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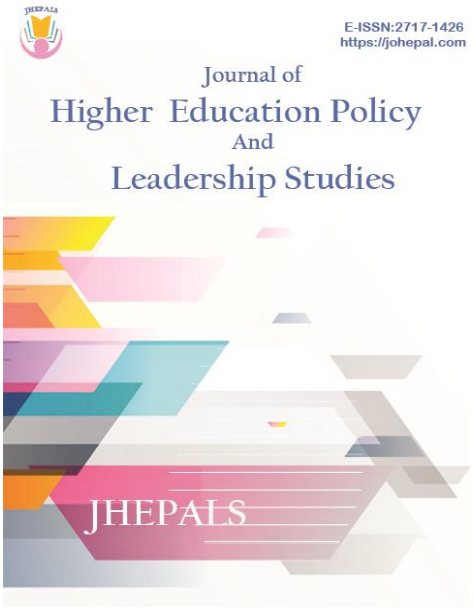
Teaching AI Literacy in Higher Education: A Systematic Review and Pedagogical Analysis Using the 4Ps Framework



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Guiding Principles for Academic Leadership: Clichés, Proverbs, and Sayings Applicable to Academic Leadership

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Abstract

As artificial intelligence (AI) becomes increasingly integrated into everyday life and professional domains, higher education institutions face a growing imperative to cultivate AI literacy among students. This systematic review synthesizes findings from 25 peer-reviewed empirical studies published between 2019 and 2025, focusing on instructional methods and challenges related to teaching AI literacy in higher education. Guided by a custom-developed 4P Framework—Pedagogical Approaches, Purpose of Instruction, Participant Profiles, and Platforms & Tools—the review identifies dominant trends such as the widespread use of project-based learning, the central role of ChatGPT and other generative AI tools, and a pedagogical shift toward ethical reflection and interdisciplinary integration. Findings reveal a dynamic but fragmented landscape where technical training is increasingly supplemented with critical evaluation, ethical reasoning, and socio-cultural awareness. However, gaps remain in global representation, policy engagement, and platform diversity. This study provides a foundational map for educators, curriculum designers, and policymakers seeking to design inclusive, reflective, and future-ready AI literacy programs in higher education.

Keywords: AI Literacy; Higher Education; Pedagogical Approaches; Generative AI Tools; Curriculum Design; Systematic Review

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Introduction

In recent years, artificial intelligence (AI) has rapidly transformed the social, economic, and technological landscapes, becoming an integral part of daily life and professional domains (De Freitas & Weingart, 2021; Kong et al., 2022a). As AI technologies continue to evolve and exert increasing influence across sectors, there is a growing recognition of the need to cultivate AI literacy—the foundational knowledge, cognitive skills, and ethical awareness required to understand, use, and critically evaluate AI systems (Long & Magerko, 2020; Ng et al., 2023). Higher education institutions have responded to this imperative by embedding elements of AI literacy into a wide range of programs, aiming to prepare students not only as consumers of intelligent technologies but also as reflective and responsible participants in AI-driven societies (Kong et al., 2021).

Despite growing interest in this area, the domain of AI literacy education remains conceptually and pedagogically fragmented. The approaches to curriculum design, instructional delivery, and assessment of AI literacy vary widely, with some programs rooted in traditional computer science education, while others adopt interdisciplinary, ethics-oriented, or application-focused models (Hornberger et al., 2023; Kong et al., 2022a). Moreover, faculty members and institutions often encounter substantial challenges in implementing effective AI literacy instruction. These include the absence of universally accepted definitions of AI literacy (Ng et al., 2023), insufficient professional development opportunities for instructors (Zawacki-Richter et al., 2019), inadequate access to age-appropriate teaching tools, and limited guidance for integrating AI content across non-technical disciplines.

While a small number of recent studies have attempted to map the broader landscape of AI education, comprehensive reviews with a focused lens on AI literacy in higher education remain scarce. For instance, Ng et al. (2023) provided a thematic overview of AI teaching and learning from 2000 to 2020, yet their scope primarily encompassed general AI instruction across all educational levels. There is, therefore, a significant gap in the literature concerning how AI literacy is specifically conceptualized, taught, and assessed within post-secondary institutions. This absence of a systematic synthesis presents an obstacle to the advancement of evidence-informed curriculum development and institutional policymaking.

The present study seeks to address this gap by conducting a systematic review of peer-reviewed academic literature with the aim of identifying the main instructional methods employed in teaching AI literacy in higher education and examining the recurring challenges reported in the literature. By analyzing the educational strategies, technological tools, and conceptual frameworks used across various institutions, this review not only consolidates current knowledge but also broadens our understanding of the diversity of approaches in this emerging field. It offers valuable insights for educators, curriculum designers, and policymakers seeking to craft more coherent, inclusive, and pedagogically effective AI literacy initiatives. In doing so, the study provides a foundation for designing better-informed and context-sensitive educational practices that align with the evolving demands of the AI era.

The central research question guiding this review is: What are the main methods and challenges of teaching AI literacy in higher education? By synthesizing empirical and

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theoretical contributions from diverse disciplinary perspectives, this review contributes to the growing conversation around equipping students with the competencies necessary to thrive in an AI-mediated world.

State of the Art: AI Literacy Education in Higher Education

The integration of artificial intelligence (AI) into higher education has accelerated significantly in the past five years, driven by the growing influence of AI in professional, societal, and personal contexts. In parallel, the concept of AI literacy has emerged as a crucial educational objective, aiming to equip students with the ability to understand AI technologies, critically evaluate their implications, and apply them ethically in diverse fields (Long & Magerko, 2020; Ng et al., 2023). As AI shifts from specialized domains into everyday applications, higher education institutions have begun reassessing their roles in preparing students not only as technical users of AI systems but also as ethically, technically and professionally aware citizens in AI-mediated societies (Haroud & Saqri, 2025; Zawacki-Richter et al., 2019).

Early discussions around AI literacy focused primarily on K12 contexts and basic digital fluency (Eaton et al., 2018). However, recent efforts have extended this focus to tertiary education, with scholars emphasizing the necessity for discipline-specific, critical, and cross-functional approaches to teaching AI concepts (Chan, 2023; Kong et al., 2021). AI literacy in higher education is now increasingly defined as a multidimensional construct that includes technical proficiency, algorithmic thinking, data awareness, socio-ethical reflection, and the ability to communicate AI-related insights across disciplines (Ocen et al., 2025).

Studies such as those by Ng et al. (2023) and Zawacki-Richter et al. (2019) reveal that instructional strategies in AI education are still evolving. While computer science departments often take the lead in offering AI-related content, interdisciplinary programs and non-STEM fields are also beginning to incorporate AI literacy components. Some universities have implemented project-based and inquiry-driven approaches, using real-world problems to foster critical engagement with AI tools (Dahlström & Norberg, 2025). Other efforts emphasize library-led initiatives to democratize access to AI literacy resources and provide workshops for students and faculty across all disciplines (Alabool, 2023; Khlaif et al., 2025).

Despite these efforts, the pedagogical infrastructure for AI literacy remains underdeveloped. Key barriers include faculty's limited expertise in AI, lack of standard curricular frameworks, and the need for updated institutional policies that support inclusive and adaptive learning models (Duvall et al., 2025). There are also challenges around aligning AI education with ethical and legal standards, especially concerning data privacy, algorithmic bias, and academic integrity (Chen et al., 2020; Hornberger et al., 2023).

Notably, recent literature highlights the value of integrating AI literacy within digital and academic literacy programs. For instance, Lin and Chen (2024) explore how AI tools can enhance student learning but also require thoughtful pedagogical design to avoid cognitive overload or ethical oversights (Lin & Chen, 2024). Similarly, initiatives in South Africa (Ocen et al., 2025) and Asia (Moorhouse et al., 2024) illustrate culturally adapted strategies that blend AI awareness with multilingual and multicultural education, suggesting a move toward globally sensitive frameworks for AI literacy.

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Consequently, the state of AI literacy education in higher education is dynamic but fragmented. Institutions are actively experimenting with models that span from discipline-integrated instruction to co-curricular programming and infrastructure development. However, systematic knowledge about the most effective instructional methods and the most pressing implementation challenges remains limited. This gap underscores the need for a comprehensive synthesis of current practices and problems—a need this systematic review directly addresses.

Research Methodology

This study employs a systematic literature review to identify, evaluate, and synthesize empirical research on methods and challenges related to teaching artificial intelligence (AI) literacy in higher education. The review process was conducted in accordance with the PRISMA 2020 checklist (Page et al., 2021), ensuring methodological transparency, reproducibility, and scientific rigor.

Data Sources and Search Strategy

To ensure a comprehensive and high-quality evidence base, two of the most authoritative academic databases—Web of Science (WoS) and Scopus—were selected for the literature search. These platforms are widely regarded for their reliability in indexing peer-reviewed scholarly works and for providing robust citation metrics that indicate research impact and quality.

The search was conducted across titles, abstracts, and keywords using English-language filters. *To enhance relevance, the search was limited to the years 2019 to 2025†, and further constrained to documents in English. In Web of Science, the search was restricted to the Research Area of Education and Educational Research, whereas in Scopus, where education is not explicitly categorized, the scope was limited to the broader domain of Social Sciences.

Initial Retrieval and Screening

The initial search across both databases yielded 1,137 articles. These records were exported in RIS format and imported into the Mendeley Reference Manager. Mendeley's deduplication tool was used to identify and eliminate 35 duplicate records, resulting in 1,102 unique articles. In this article, artificial intelligence was used as one of the evaluators for category extraction, coding, and linguistic editing.

Each article's abstract was then carefully screened according to a set of inclusion and exclusion criteria, designed to ensure the review's focus and quality. Following this screening, a total of 25 studies met all eligibility criteria for full-text analysis. To reduce bias and maintain consistency, the following inclusion and exclusion criteria were applied as shown in table 1.

* Search strategy: ("artificial intelligence") and ("higher education" or universit* or "post secondary" or "tertiary education" or academ* or college*) and (teach* or educat* or curricul* or instruct* or learn* or train* or course* or develop* or pedagog* or class*) and (competenc* or skill* or literacy)

† After 2019, Education has undergone many changes due to the coronavirus pandemic.

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Table 1.
Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Peer-reviewed journal articles published in Web of Science or Scopus	Conference papers, reviews, editorials, and other non-article scientific documents
Empirical, practical, and evidence-based research studies	Review papers or purely theoretical discussions
Studies involving students in higher education (undergraduate/postgraduate)	Studies related to organizational, corporate, K–12, or public/faculty training education
Articles that explicitly describe a course, program, or instructional method aimed at enhancing AI literacy	Articles that do not clearly describe any instructional intervention related to AI literacy development
After 2019	Before 2019

All 25 selected articles were subjected to a detailed evaluation using the PRISMA 2020 checklist. Each article was scored based on relevance, empirical robustness, and clarity of educational focus. As a result of this evaluation process, all 25 articles were selected for thematic coding and synthesis.

Data Extraction and Coding

Key information was extracted from each article, including the study's aims, instructional strategies, content areas, technological tools, educational contexts, and reported outcomes. The extracted data were analyzed using a qualitative thematic coding approach to identify recurring instructional models, pedagogical challenges, and implementation gaps. A visual overview of the search, screening, and selection process (Figure 1) is presented in the PRISMA flow diagram (Haddaway et al., 2022).

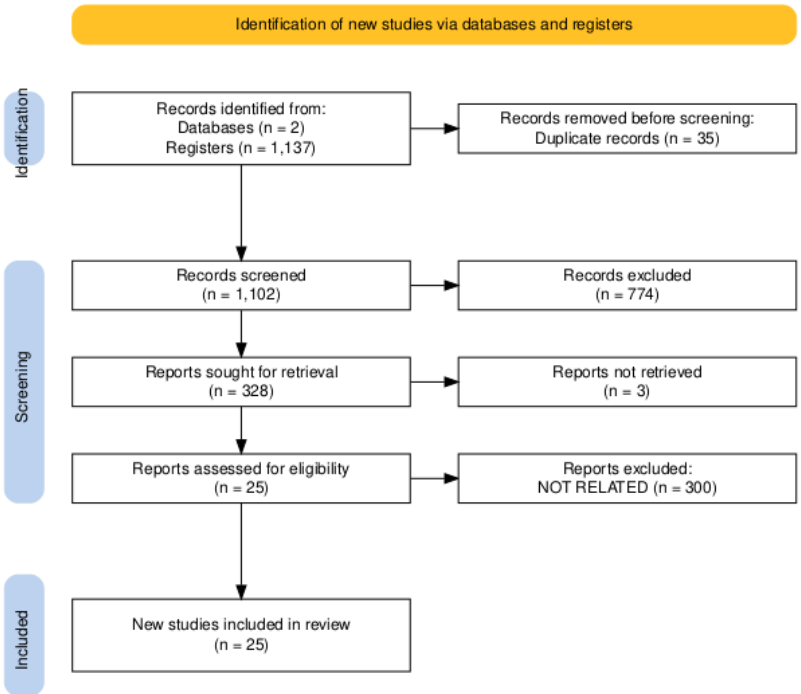

Figure 1. PRISMA Selection process

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Results and Discussion

The findings of this systematic review provide compelling evidence that AI literacy instruction in higher education is rapidly evolving in both scope and pedagogical design. Rather than being confined to technical training or computational skill-building, AI literacy is increasingly conceptualized as a multidimensional competency encompassing critical evaluation, ethical awareness, and human–AI collaboration. The application of the 4P Framework—Pedagogical Approaches, Purpose of Instruction, Participant Profiles, and Platforms and Tools—enabled a structured synthesis of diverse educational interventions. This framework revealed not only dominant trends, such as the widespread use of project-based learning and ChatGPT, but also important gaps in areas like policy engagement, multimodal methods, and equitable global access. These findings underscore a shifting paradigm: AI literacy is no longer merely a functional requirement but is emerging as a foundational element of responsible, reflective, and future-ready higher education. In the following sections, we describe each Ps of our conceptual model in a independent section.

Pedagogical Approaches: Constructivist Foundations with Emerging Innovations

The landscape of AI literacy instruction in higher education is predominantly shaped by constructivist principles, with a notable emphasis on active learning and student-centered methodologies. Among the most frequently used pedagogical models is Project-Based Learning (PBL), which appears in a significant number of studies (Abichandani et al., 2023; Kong et al., 2022b; Modran et al., 2024). These interventions engage students in solving real-world problems using AI tools, often culminating in the creation of functional applications or systems. This approach not only facilitates technical skill acquisition but also fosters collaboration, creativity, and critical thinking, making it particularly well-suited for AI contexts that demand interdisciplinary competence.

Several studies further integrate flipped classroom models, where students first engage with instructional content independently (often via online readings or videos) and then apply their knowledge during in-class sessions. For instance, Kong et al. (2021, 2022b) implemented flipped models across AI literacy modules to promote learner autonomy and flexible pacing (Kong et al., 2021; Kong et al., 2022b). The integration of PBL within these flipped frameworks provides a dual-layered instructional model: students build foundational understanding asynchronously and then participate in synchronous, application-driven problem solving.

Innovative extensions to these conventional approaches are becoming increasingly visible. Tzirides et al. (2024) introduced a cyber-social pedagogy, blending AI feedback tools with collaborative peer activities, thereby facilitating a co-creative learning environment where human and machine intelligence interact (Tzirides et al., 2024). Similarly, Garg et al. (2025) explored structured prompt engineering training, teaching students how to generate effective AI prompts using techniques such as few-shot prompting and the CLEAR framework (Garg et al., 2025). This pedagogical focus on meta-AI skills—knowing not just how to use AI, but how to communicate with it—marks a significant advancement in curriculum design.

Equally progressive are participatory and ethically oriented pedagogies. Bilikozen (2024) encouraged students to co-develop classroom policies for ethical AI use, thereby promoting critical agency and ownership over AI-related decisions (Bilikozen, 2024).

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Holzmann et al. (2025) employed a fact-checking model that tasked students with verifying the reliability of AI-generated outputs against primary research literature (Holzmann et al., 2025). These approaches foster a deeper engagement with the sociotechnical implications of AI, pushing learners beyond surface-level interaction.

However, it is worth noting that gamification and embodied AI learning remain underexplored. Only Yusuf (2024) integrated game-like progression mechanics into scaffolded critical thinking instruction(Yusuf et al., 2024). Likewise, arts-based methods such as multimodal storytelling and image generation were only featured in a handful of studies (Jiang, 2025; Wünsch-Nagy, 2025). This signals an opportunity for future instructional design to expand the affective, creative, and somatic dimensions of AI learning experiences. The summary of pedagogical approaches is illustrated in table 2.

Table 2.
Summary of Pedagogical Approaches

Pedagogical Approach	Example Studies	Notable Features
Project-Based Learning (PBL)	Abichandani (2023), Kong et al. (2022a&b), Modran et al. (2024)	Real-world application, collaborative experimentation
Flipped Classroom	Kong et al. (2021, 2022a&b)	Pre-class content delivery, in-class applied practice
Prompt Engineering Training	Garg et al. (2025)	Few-shot prompting, CLEAR framework, coding assistance
Cyber-social / Multimodal	Tzirides et al. (2024), Wünsch-Nagy (2025)	Human-AI co-creation, digital compositions, peer dialogue
Self-Regulated / Reflective	Ou et al. (2024), Holzmann (2025)	Portfolios, learning journals, ethical deliberation
Participatory / Ethics Pedagogy	Bilikozen (2024), Ngo & Hastie (2025)	Co-construction of AI policy, classroom-based ethical discussion
Gamified / Scaffolded Learning	Yusuf et al. (2024), Tseng et al. (2025)	Tiered challenges, mastery learning, collaborative play

Purpose of Instruction: From Tool Use to Ethical Empowerment

The instructional goals articulated in the literature reflect a clear evolution in AI education—from an initial focus on functional proficiency to a broader emphasis on critical, ethical, and interdisciplinary competencies. Earlier programs often centered on technical comprehension, including foundational knowledge of artificial intelligence concepts, such as machine learning algorithms, neural networks, and data processing frameworks. These were typically taught in STEM contexts to enhance students' confidence and fluency with AI tools (Abichandani et al., 2023; Chen & Zhang, 2024; Kong et al., 2025).

As the field matures, however, newer programs increasingly target more complex outcomes. Many studies integrate critical thinking, ethical reasoning, and bias awareness into their curricula. For example, Holzmann et al. (2025) tasked students with using ChatGPT to generate scientific content and then verify that information against peer-reviewed research, fostering both source validation skills and a healthy skepticism toward AI-generated output (Holzmann et al., 2025). Similarly, Ngo and Hastie (2025) embedded AI literacy into an English for Academic Purposes (EAP) module, helping international students

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learn prompt engineering, tool comparison, and ethical communication practices (Ngo & Hastie, 2025).

Other programs extend beyond critique toward empowerment and agency. Ou et al. (2024) developed the concept of "Critical GAI Literacy," which emphasizes not only responsible use but also self-directed learning, reflection, and creative engagement(Ou et al., 2024). Tzirides (2024) and George-Reyes et al. (2024) encouraged learners to co-create academic or entrepreneurial content using generative AI tools, cultivating both expressive fluency and ethical awareness (George-Reyes et al., 2024; Tzirides et al., 2024).

Interdisciplinary integration is also gaining prominence. Alamäki et al. (2024) linked AI literacy to the Sustainable Development Goals (SDGs), encouraging students to conceptualize AI applications in climate action and resource management (Alamäki et al., 2024). Tseng et al. (2025) and Shimizu et al. (2023) incorporated AI into medical and nursing education, focusing on evidence-based practice, case reporting, and ethical AI usage in clinical environments (Shimizu et al., 2023; Tseng et al., 2025). Across all these examples, AI literacy is no longer confined to understanding AI; it now demands that learners develop a reflexive, critical, and socially grounded engagement with AI as a socio-technical force. In this regard, table 3 illustrates the summary of instructional purposes.

Table 3.
Summary of Instructional Purposes

Instructional Focus	Example Studies	Description
Technical Understanding	Abichandani (2023), Chen & Zhang (2024), Kong (2023)	Neural networks, data analysis, model training
Practical Tool Use	Tseng et al. (2025), Garg et al. (2025), Kurt et al. (2024)	Writing assistance, programming, AI-enhanced feedback
Critical Evaluation & Bias Awareness	Holzmann (2025), Yusuf et al. (2024), Ngo and Hastie (2025)	Bias detection, source validation, ethical AI interrogation
Ethical & Social Implications	Bilikozen (2024), Alamäki et al. (2024)	Plagiarism, fairness, sustainability, AI policy
AI-Human Collaboration / Prompt Literacy	Tzirides et al. (2024), Ou et al. (2024)	Human-AI interaction, prompt iteration, digital authorship
Innovation / Entrepreneurship	George-Reyes et al. (2024), Gupta & Jaiswal. (2024)	Narrative design, opportunity recognition, industry application
Sustainability / Governance	Alamäki et al. (2024), Gupta & Jaiswal (2024)	SDG integration, management of AI futures

Participant Profiles: Disciplinary Diversity, But Geographic and Cultural Gaps Remain

The reviewed studies demonstrate a considerable range in the types of students and academic contexts targeted by AI literacy programs. A large proportion of interventions were designed for undergraduate students, particularly those enrolled in STEM disciplines such as computer science, engineering, and data science. These programs (Abichandani et al., 2023; Chen & Zhang, 2024; Kong et al., 2025) often introduced foundational AI concepts, coding practices, or machine learning tools, reflecting the technical core of many AI curricula.

Beyond STEM, several programs engaged interdisciplinary learners by incorporating elements of AI literacy into business, sustainability, or liberal arts curricula. Alamäki et al. (2024), for instance, focused on business students' understanding of AI in the context of

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sustainability (Alamäki et al., 2024), while Gupta and Jaiswal (2024) examined management students' development of AI competencies tied to ethical leadership and problem-solving (Gupta & Jaiswal, 2024). These examples reflect a trend toward mainstreaming AI literacy across disciplines and professional tracks.

A particularly noteworthy cluster of studies focused on language learners, including L2 and English for Academic Purposes (EAP) students. In these cases (Bilikozen, 2024; Kurt & KURT, 2024; Ngo & Hastie, 2025), AI tools such as ChatGPT were integrated into academic writing instruction, prompting learners to engage critically with AI-generated feedback, practice paraphrasing, and explore ethical boundaries around text generation. These programs often emphasized not only language proficiency but also digital literacy and responsible AI use, recognizing that students may encounter AI tools in both academic and professional contexts.

Graduate and doctoral students were also the focus of a smaller subset of studies. Tzirides et al. (2024) designed a cyber-social model for graduate students in education, blending multimodal literacies with AI-assisted feedback mechanisms (Tzirides et al., 2024). Ou et al. (2024) implemented a self-regulated learning framework for PhD-level L2 learners, explicitly targeting critical GAI literacy and reflective authorship practices (Ou et al., 2024). These interventions highlight a growing recognition that AI literacy is essential not only for undergraduates but also for more advanced academic audiences navigating the complexities of academic writing, publication, and research ethics.

Despite the disciplinary diversity, geographic and cultural representation was limited across most studies. The majority of interventions were conducted in North America, East Asia, and Western Europe. Only a few studies—such as Yusuf et al. (2024) conducted in Nigeria, or Modran et al. (2024) in Romania—provided insight into AI literacy education outside of Global North contexts. Moreover, even in multicultural programs (e.g., Bilikozen 2024 in the UAE), cultural variability was not systematically analyzed (Bilikozen, 2024; Modran et al., 2024; Yusuf et al., 2024). Future research and curriculum design should give greater attention to the socioeconomic, infrastructural, and linguistic barriers faced by underrepresented learners in global AI ecosystems. For this section, tables 4 indicates the summary of participant profiles.

Table 4.
Summary of Participant Profiles

Learner Type	Example Studies	Notes
Undergraduate (STEM)	Kong (2022), Abichandani et al. (2023), Chen & Zhang (2024)	Emphasis on conceptual and technical AI skills
Interdisciplinary Learners	Alamäki et al. (2024), Gupta & Jaiswal (2024)	Integrated with business, ethics, and sustainability
L2 Writers / EAP Learners	Ngo & Hastie (2025), Kurt & Kurt (2024), Bilikozen (2024)	Focus on academic writing, feedback, and responsible AI use
Graduate / Doctoral Students	Ou et al. (2024), Tzirides et al. (2024), Hwang & Wu (2025)	Advanced literacy, research-oriented and multimodal contexts
Pre-service Teachers	Kurt & Kurt (2024)	AI-enhanced teaching preparation in language education
Healthcare Students	Tseng et al. (2025), Shimizu et al. (2023)	AI for clinical case reporting, ethical medical usage

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Learner Type	Example Studies	Notes
Non-Western or Global South	Yusuf et al. (2024), Modran et al. (2024)	Few studies analyzed regional challenges or culturally situated pedagogy

Platform & Tools: ChatGPT as a Core Medium, But Ecosystems Are Expanding

In terms of technological platforms, one of the most striking patterns across the reviewed literature is the ubiquity of ChatGPT. This tool, powered by OpenAI's large language model (LLM), was used in over two-thirds of the studies, making it the most consistently integrated AI platform in educational settings. ChatGPT served a range of functions, including academic writing support, feedback generation, paraphrasing assistance, code generation, and reflective critique. Studies like Kurt and Kurt (2024) and Ngo and Hastie (2025) embedded ChatGPT within structured writing activities; while others, such as Holzmann et al. (2025), utilized it as a point of critical inquiry, requiring students to validate or fact-check AI-generated outputs.

Despite its dominance, ChatGPT was not the only tool used. Several studies leveraged AI training and prototyping platforms such as Google Teachable Machine, Microsoft Azure Machine Learning Studio, and TensorFlow Lite. These were typically integrated into STEM-oriented programs focused on building practical AI models and engaging with supervised learning algorithms. For instance, Kong et al. (2022a&b) and Kong et al. (2023) used these platforms to guide students through the end-to-end process of dataset collection, model training, and ethical evaluation of outputs (Kong et al., 2023; Kong et al., 2022b).

The use of visual and generative design tools also appeared in studies that emphasized multimodal learning or visual literacy. Midjourney, DALL·E, Canva, and GenCraft were used in programs by Hwang and Wu (2025), Jiang (2025), and Wünsch-Nagy (2025) to help students create posters, analyze cross-cultural imagery, or reflect on the socio-aesthetic implications of AI-generated visuals. These interventions often encouraged creativity, critical reflection, and digital authorship, thus expanding the scope of AI literacy beyond functional or technical skillsets.

Interestingly, Ou et al. (2024) and Tseng et al. (2025) showed that productivity-oriented AI tools, such as Copilot, Elicit, and ResearchRabbit, are increasingly being integrated into academic research and knowledge organization. However, AI governance platforms, simulation tools for policy learning, and culturally contextualized tools remain largely absent in the reviewed corpus. Moreover, very few programs utilized institution-specific LMS integrations or regional AI tools tailored for non-English speakers.

This suggests that while the platform ecosystem is diversifying, much of the current AI education landscape is still dominated by Western-developed, English-language platforms. There is a clear need for the development of localized, multilingual, and open-access AI tools that better align with the global reach and ethical imperative of equitable AI literacy. Table 5 shows the summary of platforms and tools.

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Table 5.
Summary of Platforms and Tools

Tool / Platform Category	Example Tools / Studies	Use Case
Generative Text (LLMs)	ChatGPT, Perplexity, Copilot (Ngo & Hastie, 2025, Kurt & Kurt, 2024, Tseng et al., 2025)	Writing, grammar, feedback, ideation, prompting
AI Literacy / ML Training	Google Teachable Machine, Azure ML Studio, TensorFlow Lite (Modran et al. 2024)	Hands-on training, modeling, supervised learning
Visual GenAI / Design Tools	Midjourney, DALL·E, Canva, GenCraft (Hwang & Wu, 2025, Wünsch-Nagy, 2025)	Poster creation, cross-cultural analysis, digital design
Domain-Specific / Technical Tools	YOLOv5, PSoC 6, Keras, SensiML (Abichandani et al. 2023, Modran et al. 2024)	Neural networks, IoT integration, edge computing
Academic/Research Assistants	Elicit, ResearchRabbit, Obsidian (Ou et al. 2024, Gupta & Jaiswal, 2024)	Academic research, source mapping, reflection

Overall insights

Taken together, the findings from this review suggest that AI literacy in higher education is evolving into a multidimensional construct, one that requires students not only to understand and apply AI tools, but also to critically evaluate their outputs, reflect on their limitations, and consider the broader social, ethical, and cultural implications of their use. The 4P Framework—comprising Pedagogical Approach, Purpose of Instruction, Participant Profile, and Platform & Tools—proves highly effective in organizing and synthesizing this diversity of instructional practices and research trends.

Pedagogically, educators are increasingly adopting blended, reflective, and participatory learning models that go beyond traditional lectures to engage learners as co-creators of knowledge. In terms of instructional purpose, programs are expanding from narrow technical training toward empowerment-focused education, emphasizing ethics, sustainability, and interdisciplinary integration. The diversity of learners engaged is promising, though future work must address gaps in geographic, linguistic, and cultural inclusion. Finally, while the dominance of tools like ChatGPT reflects current usability and accessibility trends, a more equitable and globally inclusive tool ecosystem remains a crucial next step.

This synthesis not only provides a map of current efforts but also charts future directions for AI literacy that are critical, inclusive, and pedagogically robust. The Analytical Table of AI Literacy Teaching, based on the 25 selected studies and structured using your 4P Framework is shown in shape 6.

Table 6.
The Analytical Table of AI Literacy based on 4P framework

Category	Theme	Frequency	Interpretation
Pedagogical Approaches	Project-Based Learning	7	Highly effective for real-world AI problem-solving. Most frequently used method. Encourages creativity and collaboration.
Pedagogical Approaches	Flipped Classroom	4	Supports self-paced learning. Often combined with hands-on labs and workshops.
Pedagogical Approaches	Prompt Engineering & Ethics	5	Focuses on meta-AI literacy like crafting prompts and analyzing responses. Reflects maturity in AI understanding.

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Category	Theme	Frequency	Interpretation
Pedagogical Approaches	Gamified/Scaffolded Learning	2	Emerging trend. Promotes motivation and progression-based learning. Underutilized in AI literacy.
Purpose of Instruction	Critical Evaluation	6	Most emphasized competence. Includes bias detection, source validation, and evidence-based skepticism.
Purpose of Instruction	Ethics & Social Implications	5	Prominent across domains. Encourages students to reflect on fairness, privacy, and social consequences of AI.
Purpose of Instruction	Technical/Tool Use	9	Covers foundational AI knowledge, tool fluency (e.g., ChatGPT, Azure), and basic coding. Essential baseline literacy.
Participant Profiles	Undergraduate STEM	6	Core focus group. Most curricula assume some prior knowledge of technology.
Participant Profiles	L2 / EAP Students	3	Rising demographic. Curricula adapted to emphasize writing, ethics, and digital authorship with GenAI tools.
Participant Profiles	Graduate / Doctoral	3	Focused on reflective learning, prompt literacy, and research ethics. Tends to explore deeper metacognitive AI literacy.
Platforms & Tools	ChatGPT and LLMs	17	Most used platform. Accessible, flexible, and versatile across disciplines.
Platforms & Tools	Visual GenAI (DALLÂ·E, Midjourney)	4	Used in creative disciplines. Encourages multimodal literacy and critical reflection on image synthesis.
Platforms & Tools	ML Training Tools (Teachable Machine, Azure)	6	Employed for model building and supervised learning. Bridges theory with hands-on experience.

Regarding the Pedagogical Approaches, Project-Based Learning emerged as the most common instructional strategy, present in 7 of the studies. It was widely used to contextualize AI tools in real-world applications, making abstract concepts more tangible. Flipped classrooms, used in 4 studies, allowed students to build foundational knowledge independently before engaging in collaborative, hands-on activities. An innovative area gaining traction was prompt engineering & ethics, reflecting a more advanced understanding of how students engage with generative AI. However, gamified and scaffolded learning approaches were underutilized, suggesting room for expanding engagement-focused methods in AI literacy education.

About the Purpose of Instruction, AI literacy programs often pursued overlapping objectives. Technical/tool use (notably ChatGPT and ML tools) was the most frequent goal, reflecting the field's roots in digital skills training. However, a notable shift was seen toward critical evaluation and ethical awareness, particularly in domains like healthcare, language education, and interdisciplinary science. These competencies help learners navigate the uncertainties, biases, and implications of AI-generated content. Ethics-based literacy, especially relating to fairness, privacy, and misinformation, is fast becoming central to responsible AI education.

In Participant Profiles, Undergraduate STEM students remain the primary demographic, especially in engineering and data science programs. However, there's a notable rise in AI instruction for L2 writers and academic English learners, where AI is both a tool and a subject of critique. Graduate and doctoral students, though less represented, are involved in reflective AI use, research integration, and ethics. This suggests a growing interest in integrating AI literacy across educational levels and disciplines, albeit with an imbalance favoring technology-driven contexts.

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Finally in the scope of Platforms and Tools, Unsurprisingly, ChatGPT and similar LLMs dominate the landscape, being used in 17 of the studies. These tools are appreciated for their accessibility, wide applicability, and ability to demonstrate immediate AI feedback. Still, other tools—like DALL·E and Midjourney—introduce students to visual literacy and multimodal content analysis, especially in arts and design fields. Meanwhile, platforms like Google Teachable Machine and Azure offered more structured, programmable environments for machine learning practice, giving students insight into model training and deployment processes.

Insights into the Pedagogical Landscape of AI Literacy in Higher Education

The findings of this systematic review reveal that AI literacy education in higher education is undergoing a marked transformation. A predominant trend among the selected studies is the widespread adoption of project-based and reflective learning methodologies. Project-Based Learning (PBL) emerged as the most frequently utilized approach, serving as a powerful means of contextualizing AI concepts through real-world applications. This method fosters student engagement, collaboration, and critical thinking, enabling learners to transition from passive recipients of knowledge to active co-creators. Additionally, reflective and self-regulated learning practices were prevalent in several programs, emphasizing metacognitive engagement and ethical reasoning alongside technical proficiency.

A notable pedagogical shift is also apparent in the evolving purposes of instruction. While foundational AI instruction traditionally focused on technical skills—such as understanding algorithms, coding, and tool usage—contemporary curricula are increasingly emphasizing ethical awareness, critical evaluation, and AI-human collaboration. These expanded objectives align with emerging frameworks in AI literacy that position students not only as users of AI technologies but also as informed evaluators and ethical decision-makers. Programs now commonly address issues such as algorithmic bias, misinformation, privacy, and the broader societal implications of generative AI.

Importantly, AI literacy is no longer confined to STEM fields. This review identifies a significant diversification in disciplinary integration, with AI instruction extending into fields such as education, language learning, design, business, and healthcare. In these contexts, AI serves not only as a computational tool but also as a medium for creativity, inquiry, and reflective dialogue. For example, AI-supported writing tools are being used in L2 education to foster academic authorship and citation awareness, while image-generation platforms are used in design and humanities classrooms to explore sociocultural narratives and ethical representation.

In terms of technological platforms, ChatGPT and similar large language models (LLMs) dominate current instructional practice. Their widespread use across disciplines stems from their accessibility and versatility. However, this reliance presents both pedagogical and ethical challenges, particularly when educational ecosystems become dependent on proprietary, English-centric platforms. Other tools, such as Google Teachable Machine, Microsoft Azure ML Studio, and DALL·E, were also used to varying degrees, supporting hands-on machine learning training and creative multimodal exploration. Nonetheless, the overall ecosystem remains relatively narrow, and there is a pressing need to diversify the technological base used in AI literacy education to ensure broader pedagogical relevance and inclusion.

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This review also identifies key gaps in the literature. While many programs now incorporate ethics, very few explicitly address AI policy, global governance, or regulatory awareness—areas that are essential for preparing learners to engage in broader societal debates. Furthermore, geographic representation within AI literacy education research remains skewed toward the Global North, with minimal attention given to learners in the Global South, low-resource settings, or marginalized linguistic and cultural communities. This imbalance highlights the need for more culturally responsive and equitable approaches to AI education.

Overall, the application of the 4P Framework—focusing on Pedagogical Approaches, Purpose of Instruction, Participant Profiles, and Platforms & Tools—enabled a nuanced analysis of the reviewed literature. It revealed that while significant progress has been made in designing context-sensitive, interdisciplinary, and critically engaged AI literacy programs, there remain substantial opportunities to expand access, address policy dimensions, and diversify both pedagogical strategies and technological platforms. The future of AI literacy in higher education depends not only on teaching technical fluency but also on cultivating ethical reasoning, cross-cultural awareness, and the capacity to navigate and shape evolving AI systems with confidence and care.

Conclusion

This systematic review synthesized 25 empirical studies to explore how AI literacy is being taught in higher education, guided by a custom-developed 4P Framework encompassing Pedagogical Approaches, Purpose of Instruction, Participant Profiles, and Platforms & Tools. The findings illuminate both emerging patterns and persistent gaps in the design, delivery, and contextualization of AI education across disciplines and institutional settings.

A central conclusion is that AI literacy is transitioning from a narrow focus on technical skill acquisition toward a broader, more holistic educational paradigm. Project-based learning, reflective practices, and ethical inquiry now feature prominently in many programs, underscoring the value of active and critical engagement with AI systems. Instructional objectives have similarly evolved to emphasize not only functional fluency with AI tools but also critical evaluation, ethical reasoning, and human–AI collaboration. These shifts signal a growing recognition that AI literacy is not merely about tool usage, but about empowering students to navigate and shape socio-technical systems responsibly and creatively.

The review also highlights a significant diversification in learner populations and disciplinary applications. While STEM undergraduates remain a primary focus, educators are increasingly tailoring AI literacy for language learners, healthcare students, designers, and business professionals. However, geographic representation remains limited, with an overconcentration in Global North contexts and insufficient engagement with the infrastructural and cultural needs of underrepresented or resource-constrained learners. Addressing this imbalance is essential for advancing equity and inclusion in global AI education.

In terms of tools and platforms, the predominance of ChatGPT and similar LLMs reflects their accessibility and pedagogical flexibility. Yet this also raises concerns regarding platform dependency, language limitations, and ethical transparency. The findings suggest

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an urgent need for a more diverse and open technological ecosystem—one that includes domain-specific tools, multimodal platforms, and contextually adaptable AI systems.

Finally, the application of the 4P Framework proved instrumental in organizing and interpreting the varied educational practices documented in the literature. By categorizing teaching methods through these four dimensions, the framework offers a robust analytical lens for future research and curriculum design.

In conclusion, AI literacy education in higher education is rapidly evolving into a dynamic, interdisciplinary, and ethically engaged field. To ensure its continued growth and relevance, future efforts must prioritize inclusive pedagogies, policy awareness, platform diversity, and global accessibility. Only then can AI literacy be cultivated not just as a skillset, but as a foundational component of responsible citizenship in an AI-driven world.

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Use of Generative AI/ AI-assisted Technologies Statement

During the preparation of this work, the authors used [GPT-4] to translate the interpretation section of Table 6 (from Persian to English) and to proofread the final manuscript for language fluency. Additionally, [ChatGPT] was employed in the early stages of the literature review to summarize articles for initial screening. After using these tools, the authors carefully reviewed and edited all content as needed and take full responsibility for the final published article.

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