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REVIEW

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A Review of Digital Technology in Informal Education and Its Role in Educational Equity

Yufei Jiang [1], Chaoqun Lu [2], and Bin Hu [1]

[1] School of Law, Hangzhou City University, People's Republic of China
[2] Faculty of Education, University of Macau, People's Republic of China

Correspondence: Chaoqun Lu (chaoqunlu@um.edu.mo)

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Abstract

Digital technologies have profoundly transformed the landscape of education, enhancing learning approaches while raising concerns about digital equity. This review pays particular attention to informal education settings (e.g., public libraries, museums, and telecentres) and examines the application of digital technologies in these settings and their role in educational equity. Specifically, it focuses on the diverse Guangdong–Hong Kong–Macao Greater Bay Area (GBA), exploring the implications of digital technologies from a global perspective. Through a scoping review of 31 studies, this study synthesizes a broad spectrum of digital technologies employed in informal education, ranging from conventional digital tools (e.g., internet-enabled computers, printers, and CD-ROMs) to advanced digital technologies (e.g., online public access catalogs, immersive technologies, and artificial intelligence). By applying the PROGRESS-PLUS framework's equity dimensions, the review reveals the dual role of digital technologies: On one hand, the integration of digital technologies in informal education fosters inclusion for minority groups and improves accessibility to learning resources; on the other hand, it exacerbates disparities for individuals lacking access to digital infrastructure or sufficient digital literacy. The discussion explores the challenges and opportunities of digital integration in informal education, with specific implications for the GBA in China.

Keywords

digital technology; equity; Greater Bay Area; informal education

1. Introduction

Digital technology, ranging from personal computers and tablets to cameras, calculators, digital toys, software, apps, augmented reality (AR), virtual reality (VR), and "pervasive platforms" like the Internet, has

profoundly shaped the educational landscape (Haleem et al., 2022). The increasing use of digital technology in educational settings has made it a topic of global interest, and a growing number of studies focus on the integration of digital technology in education. Nevertheless, digital technologies are considered to be a double-edged sword. On one hand, digital technologies could promote educational equity by facilitating the teaching of students with special learning needs, fostering inclusive learning environments, and improving access to educational resources (Haleem et al., 2022). On the other hand, some argue that digital technologies might widen existing gaps and inequalities due to limited digital experiences and inadequate digital capabilities (Timotheou et al., 2023). These issues of digital equity tend to be especially pronounced in informal educational settings. Given the significant role that digital technologies play in informal education, particularly in facilitating learners' participation in simulations and the exploration of multimedia materials (Ramsurrun et al., 2024), this review focuses on informal settings. This emphasis on informal education, an area relatively under-researched or under-theorized compared to formal education, is crucial to enhance our understanding and to map the integration of digital technologies across the educational landscape more effectively.

1.1. Formal, Non-formal, and Informal Education

Education features three distinct learning environments where digital technologies are deeply integrated: (a) formal education, (b) non-formal education, and (c) informal education (European Union, 2001; Johnson & Majewska, 2022). Formal education is characterized by its structured nature and the attainment of formal qualifications like degrees or diplomas through established educational institutions, such as elementary schools and bachelor's degree programs. Non-formal education, while typically structured, is more flexible than formal education and is usually offered outside of conventional classrooms, in settings such as fitness programs and swimming courses. In contrast, informal education does not adhere to a formalized structure and lacks predefined objectives. Informal education often arises from everyday experiences without a formalized structure or certification. Informal educational activities are unregulated and encompass a diverse array of experiences, including visits to museums, trips to public libraries or science fairs, listening to educational radio broadcasts or watching informative TV programs, reading scientific journals and magazines, and participating in scientific competitions. Informal education serves as a supplement to both formal and non-formal education (European Union, 2001). For example, children's understanding of science may develop through taking science courses at school (i.e., formal education), participating in STEM after-school programs, and tutoring services (i.e., non-formal education), and visiting science museums (i.e., informal education).

1.2. Digital Equity and Educational Equity

The concept of equity in digital technology integration within informal education is complex and multifaceted. Two core concepts are closely related to and intertwined with the equity issue: digital equity and educational equity. The current review study adopts educational equity to represent all equity-related issues in the integration of digital technologies in informal education environments, which includes the concept of digital equity.

Digital equity in education encompasses five dimensions: (a) access to hardware, software, and internet connectivity; (b) access to meaningful, high-quality, and culturally relevant content in local languages;

(c) access to the creation, sharing, and exchange of digital content; (d) access to educators who are proficient in using digital tools and resources; and (e) access to high-quality research on the application of digital technologies to enhance learning (Resta et al., 2018, p. 991).

Educational equity ensures that all individuals have access to the resources and support they need to succeed, regardless of their socio-economic background or other demographic factors (Gorski, 2005). Equity here does not mean achieving equal educational outcomes; rather, it means that differences in educational outcomes should not be attributed to an individual's background or to economic and social circumstances over which the individuals have no control (Levinson et al., 2022).

1.3. Greater Bay Area

The Guangdong–Hong Kong–Macao Greater Bay Area (GBA) is a cluster of cities in the Pearl River Delta region of southern China, encompassing nine cities in Guangdong Province (Guangzhou, Shenzhen, Zhuhai, Foshan, Dongguan, Huizhou, Jiangmen, Zhaoqing, Zhongshan) along with the two special administrative regions of Hong Kong and Macao. This region exhibits significant variations in economic development, culture, and language (Zheng, 2019), which are closely linked to challenges in educational equity (OECD, 2018). Consequently, targeted guidance is essential.

Official organizations in the GBA have launched a variety of activities and projects to foster educational equity. For instance, universities and educational institutions in the GBA have initiated collaborative educational schemes, student exchanges, and vocational programs (GBA, 2025). In recent years, digital technologies have been increasingly used in educational exchanges within the GBA. For example, the establishment of the GBA University Online Open Course Alliance provides access to 1,600 courses for students (The Chinese University of Hong Kong, n.d.).

While existing research on education in the GBA has predominantly focused on formal education (e.g., A. Xie et al., 2021; X. Xie et al., 2023), the GBA is also actively engaging in exchanges within the realm of informal education. For example, cultural and artistic collaborations have been established in museums and galleries, and Hong Kong films and television works have been integrated into Mainland online platforms (GBA, 2025). This review focuses on the application of digital technologies in informal educational settings. By doing so, it offers valuable insights and suggestions for enhancing educational equity and inclusion across the diverse context of the GBA. This approach is crucial for understanding and improving educational outcomes in this dynamically evolving region.

2. Previous Reviews

Given the burgeoning interest in digital technologies in informal education, there has been a notable increase in studies reviewing the field's development and synthesizing its findings. We identified seven review studies from reputable journals focusing on the use of digital technologies in informal education. As detailed in Table 1, these review studies exhibit a diversity of focal areas. For instance, some reviews targeted specific digital technologies such as AR (Markouzis et al., 2022), digital media (Degner et al., 2022), and mobile devices (Jin et al., 2019). Others explored digital technology applications in various informal education subjects, including science (Ramsurrun et al., 2024) and English language learning (Guo & Lee,

2023; Liu et al., 2025; Soyoof et al., 2023). While the existing review studies offer valuable insights into the application of digital technologies in informal education, we identified several gaps. First, some review studies have focused solely on specific types of digital technologies within informal learning contexts (Degner et al., 2022; Jin et al., 2019; Markouzis et al., 2022). Second, some review studies have focused narrowly on particular subjects of informal education, such as science education (Ramsurrun et al., 2024) and English language learning (Guo & Lee, 2023; Liu et al., 2025; Soyoof et al., 2023). While the focused approaches allow for an in-depth analysis of the digital technologies or the subjects of informal education, they cannot provide a comprehensive overview of digital technologies in informal learning environments. Our review study expanded the scope, moving beyond the exclusive examination of particular digital technologies or specific informal education subjects. We aimed to provide a holistic view of how digital technologies are employed across different dimensions of informal learning environments. More importantly, despite the significant concerns and growing interest related to equity issues within this field, there is a noticeable lack of review studies addressing the role of digital technologies in promoting educational equity within informal education settings. This review contributes more rigorous evidence regarding the application of digital technologies in informal education and deepens the understanding of how these digital technologies can benefit educational equity in informal educational settings.

Table 1. Previous review studies of digital technologies in informal education.

Former reviews	Years	No. of studies	Focus	Databases
Markouzis et al. (2022)	2012–2022	29	AR applications for mobile devices related to informal education	ERIC, ScienceDirect, Google Scholar
Degner et al. (2022)	2005–2020	26	The use of digital media in institutional informal learning places	Scopus, FIS
Jin et al. (2019)	2005–2017	28	The informal learning of older adults in using mobile devices, both academically and practically	EBSCOhost, ScienceDirect, ProQuest, SAGE, Taylor & Francis
Ramsurrun et al. (2024)	2017–2022	17	The use of digital tools and technologies in informal science education settings	ACM Digital Library, ERIC, Google Scholar, Sage, Web of Science
Guo and Lee (2023)	2010–2021	103	Informal digital learning of English	A&HCI, SSCI journals
Soyoof et al. (2023)	2017–2019	30	The extramural and extracurricular types of IDLE	Web of Science
Liu et al. (2025)	2014–2024	49	IDLE in Asian English as a foreign language context during	Scopus, Web of Science

3. Research Questions

The present study aims to illustrate how digital technologies have been used in informal education and evaluate their role in educational equity. Specifically, this study seeks to answer the following three research questions (RQ):

RQ1: What are the general characteristics of the reviewed studies, such as year of publication, geographical distribution, target populations, informal learning venues, methodologies employed, and research themes?

RQ2: How are digital technologies described in terms of their types and target users in the reviewed studies on informal educational settings?

RQ3: What roles do these digital technologies play in promoting educational equity within informal education settings?

4. Theoretical Framework: PROGRESS-PLUS Model

This scoping review utilizes the PROGRESS-PLUS framework to explore the role of digital technologies in promoting educational equity within informal education settings. Originally developed by Evans and Brown (2003), the PROGRESS framework identified core social determinants contributing to health disparities. It was later expanded to include PROGRESS-PLUS, incorporating additional context-specific characteristics such as age and disability (O'Neill et al., 2014). The enhanced framework encompasses nine key dimensions: place of residence, race/ethnicity/culture/language, occupation, gender/sex, religion, education, socioeconomic status, social capital, and additional context-specific factors linked to stigmatization and exclusion, such as disability and age. As outlined by O'Neill et al. (2014), this analytical tool serves dual purposes: systematically categorizing research data while ensuring equity considerations remain central to evidence synthesis. Due to its comprehensive approach, the PROGRESS-PLUS framework has become a widely used framework in systematic reviews focusing on equity. In this scoping review, we adopt it to methodologically assist in identifying relevant participant characteristics that reflect individual-level social determinants of informal education. Theoretically, it aids in reporting and discussing how digital technologies used in informal education can influence educational equity.

5. Methodology

Research on digital technology in informal education is still nascent, and literature on this topic remains limited. The review process is not suitable for meta-analyses or systematic reviews, which depend on a large corpus of relatively homogeneous publications to draw valid conclusions (Laupichler et al., 2022). Consequently, this study adopted a scoping review approach, commonly used to explore the scope of existing literature on a specific topic in terms of volume, nature, and characteristics of primary research (Arksey & O'Malley, 2005; Pham et al., 2014). We adhered to the PRISMA guidelines for scoping reviews (Tricco et al., 2018). The review process entailed five main stages: (a) identifying the research question(s), (b) identifying relevant studies, (c) selecting studies, (d) charting data, and (e) collating, summarizing, and reporting results (Arksey & O'Malley, 2005).

5.1. Literature Search

For the literature search, we utilized prominent databases, including Scopus, Web of Science, and EBSCOhost (which includes ERIC). These databases were selected because they are the most commonly used databases for searching eligible studies in review studies in the education field (e.g., Su et al., 2023).

Our search targeted three key terms integral to our study: digital technology, informal education, and educational equity. To ensure comprehensive coverage, we explored synonyms for these terms, refining our search to include more relevant literature. The resulting search string was: ("digital technology" OR "digital tools" OR "ICT" OR "edtech" OR "online platforms" OR "digital media" OR "mobile technology" OR "virtual tools" OR "augmented reality" OR "virtual reality" OR "mobile apps") AND ("informal education" OR "informal learning" OR "non-formal education" OR "self-directed learning" OR "lifelong learning" OR "experiential learning" OR "social learning" OR "community learning" OR "peer-to-peer learning" OR "museums" OR "libraries" OR "cultural institutions") AND ("educational equity" OR "equity in education" OR "inclusive education" OR "education equality" OR "equal access to education" OR "equity gaps" OR "education disparities" OR "learning equity" OR "digital divide" OR "access to education" OR "underserved populations" OR "low-income learners").

We also employed the backward snowballing method by reviewing the references of identified articles to discover further relevant studies. To maintain scientific rigor, this review was restricted to peer-reviewed journal articles published between 2006 and April 2025, and written in English. The literature search yielded 224 articles, with 121 from Scopus, 43 from Web of Science, and 60 from EBSCO.

5.2. Literature Selection

From an initial pool of 224 articles, we first screened titles and abstracts to remove those clearly irrelevant to our research topics. This process also involved the elimination of 51 duplicate articles. We then conducted a full-text review of the remaining papers, during which one article could not be retrieved and was subsequently excluded. Two researchers independently selected the documents based on predetermined criteria, detailed in Table 2. Inclusion criteria required that the articles (a) focused on the use of digital technologies such as AI, mobile apps, online platforms, VR, and AR, (b) addressed educational equity, (c) focused on informal educational activities such as research on personal interests using resources like books, libraries, online platforms, or seeking guidance from informal mentors, (d) included empirical data to support their conclusions, (e) were published in peer-reviewed journals, (f) were written in English, and (g) were published between 2006 and 2025. Articles were excluded if they (a) focused on non-digital technologies or formal/non-formal educational activities, (b) did not address educational equity, (c) lacked empirical data, (d) were published before 2006, (e) were written in a language other than English, or (f) were not peer-reviewed. Following this selection process, we identified a total of 31 empirical research articles. The complete search and selection process is illustrated in Figure 1.

Table 2. Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Digital technologies: Studies must focus on the use of digital technologies such as AI, mobile apps, VR, and online platforms in informal education.	Other tools: Studies that focus on non-digital tools or technologies such as traditional media (e.g., television, radio), or non-technology-based educational methods.
Educational equity: The objective of the study must be to explore or improve educational equity within the context of informal education.	Different objectives: Studies with objectives unrelated to educational equity, or those focusing exclusively on other educational outcomes.

Table 2. (Cont.) Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Informal educational activities: Studies must focus on informal educational activities, such as research on personal interests using resources like books, libraries, online platforms, or seeking guidance from informal mentors.	Formal and non-formal educational activities: Studies that focus on formal educational activities (e.g., elementary school education, bachelor's degree program) and non-formal educational activities (e.g., fitness programs, swimming courses).
Empirical evidence: The study must include empirical data supporting conclusions.	Non-empirical studies: Studies that are theoretical, such as literature reviews, meta-analyses, or book reviews.
Peer review: The study must be peer-reviewed to ensure academic rigor and credibility.	Non-peer reviewed: Studies that have not undergone the peer-review process.
Language: The article must be written in English to ensure accessibility and comprehensibility for the review team.	Other languages: Studies published in languages other than English.
Publication date: Studies published between 2006 and 2025 to capture recent and relevant developments.	Outside publication date range: Studies published before 2006 or after 2025.

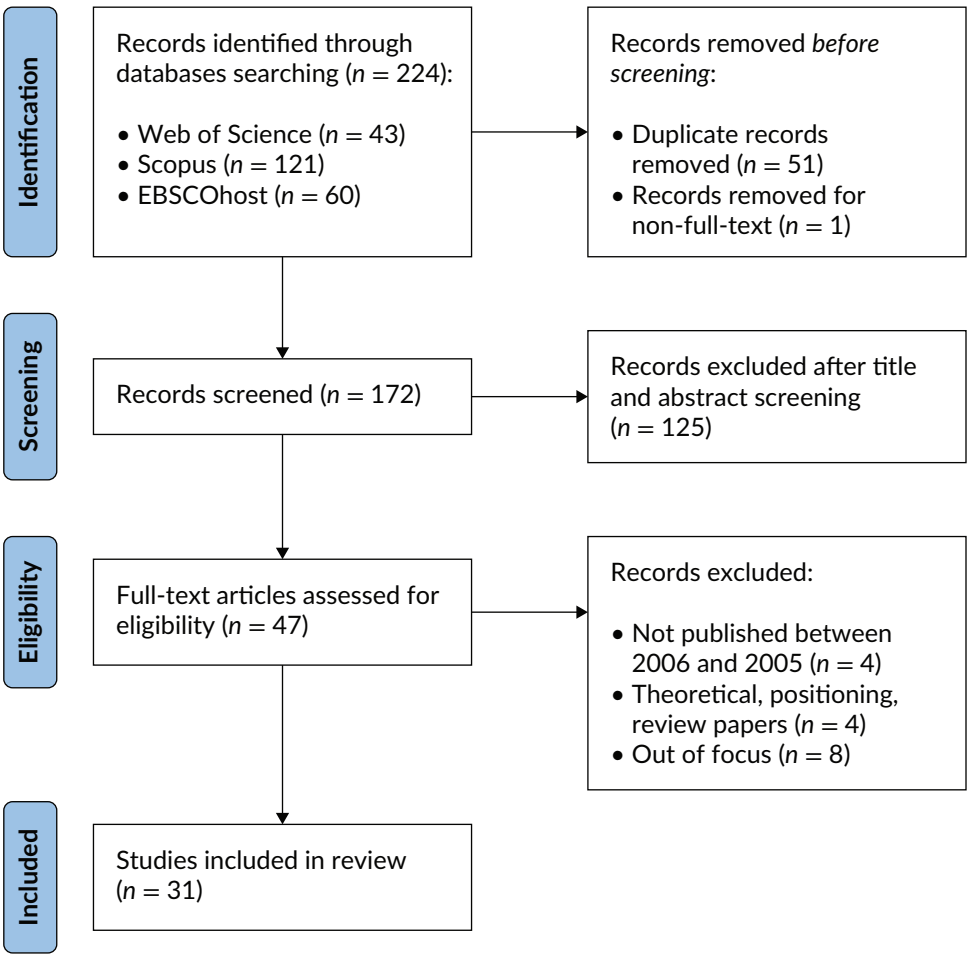

Figure 1. PRISMA flow diagram.

5.3. Data Analysis

To address RQ1 and capture the general characteristics of the 31 studies, we performed a content analysis on each article. This analysis helped us extract information including: (a) publication details such as authors and year of publication, (b) geographical regions where the studies were conducted, (c) study samples such as librarians, the general public, disabled individuals, and the elderly, (d) informal education settings such as public libraries, homes, and museums, (e) methodologies employed, categorized into qualitative, quantitative, or mixed methods, and (f) key research themes that emerged from the studies. To address RQ2 regarding the digital technologies used in the reviewed studies, we extracted and analyzed the following information: (a) types of digital technologies employed, including specific tools such as AR, VR, digital information platforms, and virtual environments; and (b) targeted users, including the general public and specific groups. To examine the role of digital technologies in educational equity (RQ3), we utilized the PROGRESS-PLUS framework. This framework guided our extraction and analysis of the following information: (a) place of residence, such as urban versus rural settings; (b) race, ethnicity, culture, and language, noting issues like social perceptions and language barriers; (c) occupation, assessing employment status, occupational status, and professional rank; (d) gender, considering gender identity and transgender minorities; (e) education, focusing on literacy levels and educational levels; (f) socioeconomic status, examining income and poverty levels; and (g) social capital and support, looking at institutional support and family support. Throughout the analysis, two researchers coded the data and resolved any discrepancies through discussion to ensure consensus and accuracy in the findings.

6. Results

6.1. General Characteristics of Reviewed Studies

A summary of the general characteristics of the reviewed studies is presented in Table 3.

Table 3. A summary of the general characteristics of the reviewed studies.

References	Geographical regions	Informal learning venues	Study samples	Methodology	Theme
Moisey (2007)	Canada	Library	Disabled	Qualitative (documentary review)	Outcomes
Russell and Huang (2009)	US	Library, home	General public	Quantitative (secondary data and survey)	Factors, outcomes
Gomez et al. (2009)	Cross-country	Library, telecentre, cybercafe	General public	Mixed (integrated iterative approach)	Factors
Greyling and Zulu (2010)	South Africa	Library	Indigenous	Mixed (interview, case study, documentary data)	Outcomes
Terry and Gomez (2010)	Cross-country	Library, telecentre, cybercafe	Women	Qualitative (interviews)	Factors, outcomes

Table 3. (Cont.) A summary of the general characteristics of the reviewed studies.

References	Geographical regions	Informal learning venues	Study samples	Methodology	Theme
Gomez and Baron-Porras (2011)	Colombia	Library, telecentre, cybercafe	General public	Mixed (survey, interview, focus group secondary data)	Factors, outcomes
Baron-Porras and Gomez (2012)	Colombia	Library, telecentre, cybercafe	General public	Mixed (interviews, focus groups, secondary data)	Factors, outcomes
Ani et al. (2014)	Nigeria	Library, home	Academic staff	Quantitative (questionnaire)	Factors
Nwakwuo and Nwakwuo (2014)	Nigeria	Library	Experts	Quantitative (questionnaire)	Factors, outcomes
Houghton (2014)	Australia	Library	Experts	Qualitative (interviews)	Outcomes
Gomez (2014)	Cross-country	Library, telecentre, cybercafe	General public	Mixed (interview, survey)	Factors, outcomes
Nyahodza and Higgs (2017)	South Africa	Library	Students, experts	Qualitative (interview, questionnaire)	Factors, outcomes
Beyene (2018)	Norway	Library	Disabled	Qualitative (interview)	Factors, outcomes
Mihelj et al. (2019)	UK	Museum, gallery	General public	Quantitative (secondary data)	Factors, outcomes
Ayoung et al. (2020)	Ghana	Library	Students, experts	Qualitative (interviews, focus groups, observations)	Outcomes
Rana et al. (2020)	Pakistan	Library	Experts	Quantitative (questionnaire)	Factors, outcomes
Manžuch and Macevičiūtė (2020)	Lithuania	Library	Experts	Qualitative (recordings of discussions)	Factors, outcomes
Ledwaba (2020)	South Africa	Library	Experts	Qualitative (interviews)	Factors
Sefyrin et al. (2021)	Sweden	Library	Experts	Qualitative (interviews, focus groups, and observations)	Factors
Gee and Aguilera (2021)	US	Library	Students	Qualitative (recordings of conversation)	Outcomes
Tserklevych et al. (2021)	Ukraine	Museum	Students	Mixed (observation, questionnaire, collection of materials)	Outcomes
Appel et al. (2022)	Canada	Library	Older	Mixed (survey, interviews, recordings of observation, and debriefing)	Outcomes
Casselden (2023)	UK	Library	Older	Qualitative (interviews)	Outcomes
Suman Barath and Sudhier (2023)	India	Library	Users	Quantitative (questionnaire)	Factors, outcomes

Table 3. (Cont.) A summary of the general characteristics of the reviewed studies.

References	Geographical regions	Informal learning venues	Study samples	Methodology	Theme
Kelly et al. (2023)	Canada	Library	Experts, students	Qualitative (observations, interviews, and feedback questionnaires)	Outcomes
Beltrán and Huertas (2024)	Colombia	Community	Indigenous	Qualitative (recordings)	Outcomes
Subaveerapandiyan et al. (2024)	India	Library	Experts	Quantitative (questionnaire)	Factors, outcomes
Ehtasham and Jabeen (2024)	Pakistan	Library	Experts	Qualitative (interviews)	Factors, outcomes
Matsumoto (2025)	Spain	Home	Students	Qualitative (interviews, background questionnaire, activity sheet)	Factors, outcomes
Jung et al. (2025)	US	Library	Older, experts	Mixed (surveys, interviews)	Outcomes
Rahmanova (2025)	Azerbaijan	Library	Students, experts	Mixed (existing data, questionnaire, and interviews)	Factors, outcomes

6.1.1. When: Year of Publication

The earliest study of the 31 empirical research articles on digital technologies in informal education was published in 2007. As shown in Figure 2, there was a noticeable increase in the number of studies post-Covid-19, particularly since 2019. This rise in studies after 2019 likely reflects the rapid adoption of digital tools and platforms in response to the pandemic. The continued growth after 2019 may indicate a heightened focus on how digital technologies can address equity issues and raise new concerns about educational equity in informal education settings. This emerging trend aligns with prior reviews on the studies about the utilization of digital technologies in formal education settings (e.g., Timotheou et al., 2023) and in museums (e.g., Tham et al., 2025), which also show an uptick of studies after 2019. This increase reflects the global pandemic having accelerated paradigm shifts in visitor, learner, and educator behaviors, promoting the expanded use of digital technologies in schools, museum sectors, and tourism industries.

6.1.2. Where: Geographical Regions and Informal Learning Venues

Approximately half of the included articles emanate from Western regions. In specific, the geographical distribution shows that the research on digital technologies in informal education was diverse, spanning multiple continents, with seven studies (22.58%) conducted in Europe (one each from Lithuania, Norway, Spain, Sweden, and Ukraine; two from the UK), six studies (19.35%) in North America (three each from Canada and the US), six studies (19.35%) in Africa (one from Ghana, two from Nigeria, and three from South Africa), and five studies (16.13%) in Asia (one from Azerbaijan, two from India, and two from Pakistan).

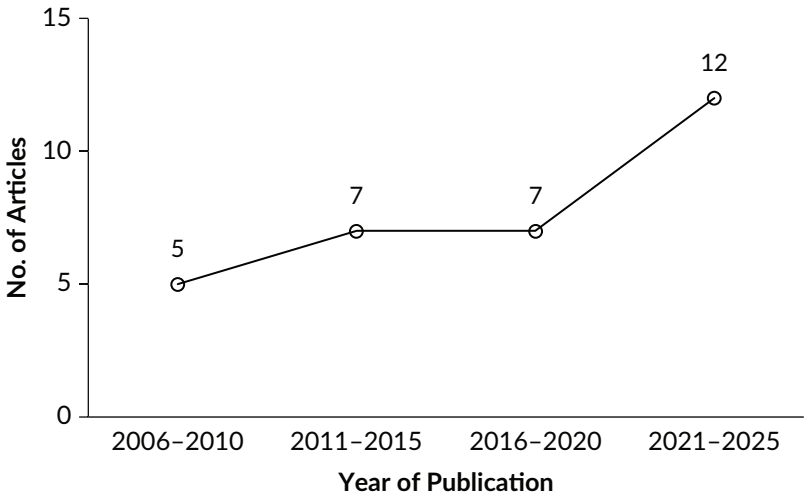

Figure 2. Number of articles published from 2006 to 2025.

Additionally, there were three studies conducted in Colombia (9.68%) and one in Australia (3.23%). Notably, three studies (9.68%) explored cross-cultural differences across 25 countries. This finding differs from other review articles on digital technology in informal education, which typically have identified a predominance of Western-focused research (e.g., Holdgaard & Olesen, 2025). This discrepancy may suggest that studies addressing equity-related issues in digital educational applications may adopt more geographically diverse perspectives.

With regards to informal learning venues, researchers have investigated a diverse range of informal learning environments, such as museums and galleries. Our review study reveals that the majority of research has examined library settings (n = 27), while fewer investigations have focused on alternative environments: cybercafés (n = 5), telecentres (n = 5), homes (n = 3), museums (n = 2), galleries (n = 1), and community settings (n = 1). Notably, five studies simultaneously analyzed libraries, cybercafés, and telecentres, collectively referred to as public access computing (PAC) venues. These diverse settings highlight the multifaceted nature of informal education and demonstrate how digital technologies can be employed across different contexts to promote educational equity and improve learning outcomes.

6.1.3. Who: Study Samples

The studies reviewed targeted a diverse range of population groups. Six of the 31 studies drew participants from the general public, with two of those studies involving participants from multiple countries. Ten studies focused on specific demographic cohorts, including seven studies covering student populations ranging from primary school to postgraduate levels, three investigations focusing on elderly populations, two studies centering on people with disabilities, and one study exploring women; one study examined ethnic minorities (i.e., Indigenous communities). Within the library setting studies, both library experts and users have been included. To be specific, thirteen studies gathered the perspectives from library experts, such as information technology librarians, library managers, information center staff, and library consultants; while twelve studies gathered the perspectives of library users. Importantly, five of these library-focused studies incorporated both perspectives.

In terms of sample size, ten of the 31 studies reviewed did not explicitly report their sample sizes. Specifically, five of the ten studies used datasets from the publicly available results of the Landscape of Public Access to ICT in 25 Countries, which was conducted between 2007 and 2009 by the University of Washington (Gomez, 2010). For the remaining studies, it was suggested that the sample sizes ranged from four to 3,720 participants.

6.1.4. How: Methodologies Employed

The methodologies used in these 31 studies show significant diversity. Specifically, qualitative methods were the most commonly used approach, with a total of fifteen studies employing this method. These typically involved methods of data collection, such as in-depth interviews, focus groups, and participant observation. Seven studies utilized quantitative methods, such as surveys or the analysis of existing datasets. Nine studies employed a mixed-methods approach that combines qualitative and quantitative methods.

6.1.5. What: Research Theme

Empirical research on digital technologies in informal education settings has primarily focused on two themes: (a) factors influencing the use of digital technologies in informal education and (b) outcomes of digital technologies in informal education.

6.1.5.1. Factors Influencing the Use of Digital Technologies in Informal Education

Nineteen studies examined or discussed factors that influence the usage of digital technology in informal education. Van Dijk's (2012) hierarchical model has posited three prerequisite conditions for successful usage of digital services, including motivation to employ digital services, physical and material access to digital technologies, and requisite digital skills. The reviewed studies indicate that cultural attitudes toward technology and gender disparities may impact people's motivations to engage with digital learning resources, while the physical and material access to digital technologies is closely associated with socioeconomic and geographic factors. Rural residence, unemployment, lower occupational status, poverty, and constrained income limit device ownership and access to PAC venues. Moreover, digital literacy levels have been found to be associated with gender and place of residence. For instance, girls and women in developing communities frequently receive inadequate ICT training, or sometimes none at all, compared to males. Individuals in developing nations such as South Africa, India, and Pakistan have been documented to possess lower levels of digital literacy and skills.

Beyond individual determinants, the reviewed literature also identifies significant environmental influences on the usage of digital technology in informal education. Crucially, effective engagement with public digital services requires not only individual motivation, access, and competence, but also "governmental literacy," which refers to the knowledge of how these organizations and services are organized and interrelated (Bernhard et al., 2019). The systematic organizational support infrastructure is critical for resolving unexpected technical disruptions and sustaining user engagement with digital technologies. In the present review, three studies emphasized the importance of library professionals' data literacy and care in determining users' abilities and motivations to integrate digital technology into informal learning.

6.1.5.2. Outcomes of the Use of Digital Technologies in Informal Education

The outcomes of integrating digital technologies in informal education settings have been examined across twenty-nine studies. Among these, a notable emphasis has been placed on the role of digital technology within public libraries, emphasizing it as a crucial tool in bridging the digital divide between rural and urban populations, different age groups, and individuals from varying socioeconomic backgrounds. The nineteen studies collectively suggest that the utilization of digital technologies in informal education environments has proven to be effective in enhancing digital skills and informal learning experiences, and it is applicable to a wide range of populations. For example, indigenous populations have notably enhanced their skilled trades and knowledge in carpentry through the application of AR technologies. Children have exhibited improved learning outcomes, including enhanced digital skills, critical literacies, and social connections, as a result of engaging with various digital technologies in informal learning settings such as game-making practices and VR experiences. Elderly individuals have reported reduced feelings of loneliness through participation in VR activities, while also enhancing their digital literacy via library digital literacy programs. Individuals with disabilities have found additional avenues for learning through the use of specialized digital tools. Patrons of libraries have displayed a heightened interest in informal learning facilitated by immersive technologies deployed in library settings.

6.2. General Characteristics of Digital Technologies

The digital technologies covered in the studies reviewed are characterized by two dimensions: the types of digital technologies and their target users (Table 4). Digital technologies can be divided into three main types: general digital technologies, advanced digital technologies, and digital-related programs and services. General digital technologies refer to basic tools like internet-equipped computers, printers, and CD-ROMs. Advanced digital technologies encompass digital information platforms (e.g., online public access catalogues, e-libraries, e-museum, e-gallery, and community web portals), virtual environments, VR, AR, AI, and natural language processing (NLP). Digital-related programs and services include initiatives like workshops that enhance digital literacy and coding games. In terms of target users, the technologies are tailored for two main groups: the general population and specific demographics, which include individuals such as those with disabilities, the elderly, and children.

The majority of the reviewed studies primarily focus on general digital technologies (87.10%) and target the general population (64.52%). Recent years have witnessed the emergence of advanced digital technologies in informal education settings. For instance, online platforms (48.39%) are among the most frequently utilized advanced digital technologies in libraries, museums, and galleries. These platforms not only provide digital information but also offer virtual environments, enabling remote access to resources and enhancing individuals' understanding of the locations of these institutions and exhibits without physical visits. Furthermore, the integration of other advanced digital technologies has significantly enriched informal education experiences. The incorporation of AI and NLP in libraries has improved search accuracy, personalized recommendations, and automated various tasks. Additionally, the use of AR in conjunction with mobile learning environments has facilitated Indigenous peoples in comprehending the entire carpentry manufacturing process more easily. Moreover, the elderly have reported decreased feelings of isolation, improved social connections, and enhanced confidence in adopting innovative technologies as a result of engaging in activities such as watching VR films. These advancements underscore the growing potential of

advanced digital technologies to enhance informal education experiences, catering to diverse audiences, and fostering enriched learning opportunities beyond traditional educational frameworks.

Table 4. A summary of the general characteristics of digital technologies.

References	Types of digital technologies			Target users	
	General	Advanced	Program/service	General	Specific
Moisey (2007)	✓				Disabled
Russell and Huang (2009)	✓			✓	
Gomez et al. (2009)	✓			✓	
Greyling and Zulu (2010)		Digital information platforms			Indigenous
Terry and Gomez (2010)	✓				Women
Gomez and Baron-Porras (2011)	✓			✓	
Baron-Porras and Gomez (2012)	✓			✓	
Ani et al. (2014)		Digital information platforms, virtual environment		✓	
Nwakwuo and Nwakwuo (2014)		Digital information platforms		✓	
Houghton (2014)	✓			✓	
Gomez (2014)	✓			✓	
Nyahodza and Higgs (2017)	✓	Digital information platforms	✓	✓	
Beyene (2018)	✓				Disabled
Mihelj et al. (2019)		Digital information platforms, virtual environment		✓	
Ayoung et al. (2020)	✓	Digital information platforms	✓	✓	
Rana et al. (2020)		Digital information platforms		✓	
Manžuch and Macevičiūtė (2020)	✓	Digital information platforms	✓	✓	
Ledwaba (2020)	✓			✓	
Sefyrin et al. (2021)	✓	Digital information platforms	✓	✓	
Gee and Aguilera (2021)			✓		Children
Tserklevych et al. (2021)		Digital information platform, virtual environment			Children
Appel et al. (2022)		VR	✓		Older

Table 4. (Cont.) A summary of the general characteristics of digital technologies.

References	Types of digital technologies			Target users	
	General	Advanced	Program/service	General	Specific
Casselden (2023)			✓		Older
Suman Barath and Sudhier (2023)	✓	Digital information platform, virtual environment	✓	✓	
Kelly et al. (2023)			✓		Children
Beltrán and Huertas (2024)		AR	✓		Indigenous
Subaveerapandiyan et al. (2024)	✓	Virtual environment, AR, VR, AI, mixed reality, NLP, and extended reality		✓	
Ehtasham and Jabeen (2024)		Digital information platform		✓	
Matsumoto (2025)	✓				Children
Jung et al. (2025)			✓		Older
Rahmanova (2025)	✓	AR, VR		✓	

6.3. The Role of Digital Technologies in Educational Equity: PROGRESS-PLUS Framework

The findings on the role of digital technologies in promoting educational equity within informal education are organized according to the dimensions of the PROGRESS-PLUS framework (Table 5). Since no studies pertaining to the dimension of religion were found, our analysis primarily concentrated on the other eight dimensions. Notably, out of the 31 studies reviewed, fifteen studies have addressed multiple aspects of the PROGRESS-PLUS framework.

6.3.1. Place

In the current review, eighteen studies provide insights into the impact of digital technology on informal education for residents in diverse places. The reviewed studies underscore the positive effects of digital technology, such as PAC venues and e-libraries, on residents in rural and urban areas, developing countries and cities, as well as marginalized and underserved communities. These technologies help bridge the digital divide, enhance access to informal learning materials, and empower individuals to engage in self-directed learning processes. However, these places often lack access to digital infrastructure due to the absence of personal computers in households, limited ICT services, and challenges in internet accessibility.

6.3.2. Race, Ethnicity, Culture, and Language

Twelve reviewed studies have explored the associations between the use of digital technologies in informal education and individuals' race, ethnicity, culture, and language. Their findings present a mixed picture regarding the impacts of digital technology on ethnic and racial minorities. Two studies suggest that these groups have limited access to ICT and visit online museums and galleries less frequently, while another study indicates that AR technology has benefited Indigenous populations. In terms of culture, three studies have

Table 5. A summary according to PROGRESS-PLUS framework.

References	Place	Race, ethnicity, culture, language	Occupation	Gender and sex	Education	Socioeconomic status	Social capital	Plus
Moisey (2007)	Rural							Disability
Russell and Huang (2009)	Rural	Ethnicity	Unemployment		Educational attainment	Income		
Gomez et al. (2009)	Rural	Language		Gender			Institutional support	
Greyling and Zulu (2010)		Language				Income		
Terry and Gomez (2010)	Rural	Language, culture		Gender, transgender	Educational attainment, literacy			
Gomez & Baron-Porras (2011)	Marginalized Community		Unemployment					
Baron-Porras and Gomez (2012)	Marginalize community						Institutional support	
Ani et al. (2014)	Developing country		Professional rank	Gender				
Nwakwuo and Nwakwuo (2014)							Institutional support	
Houghton (2014)	Urban							
Gomez (2014)	Developing country	Language, culture		Gender	Educational attainment	Income		
Nyahodza and Higgs (2017)	Developing country	Race, language				Income	Institutional support	
Beyene (2018)		Language						Disability
Mihelj et al. (2019)	Rural	Ethnicity	Occupational class	Gender	Educational attainment			Older
Ayoung et al. (2020)	Rural							

Table 5. (Cont.) A summary according to PROGRESS-PLUS framework.

References	Place	Race, ethnicity, culture, language	Occupation	Gender and sex	Education	Socioeconomic status	Social capital	Plus
Rana et al. (2020)							Institutional support	
Manžuch and Macevičiūtė (2020)	Rural					Income		
Ledwaba (2020)	Rural							
Sefyrin et al. (2021)		Language					Institutional support	Older
Gee & Aguilera (2021)								Children
Tserklevych et al. (2021)								Children
Appel et al. (2022)								Older
Casselden (2023)								Older
Suman Barath & Sudhier (2023)					Literacy			
Kelly et al. (2023)	Rural							Children
Beltrán & Huertas (2024)		Language, ethnicity						
Subaveerapandiyan et al. (2024)		Language, culture					Institutional support	
Ehtasham & Jabeen (2024)	Rural	Language						
Matsumoto (2025)						Income	Family support	Children
Jung et al. (2025)	Rural							Older
Rahmanova (2025)	Rural							

indicated that cultural attitudes towards digital technology can impact the incorporation of digital technologies into informal education. In cultures where digital technologies are deemed inappropriate or distrusted, individuals may have limited access to informal education through digital means. In cultures where digital activities are perceived as exclusive to certain groups, the opportunities for individuals to engage with digital technologies in informal education may be further restricted. Language has also been identified as a significant challenge in utilizing digital technologies. For example, issues include the lack of instructions for digital tools and platforms in users' native languages or plain language, as well as a shortage of content available in local languages on online resource platforms.

6.3.3. Occupation

Our review identified four studies that examined how occupation influences the use and access to digital technologies. Two of these studies suggest that PAC venues, particularly public libraries, can help unemployed individuals receive digital literacy training and, in turn, access more opportunities to secure employment. In contrast to individuals in lower professional positions, those in higher professional positions were found to be less likely to access digital resource platforms, which was attributed to their age. Academic staff in higher professional positions tend to be older than their counterparts in lower positions. Furthermore, individuals in higher occupational classes demonstrated a greater inclination to visit online museums and galleries.

6.3.4. Gender

Five studies have revealed that gender is associated with patterns of using digital technologies in informal learning settings. The development of digital technologies in informal education offers women individual benefits, such as increased self-esteem, reduced isolation, and access to markets, as well as collective benefits, including economic growth, improved health, and education. However, women have been found to have less access to digital technologies in informal education compared to men. Gender also influences the choice of venues for accessing digital technologies, with women more likely to opt for public libraries while men are more inclined to choose cybercafes. Additionally, women are more likely to visit online museums and galleries than men. One study also highlights the challenges faced by transgender minorities in accessing digital technologies in PAC venues.

6.3.5. Education

Four reviewed articles indicate that educational attainment and literacy play vital roles in shaping individuals' utilization of digital technologies for informal education. Two studies indicate that educational attainment is positively correlated with the frequency of using digital technologies and access to digital infrastructures. Moreover, individuals with higher educational levels exhibit a greater tendency to explore online museums and galleries than their less-educated counterparts. Interestingly, individuals with a high school education represent the most common demographic visiting PAC venues, exceeding the number of college-educated individuals. This trend could be explained by the fact that college-educated individuals often have personal computers at home. In addition to educational attainment, two studies underscore the significance of literacy. Individuals with lower levels of literacy encounter more obstacles when utilizing digital technologies in their informal educational pursuits.

6.3.6. Socioeconomic Status

Six studies have examined the relationship between socioeconomic status and the impact of digital technologies. Individuals with lower incomes are less likely to own computers, have limited internet access, and are more inclined to visit PAC venues due to the absence of personal computers at home. Consequently, the provision of free internet in libraries and digital literacy programs organized by libraries can significantly benefit individuals with low incomes.

6.3.7. Social Capital

Six studies discuss the concept of social capital. Specifically, four studies concentrate on the support and care provided by library staff. The assistance not only aids individuals in utilizing digital technologies for informal education but also enhances their confidence and willingness to engage with these tools. The current review reveals that many informal educational environments, such as libraries and museums, are deficient in technical expertise and adequate digital training for their staff. One study has explored the impact of family support on children's informal learning during the Covid-19 period, indicating the potential influence of family support on children's access to digital technology for informal education.

6.3.8. PLUS: Other Characteristics

6.3.8.1. Age

A broad spectrum of age groups has been encompassed in the eight studies reviewed. For instance, in a library's digital technology-related project, elderly individuals may alleviate feelings of loneliness and enhance their digital literacy and digital inclusion. Nevertheless, the integration of digital tools in informal educational settings poses challenges for elderly individuals, who often encounter barriers such as limited access to digital infrastructure and lower digital proficiency levels. Furthermore, the utilization of digital technologies in household and museum settings results in enhanced learning engagement and outcomes for children.

6.3.8.2. Disability

Two reviewed studies have presented findings related to individuals with disabilities. One study examined the impact of providing web-based ICT and traditional library resources to individuals with developmental disabilities, demonstrating improvements in information acquisition, social network expansion, and bridging the digital divide. One study emphasized the advantages of digital technology in informal education for individuals with print disabilities, highlighting the use of digital text formats to cater to their specific needs and preferences, while also addressing the challenges faced. Another study, while not directly focusing on individuals with disabilities, explored the potential of digital technology to promote inclusivity in informal education, drawing insights from interviews with library staff and regular users. Additionally, two studies have expressed concerns that individuals with certain disabilities, such as visual impairments, may not derive benefits from online museums, online galleries, and immersive technologies; instead, these technologies could potentially exacerbate existing inequalities.

7. Concluding Remarks

This scoping review examines the use of digital technologies in informal education and their roles in promoting educational equity, acknowledging several limitations. First, certain digital technologies implemented in educational settings were not originally designed for educational purposes (Major et al., 2018) but have been adapted for use in informal education. While the current databases provided access to a wealth of digital-related articles, specialized databases focusing on digital technology, such as IEEE Xplore Digital Library, Engineering Village (Compendex), ACM Digital Library, and ScienceDirect, were not included in this review. Future review studies are recommended to include these prominent databases to achieve a more comprehensive review. Second, we included equity-related terms to strengthen the relevance of our review study findings. However, some prior reviews using the PROGRESS-PLUS model did not explicitly include equity-related terms in their research methodologies. Instead, these studies indirectly assessed the level of equity by analyzing the proportions and characteristics of participants according to the dimensions of the PROGRESS-PLUS framework (e.g., Woolley et al., 2023). Future research could benefit from a deeper examination of participant characteristics relating to the use of digital technology in informal education settings, with the aim of uncovering the underlying dynamics of equity.

Despite these limitations, this scoping review has offered valuable insights into the use of digital technologies in informal education, with a specific focus on educational equity, particularly within the GBA context. The following sections will discuss: (a) the challenges of digital technologies in informal education, (b) the opportunities provided by digital technologies in informal education, and (c) insights for advancing informal education equity in the GBA.

7.1. Challenges of Digital Technologies in Informal Education

The integration of digital technologies in informal education faces various challenges due to organizational limitations and individual variances. Our review has identified that organizational support plays a crucial yet often inadequate role in addressing two categories of challenges. For one, many professionals in informal education, such as librarians, lack sufficient training, leading to difficulties in utilizing digital technologies, mastering digital resources integration, addressing privacy concerns, and ensuring accessibility for all users (Ehtasham & Jabeen, 2024; Manžuch & Macevičiūtė, 2020; Rana et al., 2020; Subaveerapandiyan et al., 2024). In addition to the challenges experienced by professionals in informal education, the institutions grapple with a variety of obstacles. Public libraries, for instance, often struggle with limited funding, insufficient digital infrastructure, challenges related to institutional and governmental policies, lack of expertise, and the necessity for infrastructure upgrades (Ayoung et al., 2020; Ehtasham & Jabeen, 2024; Manžuch & Macevičiūtė, 2020; Nwakwuo & Nwakwuo, 2014; Subaveerapandiyan et al., 2024). These organizational challenges lead to a lack of timely support and care for individuals, further exacerbating the difficulties people face when using digital technologies in informal settings.

Regarding individual variances, the findings of this scoping review align with Dawson's (2014) framework, which identifies three fundamental challenges concerning access, equity, and inclusion in informal education: infrastructure accessibility, literacy levels, and community acceptance. First, infrastructure accessibility serves as a fundamental element of inclusion, denoting the degree to which individuals can access the institutions and resources under consideration (Porter, 1998). It is closely linked to users' socioeconomic and

geographic factors. Our review has found that the factors such as rural residency (Gomez et al., 2009; Ledwaba, 2020; Nwakwuo & Nwakwuo, 2014; Nyahodza & Higgs, 2017; Rahmanova, 2025; Russell & Huang, 2009; Terry & Gomez, 2010), unemployment (Gomez & Baron-Porras, 2011; Gomez et al., 2009; Russell & Huang, 2009), lower occupational status (Ani et al., 2014), poverty (Gomez & Baron-Porras, 2011; Gomez et al., 2009; Terry & Gomez, 2010), and limited income (Gomez, 2014; Russell & Huang, 2009) restrict device ownership and access to PAC facilities. These individual factors, such as occupation status and income, are intertwined, potentially leading to compounded effects on digital inequity. The second challenge lies in the varying levels of digital literacy and skills. Digital literacy is about the ability to effectively utilize an infrastructure and its associated resources for personal benefit (Porter, 1998). Our scoping review has suggested that gender and place of residence are key factors associated with digital literacy disparities. For example, women in developing communities often receive inadequate ICT training compared to men (Terry & Gomez, 2010). Residents of developing countries like South Africa, India, and Pakistan have been reported to exhibit lower levels of digital literacy and skills (Ehtasham & Jabeen, 2024; Nyahodza & Higgs, 2017; Suman Barath & Sudhier, 2023). These gaps in digital literacy are not merely a reflection of unequal access to digital technology but also an outcome of existing digital inequities. Lower digital literacy can perpetuate a cycle where marginalized groups remain at a disadvantage in terms of accessing digital opportunities and benefits. Third, community acceptance poses a notable challenge to integrating digital technologies in informal education. Community acceptance, in particular, centers on fostering inclusivity for groups that have historically been marginalized (Porter, 1998). Therefore, in addition to creating more accessible informal learning opportunities, considering the utilization of a wider array of languages could be crucial (Dawson, 2014). Cultural attitudes toward technology significantly influence individuals' willingness to engage with digital educational tools. Societies that view digital technology as inappropriate or belonging to specific groups may exhibit lower motivation to access informal education through digital platforms (Gomez et al., 2009; Subaveerapandiyan et al., 2024; Terry & Gomez, 2010). Language barriers further compound the issue (Beltrán & Huertas, 2024; Ehtasham & Jabeen, 2024; Nyahodza & Higgs, 2017; Sefyrin et al., 2021).

To address organizational challenges and reduce the impact of individual variances, it is essential to tailor training programs for professionals to suit audience characteristics and digital technology features. Apart from pursuing formal degree programs like a master's degree in library science, professionals in the field can also enhance their knowledge through other institutions and platforms, such as the American Library Association and Library Juice Academy. Organizations must guide professionals on utilizing their digital technologies because proficiency in digital technologies equips professionals to effectively support audiences facing challenges in utilizing these resources. Advocating for increased funding and support for public institutions like libraries and museums to enhance their access and digital infrastructure is crucial. Noteworthy initiatives include the European Commission's proposals and financial aid to encourage museum collaborations with creative and technology partners (European Union, 2023). Additionally, non-profit organizations like the Hong Kong Jockey Club have partnered with entities such as the Palace Museum to promote Chinese cultural and arts tech talent development in Mainland China and Hong Kong (Hong Kong Palace Museum, 2025).

7.2. Opportunities of Digital Technologies in Informal Education

Our scoping review highlights the substantial opportunities that digital technologies present in informal education, particularly in promoting educational equity and inclusivity. First, public libraries are pivotal,

providing access to digital tools and literacy programs, thereby helping to bridge the digital divide for a variety of communities. Specifically, one crucial aspect involves providing affordable or free access to digital tools in informal learning settings and digital literacy programs. Public libraries serve as key locations where individuals lacking personal digital devices can access these resources (Gomez, 2014; Greyling & Zulu, 2010; Houghton, 2014; Russell & Huang, 2009). Efforts focused on digital technologies within public libraries and community spaces show promise in bridging the digital gap across diverse demographics, including rural and urban populations as well as individuals across various age groups; through these programs, societal engagement and professional opportunities are enhanced for participants (Appel et al., 2022; Beltrán & Huertas, 2024; Casselden, 2023; Ehtasham & Jabeen, 2024; Jung et al., 2025; Kelly et al., 2023; Manžuch & Macevičiūtė, 2020).

Second, in line with prior reviews on AR in informal science learning settings (Goff et al., 2018), our review suggests that the use of advanced technologies such as AR and VR has enriched learning experiences for individuals across all age groups and backgrounds. Specifically, indigenous communities have enhanced carpentry skills through AR technologies (Beltrán & Huertas, 2024). Children, engaging with digital tools such as game-making practices and VR experiences, have demonstrated improvements in digital skills, critical literacies, and social connections (Ayoung et al., 2020; Gee & Aguilera, 2021; Kelly et al., 2023; Tserklevych et al., 2021). Elderly individuals have reported diminished feelings of isolation as a result of participating in VR activities (Appel et al., 2022). Library patrons have exhibited heightened interest in informal learning opportunities facilitated by immersive technologies integrated into library environments (Subaveerapandiyan et al., 2024).

Third, the application of digital technologies in informal education not only enhances educational engagement but also has been shown to improve digital skills and social connections, enhancing the inclusivity of disadvantaged groups. Local public libraries serve as invaluable resources for adults with developmental disabilities, providing not only traditional library amenities but also access to web-based Information and communication technology (Moisey, 2007). Within these spaces, individuals facing print disabilities acknowledge the advantages of digital text formats, which cater to their diverse needs and preferences (Beyene, 2018). These findings are consistent with prior research in formal education. For example, a recent meta-analysis by Baragash et al. (2022) involving 119 participants with various disabilities demonstrated a significant positive effect of AR on their acquisition of functional skills. Koh's meta-analysis (2022) also indicated that students with intellectual and developmental disabilities showed improvement in competence and performance through the use of digital games in educational settings.

7.3. Insights for Educational Equity in Informal Education in GBA

Considering the multifaceted challenges and opportunities identified in the review, several key insights emerge for enhancing informal education equity in the GBA in China. Strategies focusing on digital accessibility, cultural diversity, multilingual support, and digital literacy empowerment can collectively promote inclusive and equitable educational opportunities for all residents within the diverse and dynamic GBA.

On the basis of the PROGRESS-PLUS framework, further insights for enhancing educational equity in informal education in the GBA can be made. First, it is essential to consider regional disparities, which may

cause discrepancies in physical and material access to digital technologies. This scoping review highlights that rural residents and individuals with lower incomes often encounter barriers to obtaining physical and material access to digital technologies. While a significant number of individuals reside in urban areas in the GBA, there are still individuals living in rural areas (Zheng, 2019). Second, income gaps may exist among different cities in the GBA, with Hong Kong and Macau exhibiting higher per-capita GDP compared to the other nine cities (HKTDC Research, 2024). Public libraries may play a crucial role in bridging this access gap by providing essential resources and opportunities for underserved communities. Therefore, public libraries and PAC venues could help to bridge access gaps for underserved communities.

Furthermore, diverse cultural representation in digital learning resources plays a vital role in sustaining individuals' motivation and willingness to engage in informal education. Within the reviewed studies, a predominant focus on mainstream cultures on the digital information platforms is observed, neglecting the dissemination of minority community cultures. By broadening the scope of cultural representation in digital platforms, minority communities can feel more engaged and connected to the educational content, fostering a sense of belonging and cultural appreciation. The GBA stands out for its diverse social ideologies and cultural contexts (X. Xie et al., 2023). Therefore, inclusivity and representation of various cultural backgrounds on the information platforms are important. Language barriers may present additional hurdles to digital technology utilization in informal education settings. In the GBA, where Cantonese, Mandarin, and English are predominantly spoken, alongside languages such as Portuguese in Macau, and Pakistani and Tamil in Hong Kong, accommodating linguistic diversity is crucial (Zheng, 2019). The adoption of multilingual features, such as AI-powered translation tools and audio guides, could enhance accessibility for these diverse language groups (Yang & Mustafa, 2024).

It is also crucial to address disparities in digital literacy. The reviewed studies have illustrated that low digital literacy leads to more barriers and less confidence in using digital technologies in informal learning processes. Diverse levels of digitization across the GBA can result in similar barriers for individuals. For example, older individuals from Hong Kong may encounter more challenges in utilizing digital technologies when they are in the more digitally advanced city of Shenzhen (Yang et al., 2023). The Covid-19 pandemic has accelerated the use of digital technologies in informal education within the GBA. For example, a series of online exhibitions during the Covid-19 pandemic has influenced the GBA's museum to develop its collections from offline to online (Zhang & Liu, 2025). This adjustment highlights the importance of bridging disparities in digital literacy. Targeted interventions, such as digital literacy workshops and expert support in public libraries, are pivotal in bridging these gaps and ensuring equitable access to digital resources.

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Conflict of Interests

The authors declare no conflict of interests.

Data Availability

Due to the nature of the research, data sharing is not applicable to this article.

LLMs Disclosure

During the preparation of this work, the authors used LLMs (ChatGPT-4-Turbo and AI-powered DeepL) for language proofreading to ensure clarity of presentation. After using the tools, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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About the Authors

Yufei Jiang is a lecturer and distinguished associate research fellow at Hangzhou City University. Her research primarily focuses on the impacts, outcomes, and interventions related to social exclusion and objectification. She has systematically extended her research agenda to incorporate behavioral approaches in public administration studies.

Chaoqun Lu is a research assistant professor at the University of Macau. Her primary research interests lie at the intersection of language education and science education. She has conducted extensive research on how science teachers teach in secondary EMI settings. She is also interested in AI/digital literacy and systematic reviews.

Bin Hu is an associate professor at Hangzhou City University, specializing in legal and regulatory frameworks for tourism, study-abroad programs, and cultural heritage preservation. His research focuses on international education contracts, tourism policy standardization, and the legal governance of museums and cultural institutions.