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Artificial intelligence in libraries: a systematic review of upskilling, challenges, and future research directions

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Abstract

Introduction. Libraries, as trusted institutions, are positioned to advance AI literacy for both staff and patrons. This study investigates how AI literacy has been conceptualised and implemented in libraries and examines the challenges these institutions face in AI upskilling and integrating AI into their services.

Method. A systematic literature review using PRISMA guidelines to identify peer-reviewed articles and practitioner reports on AI upskilling in libraries.

Analysis. Fourteen articles published between 2021 and 2025 were examined, spanning academic, public, and school libraries. Both thematic and comparative analysis were used to synthesise findings.

Results. Findings reveal significant variation in definitions of AI literacy, sectoral differences in focus (staff training in academic libraries, patron programs in public libraries, early digital citizenship in schools), and recurring challenges including cost, vendor dependence, staff anxieties, and lack of outcome evaluation. Geographic patterns show Asia leading in empirical studies, while Western literature is largely conceptual.

Conclusion. To remain relevant, libraries must move beyond fragmented, vendor-driven initiatives toward clearer definitions, equity-centered approaches, and scalable, evidence-based models that empower both staff and patrons in an AI-driven era.

Introduction

Public libraries have long stood as vital anchors of equity within their communities, with their specific roles determined by the changes in society (Juchnevič, 2014). Libraries have evolved from providing free access to books and quiet spaces for learning, to playing a leading role in bridging the digital divide by offering broadband connections, online job application support, and digital literacy training (Grimes & Porter, 2024). The rapid advancement of artificial intelligence (AI) raises concerns about a new frontier of the digital divide (Kettani et al., 2025). As the United States pursues global leadership in AI through national strategies focused on innovation and infrastructure (Krastios et al., 2025), adoption and use remain uneven (Wang et al., 2024). Libraries, with their history of advancing digital inclusion and their reputation as trusted community institutions, are well positioned to act as partners in fostering AI adoption and literacy.

An emerging concept, central to efforts to drive AI adoption and use, is AI literacy, often framed as an extension of information and digital literacy. While definitions vary, authors generally describe AI literacy as the ability to critically evaluate AI technologies, use them ethically, and recognise their biases and implications (Ng et al., 2021). Libraries are increasingly called upon to cultivate these competencies among both staff and patrons, positioning AI literacy as both a professional responsibility and a public good.

For libraries to achieve this, however, they themselves must be at the forefront of AI adoption. Library workers are expected to play a central role in shaping how these technologies are integrated into services, programs, and community engagement. Understanding their readiness for this role and the available support is critical to positioning libraries as effective partners in an AI-centered society. This paper attempts to address this by answering three research questions:

1. How are libraries conceptualising AI literacy?
2. What upskilling initiatives are being implemented to prepare both staff and patrons for this new technological landscape?
3. What challenges are currently faced by libraries, library staff, and patrons as they navigate AI upskilling and use?

To answer these questions, we conducted a review of the literature on AI literacy programs in libraries.

Methodology

Protocol

A systematic literature review is employed in this research, using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 27-item checklist (Page et al., 2021). The search was conducted on ScienceDirect and the Library, Information Science and Technology Abstracts (LISTA) databases on August 5th, 2025.

Given that this work aims to investigate findings in a rapidly evolving field and library workers may share their knowledge in non-academic publications, the search included articles from peer-reviewed journals, books, book chapters, and sources in the grey literature including white papers, conference papers, and reports. We developed three clusters of keywords to guide the search and ensure the literature captured was both representative and inclusive. The first cluster captures public libraries, the second focuses on artificial intelligence, and the third relates to digital literacy training. We used the search query ('public library') AND ('artificial intelligence' OR 'ai' OR 'emerging technology') AND (upskilling OR 'training' OR 'literacy' OR 'development'). The search was conducted on the title, abstracts, keywords, and texts and was restricted to articles published between 2020 and 2025 in English. A total of 497 records were retrieved: 406 articles from ScienceDirect database and 91 articles from LISTA database.

Selection process

The articles included in the final review were selected through a two-step process.

First-phase screening

After removing duplicates, the titles and abstracts were screened to make sure that the articles were published in English and were related to the topic of AI in libraries. After this first phase of screening, 54 articles were remaining.

Second-phase screening

Additional screening was conducted to exclude articles for which the full text was unavailable, and those published in languages other than English. The full text of four articles could not be retrieved. The full texts of the remaining publications were read and evaluated using the inclusion criteria summarised in Table 1. After the final screening, 14 articles were included in the final review. Figure 1 presents an overview of the search and review process with the total number of articles in each phase. See the Appendix for the full list of articles in the final dataset.

SPIDER	Inclusion Criteria
S—Sample	Libraries
PI—Phenomenon of Interest	AI upskilling in libraries—including training for staff and patrons
D—Design	No restriction
E—Evaluation	Experiences, perceptions, empirical analyses, theoretical papers
R—Research Type	No restriction

Table 1. Literature inclusion criteria. Adopted from (Cooke et al., 2012).

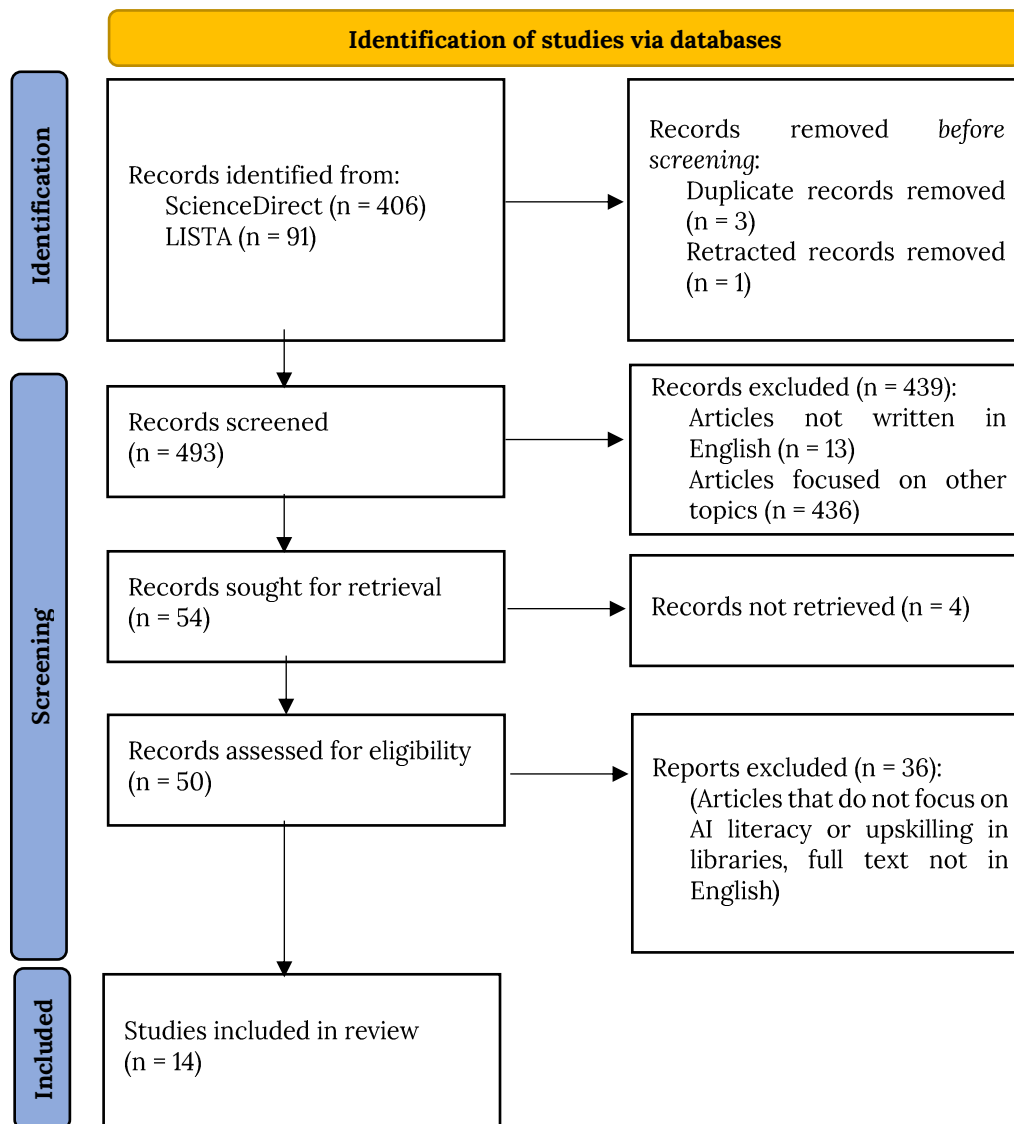


Figure 1. PRISMA flow diagram.

Attributes of the studies

As shown in Figure 2, the articles in our final dataset were published between 2021 and 2025, with 10 out of the 14 articles published in 2024. This trend suggests that as generative AI has become more widely adopted, there is growing interest in understanding how libraries and library workers are learning to use AI tools and addressing challenges related to its adoption and use.

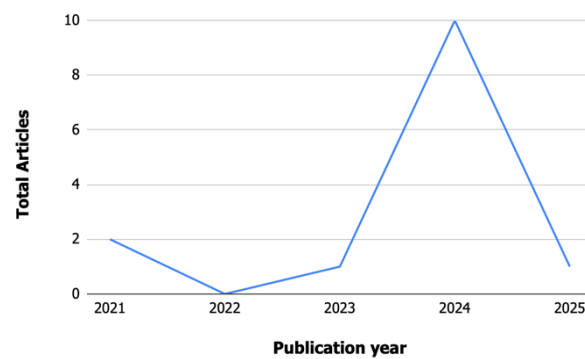


Figure 2. Distribution of the articles by publication year.

Figure 3 presents the geographical distribution of the libraries studied in the literature. Geographically, the United States led research output, with six of the studies (43%) focusing on U.S. libraries. Six articles examined upskilling efforts in libraries outside the U.S., with three specifically focusing on libraries in China. Two articles did not specify the geographic location of focus.

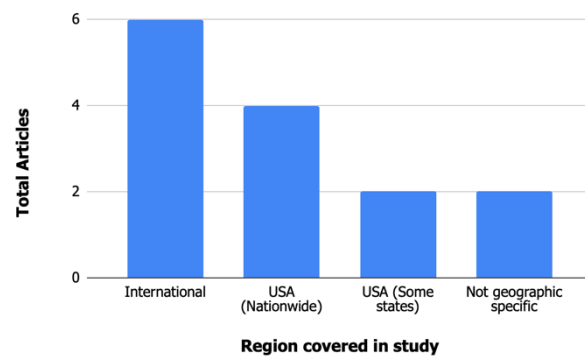


Figure 3. Distribution of the articles by region covered in the study.

Although our initial aim was to examine AI literacy, adoption, and use in public libraries, we did not exclude other types of libraries from the review. Of the 14 articles analysed, 13 specified the type of library studied. As shown in Figure 4, the majority of the studies focused on academic libraries (62%), while just under one-third (31%) examined public libraries. Only one article addressed AI literacy and upskilling in a school library serving K-12 students.

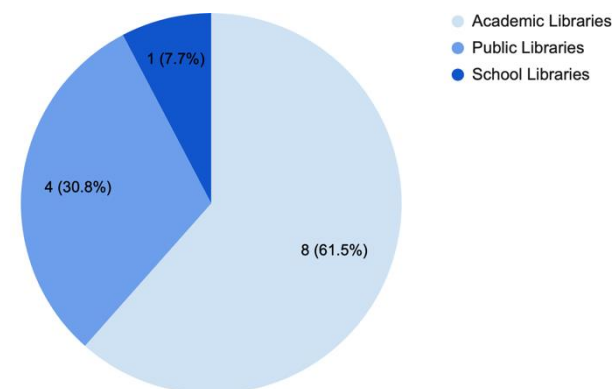


Figure 4. Distribution of types of libraries in the review.

Findings and discussion

Conceptualisation of AI literacy in libraries

AI literacy has emerged as an extension of information and digital literacy, reflecting libraries' role in helping users navigate algorithmic systems. In academic libraries, AI literacy is recognised as important but inconsistently developed. Wu et al. (2025) documented a surge of AI literacy lectures in Chinese Double First-Class universities, often vendor-led and focused on tool demonstration rather than critical reflection, with librarians playing limited roles. In contrast, Fruehauf et al. (2024) show how U.S. academic libraries can respond more directly, describing the University of South Florida's development of a Generative AI LibGuide, integration of AI into plagiarism workshops, and creation of faculty toolkits in collaboration with campus partners. Other studies emphasise staff literacy as a precondition for adoption: Li (2024) identified administrative support and professional development as critical, while (Limwichitr, 2024) highlighted cross-generational staff training under Thailand's 'Library 4.0' framework. Huang et al. (2023) add a strategic dimension, noting that Chinese universities piloted AI initiatives more actively than UK libraries, where AI appeared only superficially in digital strategies. These studies suggest academic libraries frame AI literacy more as staff development and service integration than as direct, patron-facing education.

In public libraries, AI literacy is treated more explicitly as a community service. Enis (2024) highlights scalable efforts such as New Jersey's AI Ambassadors, which trained community leaders to deliver AI literacy to hundreds of patrons. Libraries also experimented with creative generative AI programming, such as storytelling and art workshops using ChatGPT and DALL-E, positioning literacy as both empowerment and misinformation resilience. Ong and Slater (2024) extend this framing by embedding AI literacy into resume writing, and labs where staff and patrons learn together. Rubio (2024) casts libraries as '*vibrant centers of AI literacy*', emphasising critical reflection, co-design with communities, and partnerships with social justice organisations. Bélanger (2025) situates AI literacy within a tiered framework of digital competencies, culminating in the ability to critically evaluate and ethically apply AI tools, grounded in librarianship's values of access and intellectual freedom. These perspectives characterise libraries as leaders in developing AI literacy as a critical practice.

Although less studied, school libraries are emerging as important literacy sites. Seales (2024) describes school librarians teaching students prompt writing, plagiarism awareness, and bias evaluation, directly countering the myth of '*digital natives*' (Bélanger, 2025). Across sectors, the literature shows two converging trends: AI literacy is positioned as a core library function, yet it is uneven across contexts. Most studies stop short of defining AI literacy directly, instead describing competencies or programs. Where definitions are provided (Bélanger, 2025; Ridley & Pawlick-Potts, 2021; Rubio, 2024), they consistently emphasise critical evaluation, ethical use, awareness of bias, and user empowerment rather than mere technical proficiency.

Upskilling initiatives for staff and patrons

Across the literature, staff upskilling consistently emerged as a precondition for successful AI adoption and for the effective delivery of AI literacy education to patrons. Ali et al. (2021) stress that retraining and upskilling librarians is a prerequisite for integrating AI tools into library services. Without targeted professional development, librarians may lack the confidence, critical skills, and evaluative expertise needed to integrate AI tools into services or to guide communities in their ethical and informed use. Li (2024) and Gültekin and Kavak (2025) show that professional development and HR support reduce anxiety and encourage adoption. Twomey et al. (2024) demonstrate how distributed training models (involving IT staff, reference librarians, and student workers) can build staff confidence with GenAI chatbots. Some studies stress the importance of critical AI literacy, urging librarians to act as ethical evaluators of AI tools rather than passive

consumers (Affelt, 2023; Bélanger, 2025). Wu et al. (2025), however, found that many training programs are vendor-led, limiting librarians' agency and expertise development.

Upskilling patrons in AI is most evident in public and school libraries. Seales (2024) describes librarians teaching students prompt engineering, plagiarism awareness, and bias detection. Enis (2024) documents train-the-trainer models, such as New Jersey's AI Ambassadors program, which scaled AI literacy training to hundreds of patrons. Ong and Slater (2024) highlight the integration of AI literacy into racial equity frameworks, ensuring inclusivity in public programming. By contrast, academic libraries often provide AI-enabled services without explicitly training patrons, leaving a gap in higher education contexts (Li, 2024; Wu et al., 2025).

Challenges in AI upskilling, adoption, and use

The literature reveals that challenges of AI upskilling and use in libraries are not isolated but systemic, spanning administrative, staff, and patron levels. Figure 5 presents the top 10 most frequent challenges that emerged in the literature.

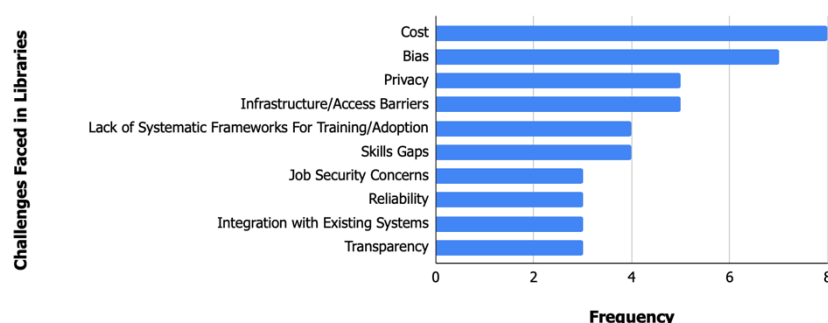


Figure 5. Top 10 most frequent challenges in AI upskilling, adoption, and use identified in the literature.

Cost emerged as the most persistent barrier, extending beyond initial technology acquisition to encompass the cost of implementing upskilling programs, environmental costs, support services, and long-term maintenance of AI systems. These financial constraints at the administrative and management level intersect with structural gaps such as the absence of frameworks to guide upskilling programs and limited opportunities for hands-on practice. Generational differences in staff further complicates implementation, requiring differentiated training approaches (Li, 2024; Limwichitr, 2024). Other issues that emerged include the tendency to rely on third-party AI systems or literacy programs—which may not be suitable (Wu et al., 2025; Breeding, 2025), the need for regular staff retraining, and concerns about whether AI use advances or undermines libraries' social inclusion goals (Ong & Slater, 2024; Rubio, 2024; Belanger, 2025). Technical barriers, such as integration difficulties and inadequate infrastructure, were also highlighted in the literature (Ali et al., 2021; Huang et al., 2023).

At the staff level, low technical skills, limited AI literacy, and perception of the usefulness of AI impact willingness to adopt or upskill in AI (Li, 2024). Some articles found that library staff view AI as a tool to enhance productivity (Twomey et al., 2024, Belanger, 2025). Other studies found that library staff express skepticism or anxiety, citing ethical concerns such as privacy, bias, misinformation, and transparency, as well as fears about job security (Gültekin & Kavak, 2025; Twomey et al., 2024; Belanger, 2025). These perceptions highlight the tension between organisational ambitions for innovation and staff uncertainty about professional impact. Finally, patron-level challenges emerge, with limited awareness of AI applications in libraries and fears of overreliance on automated systems (Enis, 2024; Twomey et al., 2024; Belanger, 2025). These

concerns suggest that adoption must be managed carefully to ensure AI complements, rather than displaces, human-centered information practices.

Best practices and practical implications

Libraries are most effective when they embed AI literacy into existing literacy frameworks, making it a natural extension of information and digital literacy (Bélanger, 2025; Fruehauf et al., 2024). Scalable models such as train-the-trainer programs (Enis, 2024) and distributed staff training (Twomey et al., 2024) expand reach while conserving resources. Partnerships with campus units or social justice organisations further strengthen programming (Rubio, 2024). Successful initiatives also ground AI literacy in ethics and equity, aligning with values of access and inclusion (Ong & Slater, 2024). Practical, hands-on learning opportunities—such as workshops, creative generative AI projects, and tutorials—make literacy engaging and accessible. Libraries should also consider developing locally informed, equity-centered programs rather than relying solely on vendor-provided solutions. Underpinning all efforts is investment in staff development, which builds confidence and reduces anxiety (Gültekin & Kavak, 2025; Li, 2024).

Limitations and future research agenda

Although AI has emerged as a prominent area of inquiry and scholarship on its applications in libraries is expanding rapidly, the literature addressing AI upskilling in libraries remains limited. The existing body of work reveals several important limitations. One of the most pressing challenges is conceptual ambiguity. While authors broadly agree that AI literacy extends from information and digital literacy traditions, there is little consensus on how to define it. Some describe it as tool competency and responsible use (Wu et al., 2025), others as algorithmic or critical awareness (Ridley & Pawlick-Potts, 2021; Rubio, 2024), and still others as the culmination of tiered digital skills leading to ethical evaluation (Bélanger, 2025). This definitional fluidity makes it difficult to design programs consistently or evaluate them across contexts.

The literature also demonstrates a sectoral imbalance. Academic libraries are often studied through the lens of staff upskilling and service integration, with relatively few accounts of sustained, patron-facing AI literacy efforts (Li, 2024; Wu et al., 2025). Public libraries, by contrast, are portrayed as leaders in delivering community-oriented programs, but these initiatives frequently rely on external funding or partnerships (Enis, 2024; Ong & Slater, 2024). School libraries, despite their central role in shaping early digital and AI competencies, remain underrepresented, with only a handful of case studies (Seales, 2024). Special and national libraries are largely absent from the discussion.

Another limitation lies in the geographic skew of research. Many empirical studies come from Asia, especially China and Turkey, while scholarship from the United States and Europe is disproportionately conceptual or commentary based. This imbalance highlights the need for comparative, cross-cultural research to understand how social, cultural, and institutional contexts shape AI literacy. In addition, many academic library initiatives rely heavily on vendor-led training or proprietary tools (Breeding, 2025; Wu et al., 2025), which reduces librarian agency. Finally, there is a notable lack of outcome data. Very few studies assess whether AI literacy programs improve user competencies, reduce misinformation, or advance equity.

Looking forward, the literature points to several priorities for a future research agenda that will enable libraries to remain relevant in an AI-saturated world. First, scholars and practitioners should work to define and operationalise AI literacy in ways that are adaptable but consistent enough for evaluation. Second, research must move toward empirical assessment of program outcomes, using mixed methods approaches to capture both immediate skill development and long-term impacts on communities. Third, coverage must expand to include school, special, and national libraries, ensuring that diverse populations are represented. Fourth, libraries must explore ways to reduce reliance on vendors by building internal expertise and cultivating staff agency in

designing literacy initiatives. Fifth, future research should place greater emphasis on investigating how libraries can mitigate bias, bridge digital divides, and model responsible technology adoption. Finally, scholars should examine scalable delivery models, such as train-the-trainer approaches and cross-institutional collaborations, that allow even resource-limited libraries to support AI literacy effectively. By pursuing this agenda, libraries can strengthen their role as trusted guides and ensure their continued relevance in the AI era.

Conclusion

This study systematically reviewed the literature on AI literacy, adoption, staff and patron upskilling, and the associated challenges in libraries. The findings indicate that although the scholarship on AI in libraries is expanding rapidly, the literature specifically addressing AI upskilling in libraries remains limited.

Fourteen articles, published between 2021 and 2025, were reviewed, representing studies on public, academic, and school libraries in US-focused and international contexts. This work revealed significant variation in definitions of AI literacy, sectoral differences in focus (staff training in academic libraries, patron programs in public libraries, and early digital citizenship in schools), and recurring challenges including cost, vendor dependence, staff anxieties, and lack of outcome evaluation.

From a practical standpoint, these findings suggest that libraries should prioritise staff upskilling as a foundational step in AI adoption and embed AI literacy within existing information and digital literacy frameworks. Library leaders should also invest in scalable training models and ongoing assessment to ensure that AI initiatives enhance libraries' longstanding commitments to access and public trust.

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develop strong debugging practices and critical AI literacy. She can be contacted at yerika.jimenez@katabasis.org

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Appendix A. Final data from the systematic literature review

Source	Type of Library	Population	Overview of AI Upskilling/Use
Ali et al. (2021)	Academic Libraries	Library workers	Upskilling librarians was limited; IT staff often fill AI-related roles. Authors stress the need for librarians to retrain and reclaim leadership. AI use in technical services (automated classification), user services (chatbots, discovery systems, digital learning support), security & circulation (RFID, self-check-in/out, facial recognition systems), and collection development (recommender systems for acquisitions and weeding). Research support includes machine learning labs for data visualisation and citation analysis.
Bélanger (2025)	Public Libraries	Library workers	Upskilling focus on librarians' existing strengths (search strategy, evaluation, privacy, metadata, instruction) and map directly to AI mediation and instruction. Tiered literacy framework: essential tech skills, emergent digital literacy, advanced digital literacy, AI literacy. Applications: chatbots, enhanced search, automated tipsheets/tutorials, personalised help for public-facing, metadata cleanup/normalisation, analytics for back-end operations.
Enis (2024)	Public Libraries	Library workers and patrons	Hands-on programs for patrons (AI storytelling, creative media, algorithmic literacy workshops). Train-the-trainer programs give librarians confidence to train peers/patrons. Professional upskilling via Coursera/LinkedIn Learning.
Fruehauf et al. (2024)	Academic Libraries	Faculty and students	A LibGuide on GenAI was created and shared
Gültekin & Kavak (2025)	Academic Libraries	Library workers	Upskilling is anxiety-focused: more frequent AI use reduces fear. Training programs recommended to build confidence and reduce anxiety. Emphasis on awareness and practice to lower anxiety and encourage adoption.
Huang et al. (2023)	Academic Libraries	Library workers	Limited systematic upskilling: AI use framed as pilot or exploratory rather than widespread staff training. China: Piloting intelligent platforms, robots, and AI-based enquiry tools. UK: Emphasis on general digital literacy, less AI-specific.
Li (2024)	Academic Libraries	Library workers	Upskilling not systematically structured but occurs through professional development workshops, on-the-job training led by experienced librarians and AI-vendor-supported training.
Limwichitr (2024)	Academic Libraries	Not specified	Integration model: AI is embedded within the library 4.0 digital transformation framework, alongside IoT, robotics, VR, and cloud computing.
Ong & Slater (2024)	Public Libraries	Library workers and patrons	For staff upskilling: Self-education, cross-departmental events, webinars, AI literacy workshops. For patron upskilling: One-on-one Digital Learning Labs (DLLs), AI in résumé building, research aid, advisory services. Applications include résumé support, readers' advisory, metadata cleaning, ethical discussions, and public awareness.

Ridley & Pawlick-Potts (2021)	Public Libraries	Library workers and patrons	Community programs for patrons: workshops, makerspaces, consumer checklists, age-appropriate training. Staff development: advocacy roles, awareness training, curricular integration. AI use focus is on libraries as mediators of algorithmic understanding rather than heavy direct use of AI tools.
Rubio (2024)		Library workers	Types of training for librarians: webinars and online courses, blended learning, hands-on workshops. Proposed training to prepare libraries to lead in critical engagement, ethical considerations, and participatory innovation.
Seales (2024)	School Libraries	Library workers, teachers, students	Upskilling librarians/teachers: Workshops, PD sessions, and Code.org AI training modules. Training focused on prompt-writing, bias evaluation, plagiarism awareness. Applications include custom assignments, keyword and resource discovery, gamified learning, personalised texts, interactive presentations.
Twomey et al. (2024)	Academic Libraries	Library workers and students	Staff training: Reference librarians trained chatbot by reviewing Q&A logs, supplying corrected responses, and updating training data. Student workers: Involved in testing and inputting real-world patron questions. Upskilling focus: practical, hands-on exposure to LLMs; prompt engineering; evaluating AI output.
Wu et al. (2025)	Academic Libraries	Library workers	Predominantly short, lecture-driven sessions; some workshops with practical exercises; external database vendor-led training; hands-on applications (e.g., flipped classroom models, research-topic optimisation, project-based exercises). Training focused on AI awareness, AI in research support, ethics, and smart library construction.