" OR "AI language model*" OR "artificial intelligence language model*" OR "AI chatbot*" OR "conversational AI")AND ("information literacy" OR "digital literacy" OR "media literacy" OR "data literacy" OR "AI literacy" OR "information skill*" OR "research skill*" OR "critical thinking" OR "information evaluation" OR "information retrieval" OR "information seeking" OR "information use")AND ("education" OR "higher education" OR "university" OR "college" OR "post-secondary education" OR "tertiary education" OR "undergraduate*" OR "graduate student*")).

Type of literature: articles or review articles.

Language: English.

Time range of search results: All searches were conducted on 21 September 2024, and the time range of search results was limited to academic articles published in the past five years (2020-2024) to ensure the timeliness and consistency of the data.

2.3 Inclusion and Exclusion Criteria:

In order to ensure that the included literature accurately reflects the actual application and impact of generative AI in information literacy education in higher education, this study adopts strict inclusion and exclusion criteria to ensure the scientific nature and relevance of the results. The following are the specific inclusion and exclusion criteria:

Inclusion Criteria:

1. Topic relevance: Only literature in the form of research articles that thoroughly explore the application of generative AI (e.g., ChatGPT) in university information literacy education and its practical impact on specific information literacy skills (e.g., information retrieval, information evaluation, critical thinking, etc.) will be included. The literature should discuss the educational function of generative AI in order to evaluate the specific role of generative AI in education.
2. Discipline area: Higher education research focusing on information science, librarianship or education to ensure the disciplinary relevance of the research.
3. Document type: Only peer-reviewed journal articles were included, excluding other non-peer-reviewed sources to ensure the quality and reliability of the research.
4. Publication date: Only documents published within the past five years (2020-2024) are included to ensure that the research discusses the latest applications and practices of generative AI.

Language of documents: Only English documents are included to ensure the international readability and academic universality of the research.

Exclusion Criteria:

1. Topic mismatch: Exclude literature that did not discuss generative AI (e.g. ChatGPT, etc.) or only covered general AI or non-generative AI tools. Exclude review articles to ensure that included studies provided a unique theoretical perspective or support for practical applications.
2. Education level mismatch: Exclude studies that involved non-university student populations or could not distinguish between university student data to ensure that the educational background of the studies was consistent with the higher education focus of this review.

3. Information literacy skills not addressed: Exclude literature that does not specifically explore the impact of generative AI on specific information literacy skills to ensure that the included studies are directly related to information literacy skills.
4. Duplication and similarity: Exclude repetitive studies with highly similar content, a lack of novelty, or published by the same author group. Exclude literature published in low-impact journals or that has not undergone rigorous peer review to ensure the credibility and rigor of the data.
5. Unavailable full text: exclude literature that is unavailable due to access restrictions or other reasons to ensure data integrity and support comprehensive analysis of the research.

The above inclusion and exclusion criteria ensure that this study only includes important, up-to-date and high-quality literature on the application of generative AI in university information literacy education, thereby improving the accuracy and relevance of the research results.

2.4 Literature Screening and Selection:

The literature screening and selection process for this study was based on the PRISMA framework and divided into preliminary search, deduplication, title and abstract screening, and full-text screening. A preliminary search yielded 678 documents (Web of Science (n=257), Scopus (n=330), ERIC (n=91)). After deduplication, 428 documents remained for primary selection, and 250 documents were not retained. After screening the titles and abstracts, 327 articles were excluded, leaving 101 potentially relevant articles for subsequent analysis. Finally, after full-text screening of the 101 articles, 49 articles met all the inclusion criteria and were included in this systematic review. The PRISMA flow diagram for the screening process is Fig. 1.

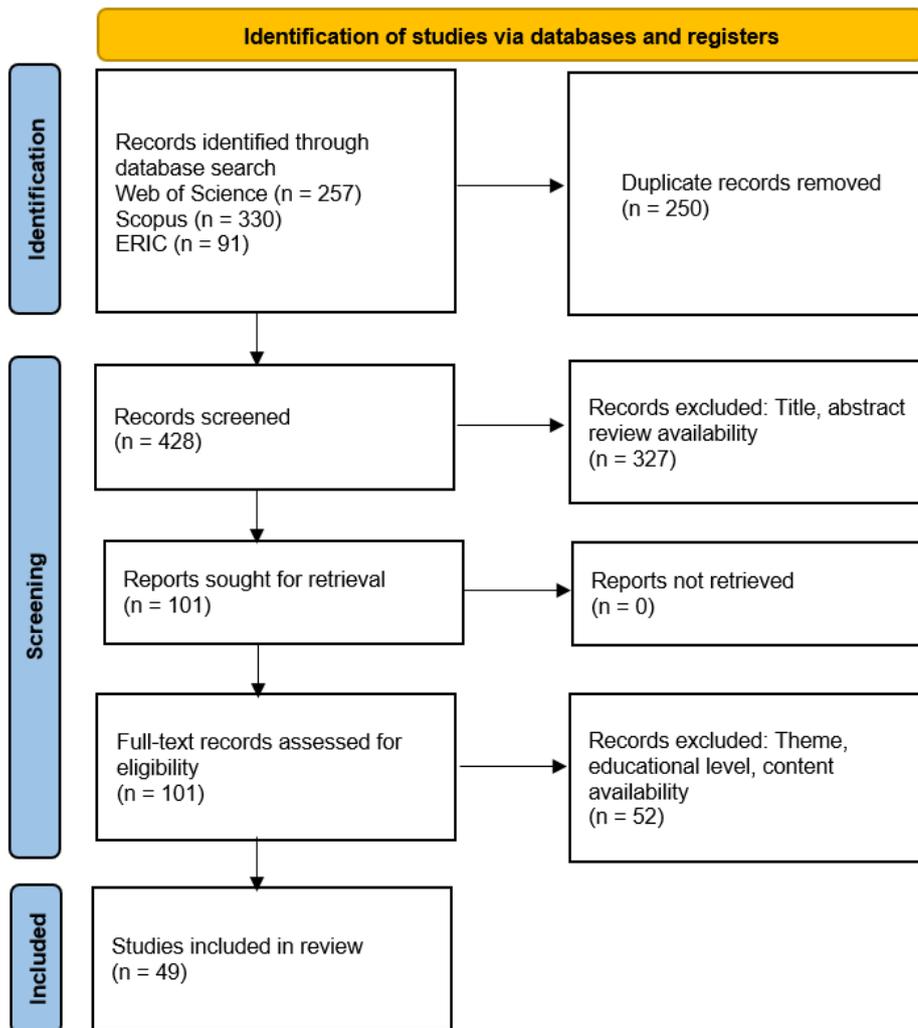


Fig. 1 PRISMA-based Screening Flow Chart

2.5 Data Extraction and Coding:

Thematic analysis was used for this systematic review. For each research question, the key information in the literature was extracted, coded, and categorized to reveal the core themes of the application of generative AI in university information literacy education. Themes formed by coding and coding category, such as Table 1 Themes Table, reflect the application characteristics, impact and practical challenges of generative AI in higher education information literacy teaching. Through this analysis process, the impact of generative AI in the areas of educational support, skills development and curriculum change is clearly demonstrated, and a systematic analytical framework is provided for the discussion and summary of this research.

Table 1 Themes Table

Research Question	Category	Definition
RQ1 (Section 3.1)	Comprehensive Learning Assistance	Generative AI provides learning support to improve learning efficiency, cultivate creativity, and promote a personalized and autonomous learning experience.
	Scholarly Assistance Tools	Generative AI can facilitate scholarly activities, providing comprehensive support from idea generation and research preparation to writing assistance and editing enhancement.
	Information literacy skills development	Through GenAI, students develop the ability to effectively retrieve, evaluate, manage and utilize information, enhancing critical thinking and decision-making skills.
	Curriculum Design and Instructional Aids	Support educators to use GenAI to develop course content and teaching strategies, optimize teaching methods, and improve teaching effectiveness and student engagement.
RQ2 (Section 3.2)	Ethical and Responsible Use of generative AI in Academia	Includes an ethical understanding and responsible use of generative AI, while covering awareness of the potential negative impacts and challenges of generative AI tools.
	Critical Thinking and Information Verification	Emphasis is placed on how students can develop critical thinking and verify the accuracy and reliability of information when confronted with bias and misinformation in AI-generated information.
	AI Interaction and Technical Skills	Covers the skills needed to interact with generative AI tools, including cue engineering, technical tool use, and an understanding of how AI works.
	Enhancement of Information Literacy and Digital Skills	This topic covers the impact generative AI (e.g., ChatGPT) has on students' digital literacy, information literacy, and AI literacy production.
	Fostering Creativity, Autonomy, and Metacognitive Skills	Involves the impact of generative AI on students' creativity, self-directed learning skills, and metacognitive skills.
RQ3 (Section 3.3)	Changes in teaching content and updates to course design with the introduction of generative AI	Adaptation and improvement of educational curricula and materials to incorporate generative AI technologies to reflect new content and learning objectives.
	Innovation of generative AI-driven teaching methods and assessment mechanisms	Covers the integration of generative AI in course design and pedagogy, including enhancing teaching effectiveness, improving the learning experience, and assessing student performance and outcomes as a result of using AI.
	Teacher's Role Transformation and Professional Development	Covers the integration of generative AI in course design and pedagogy, including enhancing teaching effectiveness, improving the learning experience, and assessing student performance and outcomes as a result of using AI.
	Ethical Considerations, Policy Development, and Academic Integrity	The role of educators has shifted from traditional knowledge transmitters to facilitators and guides, and continuous professional development is required to effectively integrate AI into education.

2.6 Quality Assessment:

The quality assessment process for this systematic review was carried out by the researcher and two fourth-year students majoring in information management. Each included article was analyzed individually by the team to ensure the rigor of the research and the reliability of the data. During the assessment process, the researcher and two students discussed and analysed the research design, data collection methods, analysis process and transparency of results of the literature to determine its quality and suitability for inclusion.

When team members have different opinions on the quality assessment of individual literature, they discuss and analyze it in depth in team meetings to reach a consensus and finally decide whether to include the literature. This process ensures the consistency and

reliability of literature screening. Although a strict standardized tool was not used, collective discussion and analysis improved the accuracy and robustness of the literature screening decisions.

III. Results

3.1 RQ1: What are the main applications of generative AI in university information literacy education?

This section explores the main applications of generative AI in university information literacy courses. The main finding of this section is that generative AI is not only used in areas such as student learning support, personalized learning and academic writing, but also provides educational assistance at multiple levels of information retrieval and skills development. The theme coding table for this section is shown in Table 2.

Table 2 Themes and Coding Table of RQ1

Category	Code	References Number	Reference Points Number
Comprehensive Learning Assistance	Enhancing Learning Experiences	29	35
	Personalized and Autonomous Learning Support	23	26
Scholarly Assistance Tools	Academic research assistant	14	17
	Academic writing assistance	14	15
Information literacy skills development	Enhancing Critical Thinking, Problem-Solving, and Knowledge Acquisition	6	6
	Facilitating Information Search, Organization, and Communication	6	8
	Promoting Creativity, Reflection, and Motivation	4	4
Curriculum Design and Instructional Aids	AI in Curriculum and Course Design	7	8
	AI in Instructional Support	6	8
	AI in Educational Innovation	4	4
	AI in Information Literacy	5	8

3.1.1 Comprehensive Learning Assistance

Enhancing Learning Experiences:

Generative AI supports students in mastering complex concepts, completing intricate tasks, and enhancing practical skills (James & Hampton Filgo, 2023; Naamati-Schneider & Alt, 2024; Zhao et al., 2024). It provides cross-disciplinary knowledge and resources in areas such as software development, language learning, and chemistry experiments, helping students bridge theory and practice while boosting problem-solving skills and confidence (Almahasees et al., 2024; Pretorius, 2023; Wang et al., 2024).

Generative AI significantly improves learning efficiency by aiding data processing, text summarization, and interdisciplinary learning, enabling students to assimilate large volumes of information in a short time (Essien et al., 2024; Javaid et al., 2023; Rasul et al., 2024). It provides strong support to streamline and enhance the academic workflow at all stages of question answering, information processing, knowledge construction and essay drafting (Deschenes & McMahon, 2024; Farhi et al., 2023).

The human-computer interaction capabilities of generative AI can promote student learning engagement, stimulate knowledge exploration and enhance student creation (Bozkurt, 2024; Pozdniakov et al., 2024; Rahman & Watanobe, 2023). With AI tools such as video making, article writing, information search, brainstorming, and task scheduling, students are able to experiment and create in a different environment (Borkovska et al., 2024; Kajiwara & Kawabata, 2024; McLeod & Richardson, 2023; Muengsan & Chatwattana, 2024). There are cases that show that embedding generative AI into a learning partner system can increase student engagement in learning, improve learning efficiency, and enhance learning self-efficacy (Cain, 2024; Hu et al., 2024).

Personalized and Autonomous Learning Support:

Generative AI can adapt the output to the learning characteristics of the student during the process of interaction with the student (Michel-Villarreal et al., 2023; Pozdniakov et al., 2024). Generative AI delivers customized resources in a way that students like to use, which can enhance learning, fill in knowledge gaps, and create personalized learning environments (Borkovska et al., 2024; Javaid et al., 2023; Karakose & Tülübaş, 2023; Naamati-Schneider & Alt, 2024; Xu et al., 2024).

Intelligent feedback from generative AI can integrate resources, summarize material, and construct knowledge according to students' requirements, which can help students to deepen their understanding, improve their learning experience, and finally create new ideas (Ciampa et al., 2023; Javaid et al., 2023; Noroozi et al., 2024; Sağın et al., 2024; Sun & Hoelscher, 2023).

Generative AI can help students control their own pace of learning, complete college assignments independently, and learn complex material in a way that matches their individual mindset (Chaudhuri & Terrones, 2024; Essel et al.). In addition, generative AI improves students' self-efficacy and self-regulation of learning and promotes independent learning (Hu et al., 2024; Li et al., 2024; Rasul et al., 2024).

3.1.2 Scholarly Assistance Tools

Academic research assistant: Generative AI can provide researchers with full-process support, so that they can focus on innovative thinking (Li et al., 2024). First, generative AI can assist researchers in the early stages of academic research by assisting them in brainstorming to generate original ideas (Chen et al., 2024; James & Hampton Filgo, 2023). Second, generative AI is able to break down, refine and explain complex concepts, helping researchers to clarify the problems to be solved in the academic research process (Pretorius, 2023; Zhao et al., 2024). In addition, while efficiently recommending key literature and academic resources, generative AI can integrate information, quickly generate background information and explore topics, ensuring that research has a clear direction and an adequate information base (Carroll & Borycz, 2024; Deschenes & McMahon, 2024; Noroozi et al., 2024; Sun & Hoelscher, 2023). Finally, researchers can use generative AI to summarize key citations, understand and locate academic concepts, refine research topics, conduct literature reviews and generate concept maps (Chaudhuri & Terrones, 2024; Tzirides et al., 2024).

Academic writing assistance: Generative AI helps students outline and structure their writing (Sun & Hoelscher, 2023). It provides clear frameworks and specific suggestions, especially in new research areas (Essien et al., 2024). Its editing and paraphrasing features improve grammar, punctuation, and clarity (Farhi et al., 2023). Students can refine their language and optimize academic writing with these tools (Deschenes & McMahon, 2024; McLeod & Richardson, 2023). The efficient information gathering ability of generative AI helps students save a lot of time during the writing preparation stage (Zhao et al., 2024). Many students use it to understand, integrate, and compose content more efficiently (Chaudhuri & Terrones, 2024). In scientific writing, it enhances reading, writing, and critical thinking skills (Chen et al., 2024; Essien et al., 2024). Despite concerns about reliability, students value its role in improving accuracy and efficiency in academic writing (Zou et al., 2024).

3.1.3 Information Literacy Skills Development

Enhancing Critical Thinking, Problem-Solving, and Knowledge Acquisition: Generative AI guides students in multi-angle analysis, fostering independent and creative thinking while improving their ability to judge information authenticity (Essien et al., 2024). As a metacognitive scaffold, it aids in breaking down complex problems, deepening subject knowledge, and strengthening critical thinking through advanced natural language processing (Exintaris et al., 2023; Farhi et al., 2023; Sun & Hoelscher, 2023; Wang et al., 2024).

Facilitating Information Search, Organization, and Communication: Generative AI helps students overcome challenges in complex information retrieval, refine search strategies, and enhance accuracy in acquiring information (Carroll & Borycz, 2024; Hu et al., 2024; James & Hampton Filgo, 2023). It also structures and visualizes data, improving information management and supporting group discussions and knowledge sharing (Carroll & Borycz, 2024; Lee & Park, 2024).

Promoting Creativity, Reflection, and Motivation: Generative AI stimulates idea generation through iterative feedback across multiple modes (e.g., text, video, and images). It promotes critical reflection, enhances motivation, and strengthens students' sense of self-efficacy (Farhi et al., 2023; Javaid et al., 2023; Oddone et al., 2024; Tzirides et al., 2024).

3.1.4 Curriculum Design and Instructional Aids

AI in Curriculum and Course Design: Generative AI is already being used to efficiently prepare learning materials such as question explanations and learning videos, which allows teachers to focus on more in-depth teaching activities (Farhi et al., 2023; Javaid et al., 2023). In addition, generative AI can also help teachers enrich course content, edit teaching plans, and improve teaching plans (Karakose & Tülübaşı, 2023; Pozdniakov et al., 2024).

AI in Instructional Support: Generative AI plays an important role in supporting automated management of teaching and learning. For example, it can automatically mark exams and assignments, support teaching assessment, handle common problems, create teaching scenarios, etc. (Chaudhuri & Terrones, 2024; Houston & Corrado, 2023; Javaid et al., 2023; Karakose & Tülübaşı, 2023). These applications reduce the burden on teachers, who can focus on higher-level cognitive activities with their students (Karakose & Tülübaşı, 2023; Lo, 2023).

AI in Educational Innovation: In terms of educational innovation, generative AI shows potential for transforming teaching and learning (Sağın et al., 2024; Tzirides et al., 2024). For example, the mandala diagram framework helps students organize and reflect on learning resources with the help of generative AI (Hu et al., 2024). A game-based learning platform embedded with generative AI improves students' digital literacy (Muengsan & Chatwattana, 2024).

AI in Information Literacy: Generative AI has been tried and tested in information literacy teaching, an approach that enhances students' core information literacy skills such as collaboration, communication, information evaluation, critical thinking and creativity (Carroll & Borycz, 2024; Chaudhuri & Terrones, 2024; Houston & Corrado, 2023).

3.2 RQ2: How does generative AI impact the development of information literacy skills in university students?

The introduction of generative AI has had a profound impact on the development of students' information literacy skills. This section analyses the role of generative AI in enhancing critical thinking, information evaluation, technical skills, and metacognition. The topic coding table "Table 3" shows the specific impact of generative AI on the development of students' information literacy skills.

Table 3 Themes and Coding Table of RQ2

Category	Code	References Number	Reference Points Number
Ethical and Responsible Use of generative AI in Academia	Ethical Competence and Responsible AI Use	9	7
	Impact on Academic Integrity and Cognitive Skills	12	9
	AI Limitations, Bias, and Misinformation	18	15
Critical Thinking and Information Verification	Information literacy and critical evaluation	19	13
	generative AI interaction and cultivation of critical thinking	14	11
AI Interaction and Technical Skills	Prompt Engineering Skills	13	7
	Technical Proficiency and Understanding of AI	5	4
Enhancement of Information Literacy and Digital Skills	Enhancement of Literacy and Information Skills	9	7
	AI as a Learning Aid	4	4
Fostering Creativity, Autonomy, and Metacognitive Skills	Creativity and Innovation	9	8
	Feedback, Reflection, and Self-regulation	8	6
	Autonomy and Control	4	4
	Non-cognitive and Metacognitive Skills	4	3

3.2.1 Ethical and Responsible Use of generative AI in Academia

Ethical Competence and Responsible AI Use: Generative AI users must develop strong ethical awareness and responsibility. Students need to understand its risks, evaluate its appropriate use in academic contexts, and apply ethical principles in practice (Bearman et al., 2024; Celik, 2023; Lee & Park, 2024).

Impact on Academic Integrity and Cognitive Skills: Overreliance on generative AI can undermine creativity, critical thinking, and analytical skills (Almahasees et al., 2024; Chen et al., 2024; Deschenes & McMahon, 2024; Farhi et al., 2023; Qawqzeh, 2024; Rasul et al., 2024). Students therefore need to be equipped with the knowledge and ability to identify Generative AI errors and maintain a high degree of caution regarding academic integrity (Sun & Hoelscher, 2023).

AI Limitations, Bias, and Misinformation: While generative AI produces plausible content, students must recognize its biases, inaccuracies, and limitations (Archila et al., 2024; Bearman et al., 2024; Carroll & Borycz, 2024). Students need to develop stronger critical evaluation skills to be able to effectively analyze and resolve illusions, false citations, and contextual contradictions generated by AI (James & Hampton Filgo, 2023; Lee & Park, 2024; Sun & Hoelscher, 2023; Zou et al., 2024). There is a need for stronger peer review to find and understand the limitations of AI-assisted research, so in order to promote the informed and responsible use of AI by researchers (Kong et al., 2024).

3.2.2 Critical Thinking and Information Verification

Information literacy and critical evaluation: Students who use generative AI as an assistant need stronger assessment and judgment skills to verify the accuracy and credibility of information (Archila et al., 2024; Ciampa et al., 2023; Sun & Hoelscher, 2023). They need to assess the quality of AI-generated content, understand its basic logic, and check the results critically, not just depend on them blindly (Bearman et al., 2024; Deschenes & McMahon, 2024; Michalon & Camacho-Zuñiga, 2023). Additionally, prompt engineering skills and AI literacy are essential to maximize the effectiveness of generative AI in academic research (Kong et al., 2024; Lo, 2023; Rasul et al., 2024; Zou et al., 2024).

Generative AI interaction and cultivation of critical thinking: Student interaction to generative AI can promote reflective learning, improve decision making and master complex information (Bearman et al., 2024; Borkovska et al., 2024). Generative AI can provide different methods to solve problems in order to encourage students to discuss, compare and choose, thus in part promoting communication among students about the use of AI and improving individual critical thinking skills (Essel et al., 2024; Essien et al.,

2024; Exintaris et al., 2023; Kong et al., 2024). Computational thinking further supports critical thinking development, providing a structured approach to using generative AI effectively (Celik, 2023; Qawqzeh, 2024).

3.2.3 AI Interaction and Technical Skills

Prompt Engineering Skills: The effective use of generative AI depends on optimizing prompt quality (Bearman et al., 2024). Prompt engineering, an emerging discipline, helps AI understand context and concept relationships, reducing irrelevant or inaccurate responses (Lo, 2023). Students must refine prompts iteratively to achieve higher-quality outputs (Bozkurt, 2024; Knoth et al., 2024; Kong et al., 2024; Wang et al., 2024). Combining critical assessment with repeated questioning has proven effective in improving output accuracy (Naamati-Schneider & Alt, 2024).

Technical Proficiency and Understanding of AI: Mastering prompt engineering requires a solid foundation in conceptual and operational skills (Bozkurt, 2024). However, non-expert users often have difficulty systematically improving their prompts due to limited knowledge of the capabilities of large language models (Knoth et al., 2024). Thus, technical proficiency is essential, including understanding AI functionality and leveraging its full potential effectively (Lee & Park, 2024).

3.2.4 Enhancement of Information Literacy and Digital Skills

Enhancement of Literacy and Information Skills: Interaction with generative AI improves students' reading comprehension, academic performance, and digital discernment skills (Almahasees et al., 2024). It also fosters AI literacy, media literacy, critical thinking, and metacognitive skills (McLeod & Richardson, 2023; Xu et al., 2024). AI literacy encompasses awareness, usage, evaluation, and ethics (Celik, 2023). Generative AI enhances students' ability to identify valuable information, strengthens ethical awareness, and supports independent judgment in AI-assisted learning, helping them detect and exclude disinformation to achieve academic goals (Knoth et al., 2024; Lee & Park, 2024; McLeod & Richardson, 2023).

AI as a Learning Aid: Generative AI lowers barriers to information retrieval and improves access to quality information (Lee & Park, 2024). Studies show it enhances learning outcomes, academic confidence, information processing, and comprehension by providing real-time support and learning assistance (Essien et al., 2024; Hu et al., 2024; Rahman & Watanobe, 2023).

3.2.5 Fostering Creativity, Autonomy, and Metacognitive Skills

Creativity and Innovation: Generative AI significantly enhances students' creativity and innovation by fostering effective communication and collaboration (Lee & Park, 2024; Qawqzeh, 2024). For example, students use ChatGPT to describe images and create scenarios, stimulating imagination and overcoming creative barriers to produce unique works (Borkovska et al., 2024; Chaudhuri & Terrones, 2024; Essel et al., 2024; Houston & Corrado, 2023; James & Hampton Filgo, 2023).

Feedback, Reflection, and Self-regulation: Generative AI feedback promotes self-reflection and regulation, deepening students' understanding of learning tasks (Archila et al., 2024). Timely feedback motivates continuous reflection and revisions, improving metacognitive skills and academic performance (Houston & Corrado, 2023). This is effective in improving metacognitive skills, academic performance and future decision-making (Karakose & Tülübaş, 2023). Students can evaluate learning plans, track performance, and develop strategies through recorded reflections (Kong et al., 2024; Tzirides et al., 2024).

Autonomy and Control: Proper use of generative AI does not reduce students' control over the learning process, but rather enhances their ability to learn autonomously. Students retain autonomous control over the decision-making process when interacting with generative AI, which is in line with the principle that humans should always retain decision-making power (Kajiwara & Kawabata, 2024). For example, ChatGPT provides ideas and suggestions, while students retain control over their work (Kong et al., 2024; Rahman & Watanobe, 2023). This autonomy also boosts classroom participation and self-directed learning (Li et al., 2024).

Non-cognitive and Metacognitive Skills: Generative AI develops non-cognitive skills such as motivation and perseverance, while fostering metacognitive abilities like self-efficacy, self-regulation and decision-making (Michalon & Camacho-Zuñiga, 2023). It strengthens communication, critical thinking, and interdisciplinary skills, deepening students' understanding of learning, memory, and reasoning (Hu et al., 2024; Xu et al., 2024).

3.3 RQ3: What changes has the introduction of generative AI brought to the design and teaching methods of information literacy courses?

The application of generative AI has promoted profound changes in the design of information literacy courses and teaching methods. The topic coding table "Table 4" shows the changes brought about by generative AI in terms of personalized teaching, assessment mechanisms, the transformation of the teacher's role, and education on academic integrity.

Table 4 Themes and Coding Table of RQ3

Category	Code	References Number	Reference Points Number
Changes in teaching content and updates to course design with the introduction of generative AI	Changes in Instructional Design	24	19
	Changes in information literacy	11	10

Category	Code	References Number	Reference Points Number
	teaching		
	Teaching on prompt engineering	11	6
Innovation of generative AI-driven teaching methods and assessment mechanisms	Innovation of teaching methods	20	18
	Changes in assessment and feedback	23	18
	Critical Thinking and Problem-Solving Development	8	8
Teacher's Role Transformation and Professional Development	Changes in the role of teachers	11	11
	Teacher Professional Development and AI Technology Integration	9	6
Ethical Considerations, Policy Development, and Academic Integrity	Ethical Use and Policy Development	11	11
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3.3.1 Changes in teaching content and updates to course design with the introduction of generative AI

Changes in Instructional Design: Generative AI fosters innovation in course design by promoting in-depth student-AI interaction and integrating ethical frameworks to enhance students' judgment skills (Kajiwara & Kawabata, 2024). It supports interdisciplinary, problem-oriented learning, equipping students to tackle complex issues while broadening their perspectives (Dianova & Schultz, 2023; Knoth et al., 2024; Naamati-Schneider & Alt, 2024). AI-driven tasks transform traditional learning models, enhance adaptability to AI tools, and develop soft skills critical for workplace competitiveness (Borkovska et al., 2024; Noroozi et al., 2024; Oddone et al., 2024; Pretorius, 2023; Ward et al., 2024). Furthermore, the integration of generative AI in curricula has heightened the focus on ethics and responsibility, helping students understand AI's societal impact (Bearman et al., 2024; Carroll & Borycz, 2024; Kong et al., 2024).

Changes in information literacy teaching: Generative AI necessitates integrating AI literacy into information literacy education (Archila et al., 2024). Educators must develop strategies to introduce generative AI, helping students master its tools, responsibly apply them, and recognize their limitations to improve AI literacy and future competitiveness (Chaudhuri & Terrones, 2024; Ciampa et al., 2023; Dianova & Schultz, 2023; Pretorius, 2023). Additionally, information literacy education should cultivate metacognitive skills and teach students how to effectively interact with AI, breaking traditional thinking patterns (Exintaris et al., 2023; Michalon & Camacho-Zuñiga, 2023).

Teaching on prompt engineering: Prompt engineering combines creativity, strategic thinking, and an understanding of generative AI (Bozkurt, 2024; Lo, 2023). Educators should emphasize teaching this skill to enable students to craft concise, adaptive prompts that balance creativity and accuracy, improving AI interaction and content quality (Knoth et al., 2024; Lo, 2023; Michalon & Camacho-Zuñiga, 2023). Frameworks like CRISPE (covering role setting, insights, statements, personalization, and experiments) guide students in generating effective prompts and leveraging AI tools strategically (McLeod & Richardson, 2023; Wang et al., 2024).

3.3.2 Innovation of generative AI-driven teaching methods and assessment mechanisms

Innovation of teaching methods: Teachers leverage diverse methods, such as the CLEAR principle and virtual role-playing, to highlight AI model limitations and guide topic exploration (Lo, 2023). These approaches enhance interaction, boost engagement, and reduce learning challenges (Carroll & Borycz, 2024; Essel et al., 2024; James & Hampton Filgo, 2023; Li et al., 2024). Generative AI enables iterative output optimization and dynamic teaching adjustments, fostering self-directed learning and significantly improving efficiency and self-efficacy (Borkovska et al., 2024; Cain, 2024; Karakose & Tülübaş, 2023; Pretorius, 2023; Rasul et al., 2024).

Changes in assessment and feedback: Generative AI supports targeted feedback, timely identification of learning difficulties, and improved assessment accuracy, helping teachers adjust instruction based on evidence (Javaid et al., 2023; Kong et al., 2024; McLeod & Richardson, 2023; Pozdniakov et al., 2024). It also facilitates adaptive assessment tools for personalized learning and motivates students through redesigned evaluation methods based on Bloom's Taxonomy (Michel-Villarreal et al., 2023; Rasul et al., 2024; Tzirides et al., 2024; Wang et al., 2024).

Critical Thinking and Problem-Solving Development: Teachers need to guide students to use critical thinking to evaluate the evidence given by AI generation (Archila et al., 2024; Naamati-Schneider & Alt, 2024). Librarians use generative AI to design interactive information literacy courses that deepen engagement and optimize research processes, fostering critical thinking (Lo, 2023; Zou et al., 2024). Generative AI can be used in the course to connect different disciplines that can promote student to understand and resolve problems from multiple perspectives, and prepare students to face a rapidly updated knowledge environment (Dianova & Schultz, 2023; Exintaris et al., 2023; Farhi et al., 2023).

3.3.3 Teacher's Role Transformation and Professional Development

Changes in the role of teachers: The role of the teacher is changing from knowledge transmitter to learning facilitator (Karakose & Tülübaş, 2023). Teachers are required to serve as a guide to help students think critically and integrate digital information. (Ciampa et al., 2023; Xu et al., 2024; Zou et al., 2024). They must master prompt engineering and feedback management to evaluate and refine AI-generated content, and to optimize its use in teaching (Bearman et al., 2024; Knoth et al., 2024; Pozdniakov et al., 2024). Additionally, teachers and librarians play a crucial role in ensuring equitable access to AI tools for all students (Pretorius, 2023).

Teacher Professional Development and AI Technology Integration: Generative AI opens new opportunities for professional growth, driving pedagogical innovation and structural changes in higher education (Ward et al., 2024). Teachers and librarians are central to reforming information literacy education, assessment, and curriculum design, preparing students for a technology-driven future (Lo, 2023; Noroozi et al., 2024). Systematic training is essential to ensure responsible AI use and adherence to professional standards, enabling educators to address challenges and lead AI integration effectively (Dianova & Schultz, 2023; Oddone et al., 2024).

3.3.4 Ethical Considerations, Policy Development, and Academic Integrity

Ethical Use and Policy Development: The ethical use of generative AI in education demands robust policy development and institutional safeguards to address the risks of stereotypes and cultural biases embedded in training data (Kajiwara & Kawabata, 2024). Institutions and educators should establish clear policies to regulate AI usage, protect academic originality, and deter misconduct (Houston & Corrado, 2023; Zhao et al., 2024). Encouraging teacher-led initiatives can foster critical thinking and creativity among students while promoting ethical AI practices (Farhi et al., 2023; Ward et al., 2024).

Academic Integrity and Plagiarism Prevention: Generative AI poses new challenges to academic integrity, as traditional plagiarism detection methods are insufficient (Kong et al., 2024). Institutions must revise anti-plagiarism policies, clarify what constitutes AI-related plagiarism, and incorporate ethical AI guidelines into information literacy curricula to promote responsible AI use and content verification (Chaudhuri & Terrones, 2024; Li et al., 2024).

Institutional and Faculty Responsibilities: The responsibility for ethical AI integration falls on both institutions and faculty members. Institutions should offer clear ethical guidelines and educate students on responsible AI application while maintaining adherence to academic standards (Oddone et al., 2024; Sağın et al., 2024; Ward et al., 2024). Faculty members play a key role in guiding students to critically evaluate AI tools and navigate their ethical limitations (Ciampa et al., 2023). At a broader level, policymakers should implement standardized frameworks that balance responsible AI use with opportunities for innovation (Farhi et al., 2023; Pozdniakov et al., 2024; Sun & Hoelscher, 2023).

IV. Discussion

The rapid advancement of generative AI technologies, including large language models like ChatGPT, has significantly reshaped higher education, particularly in the realm of information literacy education. These tools are transforming how students access and process information, while also influencing teaching strategies and curriculum design. This study investigates the integration of generative AI in university-level information literacy education, focusing on its effects on teaching methodologies, curriculum structure, and the enhancement of students' information literacy competencies.

4.1 Key findings

Generative AI demonstrates substantial potential in fostering student autonomy and enabling personalized learning pathways. It enhances learning efficiency and self-efficacy by providing real-time feedback and tailored instructional support (Almahasees et al., 2024; Zimmerman, 2000). Generative AI also helps students deepen their knowledge construction in academic writing and research through interactive tools (Deschenes & McMahon, 2024). Based on connectionist learning theory, Generative AI serves as a node of information and knowledge, helping students connect knowledge from different disciplines and achieve cross-disciplinary understanding and application (Siemens, 2005). This cross-disciplinary approach equips learners with the ability to tackle complex challenges more effectively, nurturing their innovative problem-solving skills (Borkovska et al., 2024). In addition, generative AI enhances learning motivation and effectiveness by creating diverse multimedia resources and personalized teaching (Essien et al., 2024; Hu et al., 2024).

Generative AI has a dual impact on students' development of information literacy skills. On the positive side, it strengthens critical thinking abilities and enhances students' proficiency in information retrieval and evaluation (Carroll & Borycz, 2024). On the negative side, overreliance on AI may lead to a decline in students' information evaluation skills, weaken critical thinking, and may mislead students due to AI's incorrect output (Farhi et al., 2023). To address these challenges, educators need to emphasize the importance of basic professional knowledge and systematic learning through appropriate guidance and curriculum design, cultivate students' metacognitive abilities, and ensure that they have the necessary knowledge accumulation to lay a solid foundation for information evaluation and critical thinking (Archila et al., 2024; Bearman et al., 2024).

The adoption of generative AI is also driving innovations in curriculum design and reshaping teaching methodologies, creating opportunities for more dynamic and adaptive learning environments. In terms of course design, generative AI brings prompt engineering teaching and computational thinking training. By learning prompt engineering, students can strengthen their computational thinking skills, which helps them to more flexibly apply theories to solve various problems and effectively interact with AI, thereby cultivating creativity (Bozkurt, 2024; Knoth et al., 2024; Wing, 2006). Educators therefore need to incorporate computational thinking training into their teaching, combining subject knowledge to guide students in designing effective prompts, repeated comparisons and iterative optimization (Lo, 2023; Michalon & Camacho-Zuñiga, 2023). In addition, teachers transform from knowledge transmitters to learning facilitators, working collaboratively with AI (Karakose & Tülübaş, 2023). At the same time, the limitations of traditional assessment methods require educators to innovate assessment methods to ensure that assessments accurately reflect the development of students' abilities.

At the policy and ethical levels, schools and policymakers should prioritize evidence-based decision-making, develop clear guidelines to ensure academic integrity and ethical compliance through robust evidence of effective and responsible use generated from educational practice, and avoid students becoming overly reliant on AI to the detriment of critical thinking (Chaudhuri & Terrones, 2024). To avoid inequities created by technology, equitable access to generative AI technology for all students needs to be ensured, and support provided to students with less access to technology (Pretorius, 2023). Furthermore, the limitations and potential biases of generative AI require educators and students to be equipped with the ability to critically evaluate AI content and adhere to academic ethics to avoid inappropriate use (Kajiwara & Kawabata, 2024).

Finally, generative AI raises challenges to traditional academic integrity and assessment methods, requiring educators to re-examine the purpose of assessment, emphasize original thinking and the learning process, and ensure the comprehensive development of students (Noroozi et al., 2024).

4.2 Research limitations

This study is based on a literature review, and there is insufficient support from empirical data. In the future, empirical studies should be conducted to collect the actual experiences of students and teachers to verify the effectiveness of generative AI. In addition, the research has limitations in terms of geographical and cultural contexts. The impact of generative AI in different education systems may be different, and cross-cultural comparisons can be conducted in the future. More theoretical and practical explorations are also needed on the impact of generative AI on computational thinking and prompt engineering capabilities, especially how to integrate these capabilities into teaching design.

4.3 Future research directions

1. Long-term impact assessment: Explore the long-term impact of generative AI on students' learning, critical thinking and information literacy skills, and support the continued use of AI in higher education through longitudinal studies.
2. Interdisciplinary application: Compare the effectiveness of generative AI in different disciplines, explore its potential for interdisciplinary education, and promote knowledge integration and innovation skills.
3. Hint engineering for teaching optimization: Systematically teach AI interaction and hint writing skills to improve students' creativity and efficiency when interacting with AI.
4. Ethical framework construction: Construct an ethical framework for generative AI to cultivate students' ethical awareness and sense of responsibility, ensure compliance with academic ethics, and prevent improper use.
5. Assessment tool development: Develop assessment tools to monitor cognitive activities in AI-assisted learning, avoid over-reliance on AI, and ensure the centrality of critical thinking and problem solving.
6. Transformation of the educator's role: Research how educators can transform into facilitators, work with AI, and enhance students' intellectual and emotional development in conjunction with a people-oriented teaching philosophy.
7. Technological equity and accessibility: Ensure the fairness of generative AI applications, avoid the digital divide, focus on technological support for disadvantaged groups, and ensure that all students benefit equally.

Exploring these directions can improve the application strategy of generative AI in higher education, maximize its potential, and address related challenges and risks.

V. Conclusion

This study explores in depth the application of generative AI in university information literacy education, its impact on the development of students' information literacy skills, and the changes it brings to course design and teaching methods. The results show that generative AI has significant advantages in supporting self-directed learning, personalized learning, academic research and writing; it also enriches learning resources, provides timely feedback, innovates assessment methods, and promotes the development of interdisciplinary learning and innovation capabilities.

However, its use also presents challenges. Over-reliance on AI tools can undermine critical thinking, information assessment abilities, and core knowledge foundations. Ethical concerns, including privacy risks, algorithmic bias, and unequal access to AI resources, remain pressing issues.

Educators must transition from knowledge transmitters to learning facilitators, guiding students in developing AI literacy, prompt engineering, and computational thinking skills. Effective curriculum design should emphasize practical applications of AI tools while nurturing students' intellectual and emotional growth.

On a policy level, institutions need clear regulations to ensure academic integrity and ethical AI use. Policymakers must prioritize equitable access to AI technologies and address potential digital divides. Future research should focus on long-term impacts, subject-specific effectiveness, and interdisciplinary teaching strategies to optimize AI integration in education.

In conclusion, generative AI offers transformative potential for university education, but its implementation requires careful planning and ethical oversight. With thoughtful curriculum design, innovative teaching approaches, and robust policy frameworks, AI can be harnessed to cultivate critical thinking, creativity, and moral responsibility in students. Ultimately, education must remain human-centered, ensuring technology enhances learning experiences, supports personal growth, and aligns with the evolving needs of society.

Author Contributions

He Li was responsible for the conceptualization of the study, data collection and analysis, paper writing and revision. Elvira S. Balinas was responsible for the supervision of the study, methodological guidance, paper revision guidance and review.

Declarations

Ethical Approval: This review study does not involve human participants. All referenced articles utilized in this review are appropriately cited in the manuscript's reference section.

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