Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

A Bibliometric Analysis of Digital and Information Literacy Research in Higher Education

Ahmad Fawaid Hariry

220104220026@student.uin-malang.ac.id

Universitas Islam Negeri Maulana Malik Ibrahim

Muh khairul wajedi imami

University of Technology Malaysia

Research Article

Keywords: digital literacy, information literacy, higher education, bibliometrics, Scopus, biblioshiny

Posted Date: November 5th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11293687/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

A BIBLIOMETRIC ANALYSIS OF DIGITAL AND INFORMATION LITERACY RESEARCH IN HIGHER EDUCATION

Ahmad Fawaid Hariry[1], Muh. Khairul Wajedi Imami[2]

220104220026@student.uin-malang.ac.id , khaerulalimam97@gmail.com

[1]Department of Arabic Language Education, Universitas Islam Negeri Maulana Malik Ibrahim Malang, Malang, Indonesia

[2]Faculty of Educational Sciences and Technology, Universiti Teknologi Malaysia, Johor Bahru, Malaysia

*Corresponding author: Ahmad Fawaid Hariry 220104220026@student.uin-malang.ac.id

Abstract

Digital and information literacy have become fundamental competencies for students and academic staff amid digital transformation and generative artificial intelligence. This study maps the growth, collaboration, and knowledge structure of digital-information literacy research in higher education through bibliometric analysis. Data were retrieved from Scopus (exported 16 September 2026), yielding 2,449 initial records. Rule-based inclusion-exclusion screening of titles, abstracts, and keywords produced 1,579 relevant articles published 2015-2026. Analysis was conducted using bibliometrix/biblioshiny in R, covering annual publication and citation trends, country/institution/author distribution and collaboration, source analysis, keyword co-occurrence, trend topics, and thematic mapping. Results show steady growth from 53 articles (2015) to 260 (2025), led by the United States, United Kingdom, and Spain, though author collaboration remains highly fragmented. The thematic map separates a methodologically oriented motor theme ("human," "humans," "education") from a large cluster of core literacy keywords ("digital literacy," "information literacy," "higher education"), while trend topics show "artificial intelligence" and "AI literacy" emerging as fast-growing themes since 2023. Compared with prior bibliometric studies that typically stop at 2023–2024 and rely on a single "digital literacy" keyword, this study broadens the literacy construct and extends coverage to mid-2026, applying explicit rule-based screening. Findings offer empirical guidance for researchers, higher-education policymakers, and academic librarians in shaping literacy strategies for the generative-AI era.

Keywords: *digital literacy; information literacy; higher education; bibliometrics; Scopus; biblioshiny*

1. INTRODUCTION

The emergence of generative artificial intelligence (AI) since late 2022 has fundamentally reshaped the digital competencies required of students and academic staff in higher education. Chan and Lee's (2023) study on the generation gap in ChatGPT adoption found that Generation Z students are significantly more willing to adopt generative AI tools for learning than Generation X or millennial instructors, creating a new literacy divide between teachers and learners. In parallel, a transnational survey by Mansoor et al. (2024) across multiple countries found wide variation in university students' AI literacy levels, while Haroud and Saqri (2025) reported diverging perceptions between teachers and students regarding whether generative AI replaces or merely supports conventional digital-literacy

skills. Related studies likewise document a GenAI divide among university students (Beckman et al. 2025), students' perceptions of AI integration in higher education (Slimi et al. 2025), and the links between digital literacy, use of AI tools, and AI-assisted learning (Joseph et al. 2024), as well as students' experiences with ChatGPT as a learning tool in health management (Naamati-Schneider 2024), while Chen et al. (2025) compared help-seeking with ChatGPT and with a human expert. Efforts to build generative-AI literacy include workshop-based interventions (Sullivan et al. 2024), and institutional concerns extend to AI governance and ethical AI literacy (Oncioiu & Bularca 2025). This phenomenon underscores that digital literacy in higher education is no longer merely the ability to operate devices, but increasingly the capacity to critically reason about the outputs of AI systems.

Digital transformation in higher education predates the COVID-19 pandemic, but the pandemic dramatically accelerated its urgency. Farias-Gaytan, Aguaded, and Ramirez-Montoya's (2023) systematic review on digital transformation and digital literacy within the complexity of higher education institutions concluded that universities worldwide must redesign their learning ecosystems to keep pace with technological change. Deroncele-Acosta, Palacios-Núñez, and Toribio-López (2023) similarly argued that post-COVID-19 technological innovation has become a permanent catalyst for digital transformation in higher education rather than a temporary emergency response. Concurrently, frameworks for teachers' digital competence have been elaborated in greater detail, as reflected in the HeDiCom framework proposed by Tondeur et al. (2023) to map higher-education teachers' digital competencies for the future. Empirical work has also examined digital literacy and competence among diverse groups in higher education, including students in health-based programmes (Aydınlar et al. 2024), first-year students in online delivery (Budiman & Syafrony 2023), students with disabilities (Cabero-Almenara et al. 2023), education-field students and stakeholders (Sarva et al. 2023), and undergraduates' views of the digital literacies they need (Smith & Storrs 2023), as well as among teaching and administrative staff, such as EFL teachers (Feng & Sumettikoon 2024), EFL lecturers' TPACK-SAMR digital literacy competence (Muslimin et al. 2023), digital competence in research work (Guillén-Gámez et al. 2024), and administrative staff (Kabakus et al. 2025). Rubric-based frameworks have also been developed to measure student and educator digital competence beyond self-assessment (González-Mujico 2024).

Conceptually, digital literacy and information literacy are two intersecting constructs whose meanings continue to evolve alongside technological change. Inamorato dos Santos et al. (2023) define academics' digital competence as a multidimensional capacity encompassing pedagogical, ethical, and reflective technology use, highlighting persistent variation across institutions (is the glass half empty or half full). Lo (2023) extends the classic Association of College and Research Libraries (ACRL) information literacy framework through a CLEAR path approach that integrates prompt-engineering skills as part of information literacy in the generative-AI era. James and Filgo (2023) likewise examine where ChatGPT fits within the Framework for Information Literacy, discussing the possibilities and

problems of AI in library instruction. Ndungu (2024) proposes a framework for integrating basic AI literacy into media and information literacy programmes in higher education, and Anson (2024) discusses the impact of large language models on students' literacy development through the academic literacies framework. This definitional shift is reinforced by Naamati-Schneider and Alt (2024), who argue that conventional digital literacy must expand into the capacity to collaborate reflectively with AI-powered assistants, given that user skills continue to evolve alongside newly emerging tools. The construct also extends beyond technology skills: information literacy has been appropriated across other disciplinary landscapes (Hicks et al. 2023), feedback literacy has been reconceptualised as an event (Gravett & Carless 2024), digital citizenship has been examined through digital literacy practice (Gu et al. 2023), and the design of assessment in a digital world has been framed through organising and authentic-assessment perspectives (Bearman et al. 2023; Nieminen et al. 2023). Libraries, in turn, are positioned within digital inclusion and digital-literacy education (Wang & Si 2024) and in digital pedagogies for librarians (Saib et al. 2023). Digital-information literacy in contemporary higher education is thus understood as a dynamic, layered competency that is never truly “mastered.”

Bibliometric research on digital literacy in higher education is not new. Latifah, Winoto, and Khadijah (2024), published in IQRA': Jurnal Ilmu Perpustakaan dan Informasi (Sinta 2-accredited), analyzed 646 Scopus documents from 2014–2023 and found the United Kingdom, Spain, and the United States dominating scientific output, with Education and Information Technologies as the most-cited journal. A comparable study by Maspiroh, Rohamtillah, and Anggraheni (2026) analyzed 457 Scopus articles from 2018-2024 using R-Biblioshiny and concluded that integration of digital tools and online learning platforms was the dominant topic. These studies consistently confirm rapid publication growth, but also explicitly recommend further research with broader construct coverage and updated data for subsequent periods.

Nevertheless, these prior bibliometric studies carry several limitations that open space for the present research. First, most restrict their search to the single keyword “digital literacy,”leaving information literacy, academic literacy, and the rapidly growing AI-literacy construct since 2023 inadequately captured. Second, the data ranges used generally stop at 2023 or 2024, missing the post-generative-AI publication surge that has become the hottest topic in 2024-2026. Third, most prior studies analyze the entire raw Scopus search output without explicit topical-relevance screening, risking inclusion of documents that merely mention literacy in passing rather than as a research focus. This study seeks to fill these gaps by combining digital, information, academic, and AI literacy constructs simultaneously, extending the data period to mid-September 2026, and applying rule-based inclusion-exclusion screening to 2,449 initial records to ensure that the 1,579 analyzed articles genuinely focus on literacy within a higher-education context.

Based on the foregoing, this study aims to dissect six key aspects of digital-information literacy research development in higher education over 2015–2026: (1) annual publication growth trends and citation patterns; (2) geographic distribution and cross-country collaboration patterns; (3) institutional contribution and productivity trends; (4) author productivity, impact, and collaboration patterns; (5) the distribution and influence of journals publishing this research; and (6) the field's knowledge structure via keyword co-occurrence analysis, trend topics, and thematic mapping. These findings are expected to serve as an empirical reference for researchers, higher-education policymakers, and academic librarians in formulating student-literacy strategies relevant to the challenges of the generative-AI era.

2. METHOD

2.1 Data Source and Retrieval Procedure

Data were retrieved from the Scopus database on 16 September 2026 using a combined search strategy covering digital, information, academic, media, data, and AI literacy constructs within a higher-education context. The initial search yielded 2,449 records with complete metadata (title, abstract, authors, affiliations, keywords, citations, DOI, and document type), which subsequently underwent a screening stage before bibliometric analysis.

2.2 Selection Procedure (PRISMA Flow Diagram)

The record-selection process adapts the logic of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow, commonly used in systematic reviews, modified for large-scale bibliometric screening. The selection flow comprises four stages: identification, screening of titles, abstracts, and keywords, eligibility determination, and inclusion in the analysis. As shown in Figure 1, of the 2,449 records identified from Scopus, 870 records were excluded during screening (exclusion codes may overlap, so the per-criterion counts exceed this total; see Section 2.3), and the remaining 1,579 records were deemed eligible and included in the bibliometric analysis. The included articles were then classified into Tier A (n = 568; 36%), in which the literacy construct appears explicitly in the title, and Tier B (n = 1,011; 64%), in which it appears in the author keywords only. Unlike conventional PRISMA, which typically includes a full-text retrieval stage prior to the final inclusion decision, screening in this study was rule-based, applied automatically and consistently to the title, abstract, and keyword metadata of every record an approach commonly adopted in large-scale bibliometric studies given the impracticality of full-text review across thousands of documents, though it carries methodological consequences discussed further in Section 5.

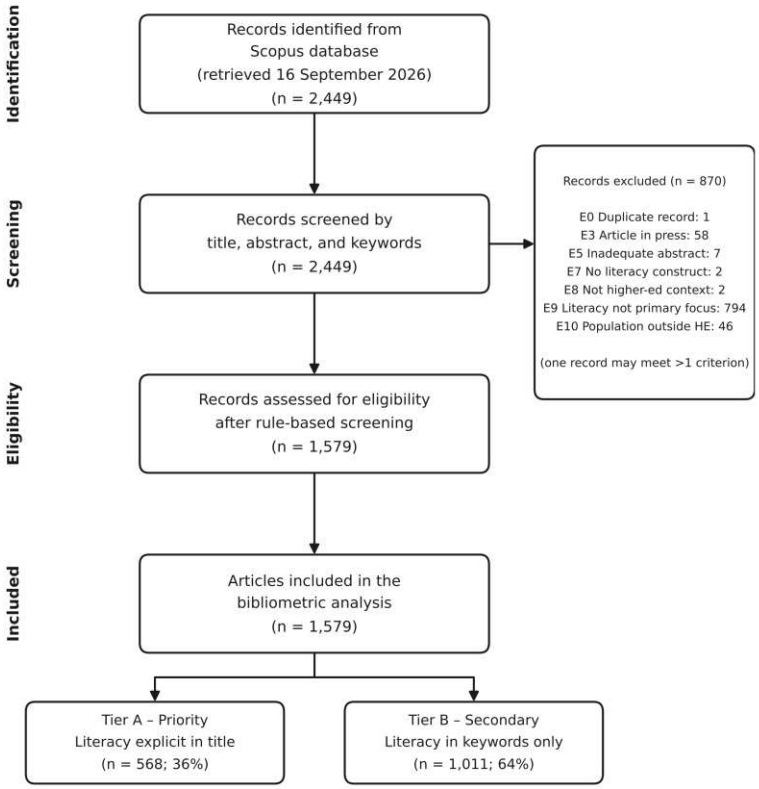


Figure 1. PRISMA flow diagram of record identification, screening, eligibility, and inclusion

2.3 Inclusion and Exclusion Criteria

Screening was applied on a rule-based basis to the title, abstract, and keywords of each record. Inclusion criteria comprised: (I1) peer-reviewed articles or review articles; (I2) written in English; (I3) final publication stage; (I4) published between 2015-2026; (I5) an adequate abstract (≥100 characters) and a traceable DOI; (I6) the literacy construct (digital, information, academic, media, data, AI, ICT, critical, or multiliteracy) as the primary focus, evidenced by its appearance in the title and/or author keywords; (I7) a higher-education setting; and (I8) a unique (non-duplicate) record. Exclusion criteria (E0–E10) covered duplication, non-article/review document types, non-English language, article-in-press status, out-of-range publication years, inadequate abstracts, absence of DOI, absence of a literacy construct, non-higher-education settings, literacy mentioned only in passing in the abstract, and a primary population outside higher education. Table 1 summarizes the number of records removed under each exclusion criterion.

[Insert Table 1 here]

Exclusion Code	Criterion	N Records
E0	Duplicate record	1
E3	Article in press (not final)	58
E5	Inadequate abstract	7

Exclusion Code	Criterion	N Records
E7	No literacy construct present	2
E8	Not a higher-education context	2
E9	Literacy not the primary focus (mentioned only in abstract)	794
E10	Primary population outside higher education	46
	Total excluded (codes may overlap >1)	870

Table 1. Summary of exclusion reasons at the screening stage

As Table 1 shows, the screening stage was driven overwhelmingly by a single criterion: E9 (literacy mentioned only in the abstract rather than as the primary focus) accounts for 794 of the 870 excluded records, roughly 91%. The remaining criteria removed far fewer records (58 articles in press under E3, 46 records with a population outside higher education under E10, and no more than 7 records under each of E0, E5, E7, and E8). This indicates that most of the noise in the initial Scopus export came from records that used literacy terms incidentally, and that the thematic-relevance rule, rather than document type or data quality, was the main filter shaping the final corpus.

Through this process, of the 2,449 initial records, 870 were excluded and 1,579 articles were retained for further analysis. Of these, 568 articles (36%) were categorized as Tier A because the literacy construct appeared explicitly in the title, while 1,011 articles (64%) were categorized as Tier B because the construct was only identified via author keywords. By construct focus, information literacy dominated (708 articles; 44.8%), followed by digital literacy (622; 39.4%), academic literacy (220; 13.9%), and AI literacy despite only emerging since 2023 already recording 11 articles (0.7%) by the end of the observation period.

2.4 Data Analysis

Bibliometric analysis was conducted using the latest bibliometrix package within R Studio via the biblioshiny interface. Analyses included: (1) annual publication and citation trends together with Annual Growth Rate (AGR), Relative Growth Rate (RGR), and Doubling Time (DT); (2) country distribution and collaboration networks (Corresponding Author's Countries, Country Collaboration Map); (3) institutional productivity and trends (Most Relevant Affiliations, Affiliations' Production over Time); (4) author productivity, local impact (h-index), and collaboration networks (Most Relevant Authors, Lotka's Law, Author Collaboration Network); (5) source distribution and impact (Most Relevant Sources, Bradford's Law, local h-index); and (6) knowledge structure via keyword co-occurrence, Trend Topics, and Thematic Mapping (motor, basic, niche, and emerging/declining themes).

AGR was calculated as AGR = [(Nt − Nt-1) / Nt-1] × 100%, RGR as the natural-log difference of cumulative publications between periods (RGR = ln(Wt) − ln(Wt-1)), and DT = 0.693/RGR, following the approach commonly used in comparable bibliometric studies (e.g., Ju et al., 2023). 2026 data are partial, as retrieval occurred in mid-September 2026; interpretation should account for the incomplete publication year.

3. RESULTS

3.1 Annual Publication and Citation Trends

Over 2015–2026, publication output grew consistently from 53 articles (2015) to a peak of 260 articles in 2025 (Table 2, Figure 1a). The 2015-2019 phase can be categorized as an initial stage with average annual growth below 100 articles, while acceleration became significant from 2020 onward, coinciding with the COVID-19 pandemic and continuing into the post-pandemic era. The sharpest surge occurred in 2024 (AGR 30.0%), coinciding with the expansion of research on generative-AI literacy in higher education. The 2026 figure (235 articles through September) shows a nominal decline relative to 2025, but this purely reflects an incomplete data-collection period rather than a genuine downward trend.

Year	N Publications	Cumulative	AGR (%)	RGR	DT (years)
2015	53	53	–	–	–
2016	62	115	16.98	0.775	0.89
2017	71	186	14.52	0.481	1.44
2018	76	262	7.04	0.343	2.02
2019	95	357	25.00	0.309	2.24
2020	99	456	4.21	0.245	2.83
2021	124	580	25.25	0.241	2.88
2022	136	716	9.68	0.211	3.28
2023	160	876	17.65	0.202	3.43
2024	208	1084	30.00	0.213	3.25
2025	260	1344	25.00	0.215	3.22
2026*	235	1579	−9.62	0.161	4.30

*Table 2. Annual growth of digital-information literacy research in higher education (2015–2026). *2026 data partial through 16 September 2026.*

Table 2 shows that growth was continuous and structurally sustained rather than a short-lived spike. Cumulative output rose from 53 to 1,579 articles, while the relative growth rate (RGR) declined from 0.775 in 2016 to 0.202 in 2023 and then remained at roughly 0.20–0.22 from 2022 onward, the pattern expected when a growing base is extended by increasingly large annual additions. Doubling time (DT) lengthened accordingly, from 0.89 years in 2016 to 3.43 years in 2023, and edged down to 3.22 years in 2025, indicating that annual output did not slow in the most recent complete years. The negative

AGR in 2026 (−9.62%) and the longer DT (4.30 years) should be read as artefacts of the partial 2026 data window rather than as evidence of contraction.

[Insert Figure 1a here]

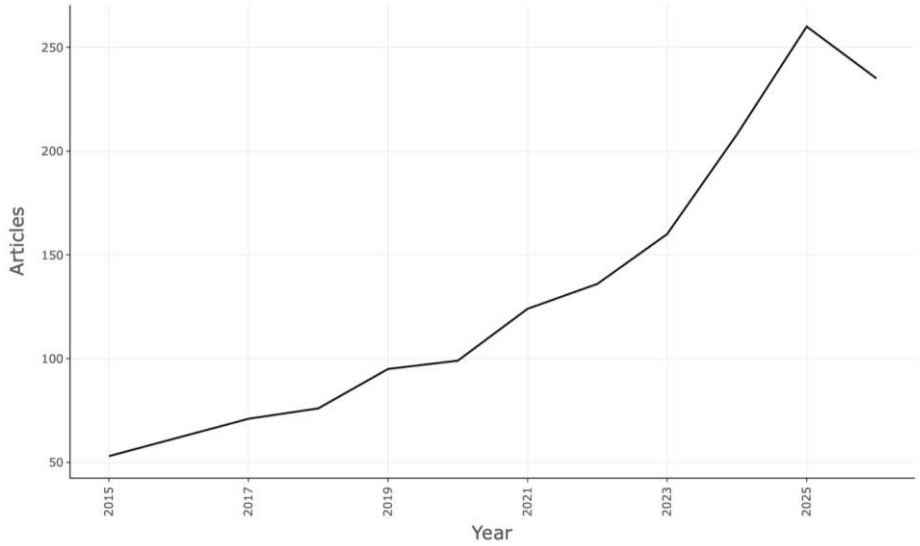


Figure 1a. Annual Scientific Production

Figure 1a visualises the same trajectory. Output rose gradually from 53 articles in 2015 to 95 in 2019, paused briefly around 2019–2020 (95 and 99 articles), and then climbed steeply to the 2025 peak of 260 articles. The curve contains no sustained dip between 2015 and 2025, which suggests that the field expanded across both the pandemic and the generative-AI periods rather than responding to either one alone. The drop to 235 articles in 2026 reflects the data window ending on 16 September 2026.

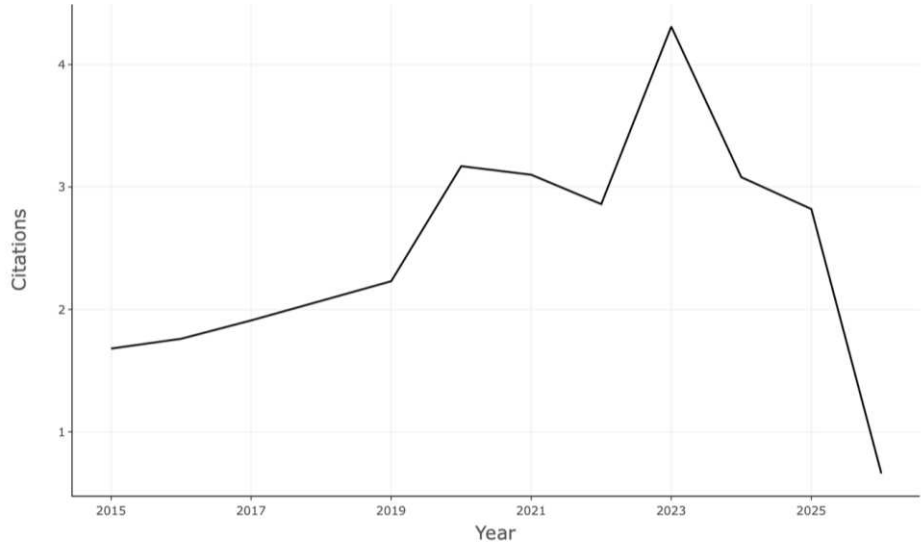


Figure 1b. Average Citations per Year

Average citations per year (Figure 1b) peaked in 2023 (4.3 citations/article/year), consistent with the high impact of ChatGPT- and generative-AI-related articles published that year — for instance,

Chan and Lee's (2023) article in Smart Learning Environments, cited 575 times globally, and Lo's (2023) article on the CLEAR path framework in the Journal of Academic Librarianship, cited 351 times. The 1,579 included articles have accumulated 19,492 citations, averaging 12.3 citations per article — a relatively high figure for an education-related field, indicating strong cross-disciplinary relevance and uptake of digital-information literacy research. The ten most globally cited articles are listed in Table 3.

[Insert Table 3 here]

No	Author (Year)	Source	Global Citations
1	Chan, C.K.Y. & Lee, K.K.W. (2023)	Smart Learning Environments	575
2	Lo, L.S. (2023)	Journal of Academic Librarianship	351
3	Hargittai, E. (2017)	Canadian Journal of Education/Communication	300
4	Getenet, S. et al. (2024)	Int. J. Educational Technology in Higher Ed.	220
5	Tejedor, S. et al. (2020)	Publications	198
6	Coiro, J. (2021)	Reading Research Quarterly	192
7	Martzoukou, K. (2020)	Journal of Documentation	188
8	López-Meneses, E. et al. (2020)	Australasian J. of Educational Technology	161
9	Nikou, S. (2021)	Education and Information Technologies	152
10	Fu, S. et al. (2021)	Behaviour & Information Technology	142

Table 3. Ten most globally cited articles in the research corpus

Table 3 shows that global citation impact is concentrated but not confined to the most recent work. The ten articles together received 2,479 citations, about 12.7% of the 19,492 citations accumulated by the entire corpus, and the two generative-AI-related articles at the top (575 and 351 citations) alone account for 926 of them. At the same time, six of the ten articles were published in 2020–2021, one in 2017, and one in 2024, so the list combines studies from the pandemic period with the newest AI-related work. The articles also appear in a broad range of outlets, from library and information science journals to general education, technology, and communication journals, reinforcing the cross-disciplinary reach noted above.

3.2 Country Distribution and Collaboration

The United States is the largest contributor by corresponding-author document count (175 documents), followed by the United Kingdom (~97 documents), Spain, Indonesia, and South Africa (Figure 2b). In terms of citation impact, the United States also leads with 1,979 citations, followed by the United Kingdom (1,873) and Spain (1,307). Multi-country collaboration (MCP) remains relatively low for most top countries, indicating that digital-information literacy research remains dominated by

single-country (SCP) rather than international partnerships. The collaboration map (Figure 2a) shows the United States as a central node with the strongest ties to the United Kingdom and several countries in Southeast Asia and Africa, while Indonesia despite substantial document contributions remains poorly connected within the cross-continental collaboration network.

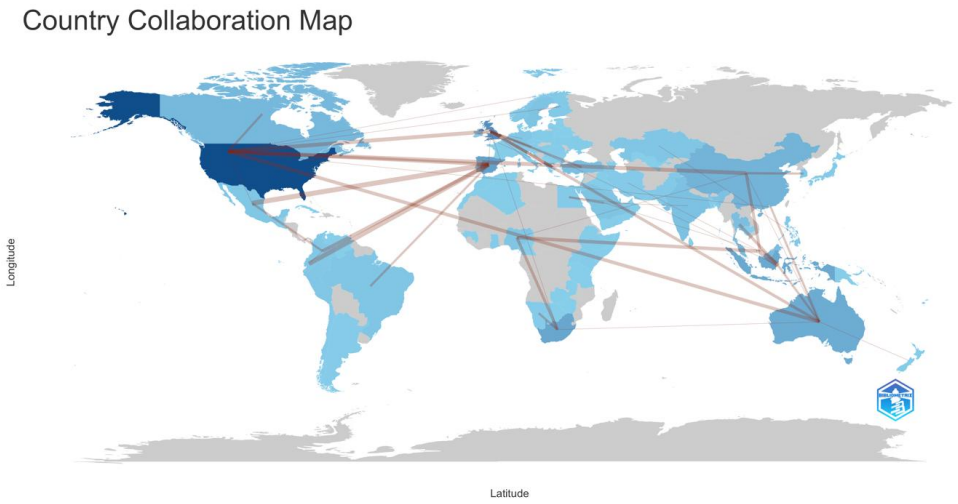


Figure 2a. Country Collaboration Map

Figure 2a shows that research output is geographically widespread but unevenly distributed. The United States is shaded darkest, followed by countries in Western Europe, Australia, and parts of Asia, while Russia and parts of Central Asia and Africa appear in grey, indicating no or negligible corresponding-author output in this corpus. Among the more visible collaboration links are those connecting the United States with Western Europe and Spain with Latin America, whereas links involving Indonesia and several African countries are fewer and thinner, consistent with the limited international connectivity discussed above.

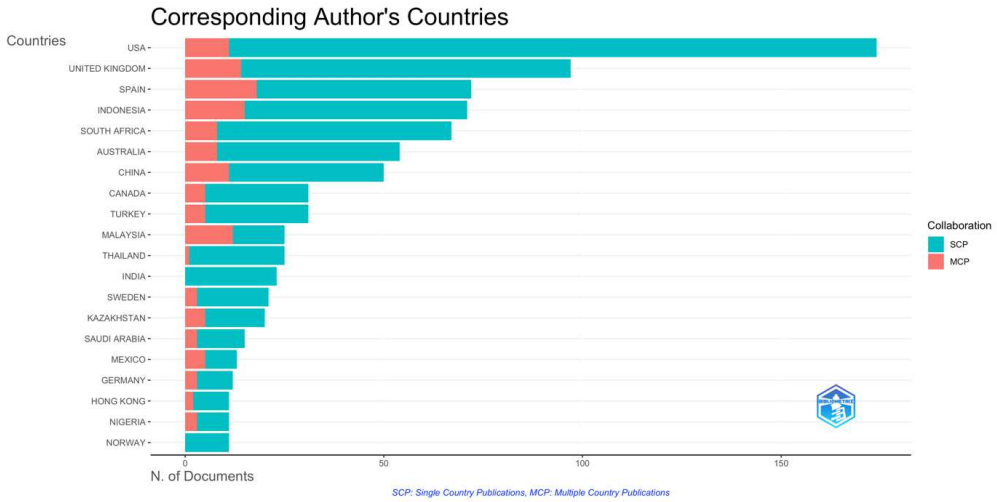


Figure 2b. Corresponding-author countries by collaboration pattern (SCP/MCP)

Figure 2b adds the collaboration profile of each corresponding-author country. Single-country publications (SCP) dominate almost everywhere: multi-country publications (MCP) make up only

about 6% of the documents from the United States and roughly one in seven from the United Kingdom, whereas the share is higher for Spain (about one in four) and highest for Malaysia (about half of its documents). India and Norway show no multi-country publications at all. The chart thus confirms that high output and international collaboration do not necessarily go together, and that the large contributors Indonesia and South Africa also publish mainly within a single country.

3.3 Institutional Distribution and Trends

The ten most productive institutions are shown in Table 4. Universitas Negeri Padang ranks first with 38 publications, followed by North Eastern Mindanao State University (32) and Prince Abubakar Audu University (27). Notably, three of the top ten institutions are Indonesian (Universitas Negeri Padang, Universitas Negeri Malang, and Universitas Negeri Yogyakarta), reflecting a significant Indonesian contribution to this field consistent with Latifah et al.,(2024) finding that Indonesia is also an important contributor to digital-literacy research in higher education.

Rank	Institution	Country	N Publications
1	Universitas Negeri Padang	Indonesia	38
2	North Eastern Mindanao State University	Philippines	32
3	Prince Abubakar Audu University	Nigeria	27
4	University of Granada	Spain	26
5	Universitas Negeri Malang	Indonesia	21
6	Charles Sturt University	Australia	16
7	Universitas Negeri Yogyakarta	Indonesia	16
8	University of Southern Queensland	Australia	16
9	L.N. Gumilyov Eurasian National University	Kazakhstan	15
10	University of California	United States	15

Table 4. Ten most productive institutions in digital-information literacy research in higher education

Table 4 shows that institutional output is highly dispersed. The ten institutions together contribute 222 publications, and none accounts for more than 38 of the 1,579 articles (about 2.4%), so no single institution dominates the field. The ten institutions come from seven countries, with Indonesia (three institutions) and Australia (two) the only ones represented more than once; the three Indonesian universities contribute 75 of the 222 publications (about 34%). Institutions from the Global North (University of Granada, Charles Sturt University, the University of Southern Queensland, and the University of California) are present but with comparatively modest counts of 15–26 publications.

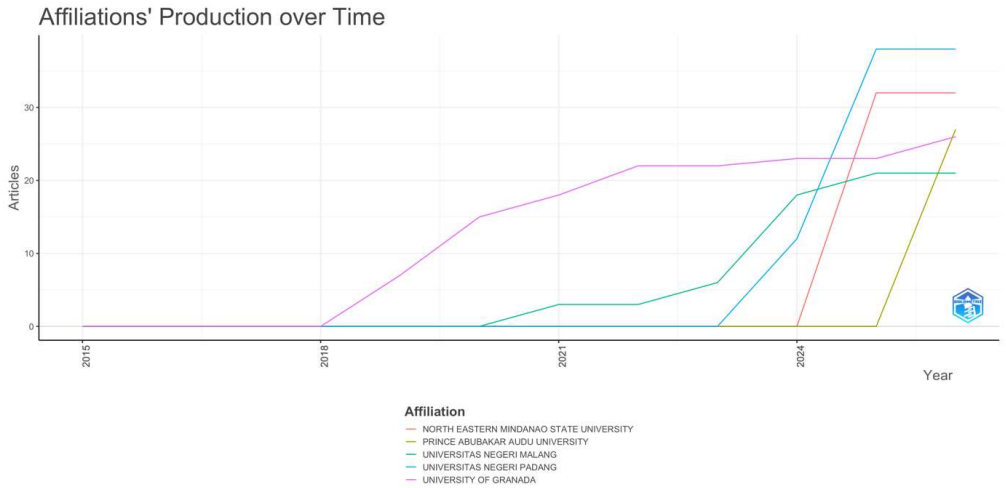


Figure 3. Cumulative production trend of the top five institutions (Affiliations' Production over Time)

Institutional growth patterns (Figure 3) show University of Granada as a pioneer with gradual growth since 2018, whereas Universitas Negeri Padang and North Eastern Mindanao State University instead show sharp, sudden surges in 2024–2025 from near zero. Such abrupt surges are commonly encountered in bibliometric fields and typically indicate a special issue, an institutional research-grant programme, or a large collaborative team publishing simultaneously; this pattern warrants further qualitative scrutiny and should not be automatically interpreted as stable, organic research growth.

3.4 Author Productivity and Collaboration

Author analysis (Table 5) shows Pinto M. as the most productive author with 15 documents and the highest local h-index (8), followed by Fernández-Pascual R. and Sales D. with 9 documents each. Compared with a more mature field such as bacterial-persister research in Ju et al.'s (2023) study where the most productive author published up to 54 documents the highest productivity figure in the digital-information literacy field (15 documents) is markedly lower. This is consistent with Lotka's Law analysis (Figure 4b), which shows over 90% of authors contributing only a single document, with productive-author proportions declining sharply and exponentially thereafter a pattern typical of a relatively young research field that has yet to develop large, established research groups.

Rank	Author	N Documents	Local h-index
1	Pinto M.	15	8
2	Fernández-Pascual R.	9	7
3	Sales D.	9	6
4	Hicks A.	6	5
5	Maybee C.	6	5
6	Caballero-Mariscal D.	5	–
7	Chen Y.	5	–
8	Hidayat H.	5	4
9	Nierenberg E.	5	–

Rank	Author	N Documents	Local h-index
10	Angell K.	4	4

Table 5. Ten most productive authors and their local impact

Table 5 confirms that author productivity is low and concentrated in only a few groups. The ten most productive authors together account for 69 documents (counted per author), and the leading three (Pinto M., Fernández-Pascual R., and Sales D.) also record the highest local h-indices (8, 7, and 6), meaning their documents are cited within the corpus itself. From the fourth rank onward, productivity falls to four to six documents per author, and for three authors the local h-index is not reported (–), suggesting limited citation linkage to their work within the corpus. Productivity and local impact therefore coincide at the top of the list but diverge quickly below it.

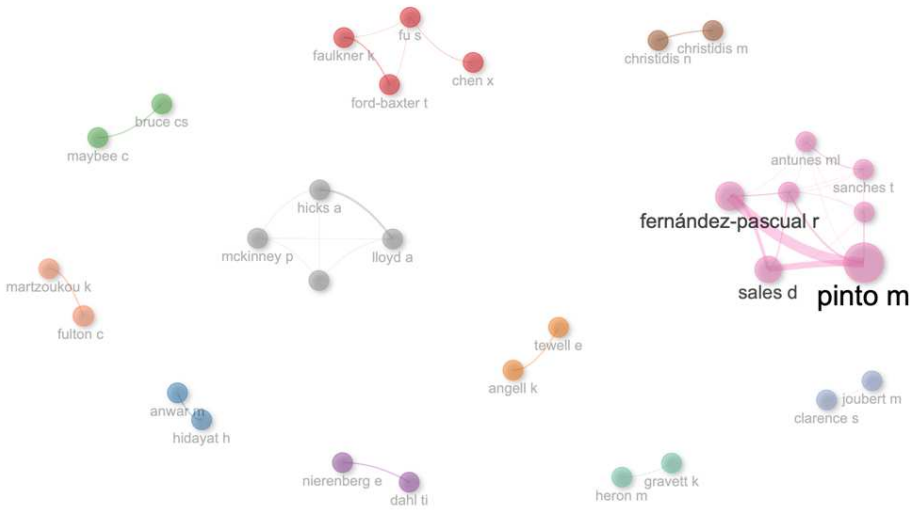


Figure 4a. Author Collaboration Network

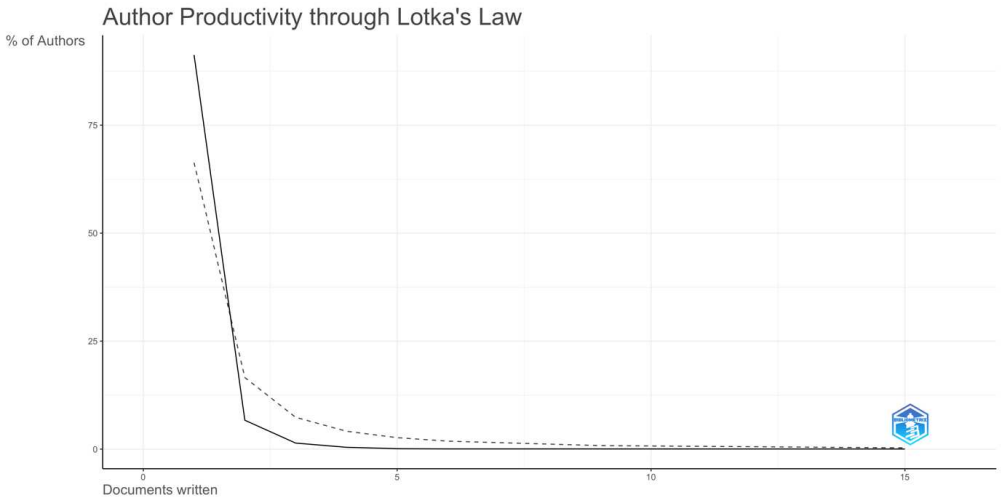


Figure 4b. Author productivity according to Lotka's Law

Figure 4b compares the observed author productivity (solid line) with the distribution expected under Lotka's Law (dashed line). Roughly 91% of authors contributed a single document, well above the roughly two-thirds expected under the theoretical distribution, and the observed share falls below the theoretical curve from two documents onward. The field therefore has more one-time contributors, and fewer repeat authors, than a conventional Lotka distribution would predict, which is consistent with a young, project-based field in which few researchers sustain a long publication series.

The author collaboration network (Figure 4a) confirms this fragmentation: rather than a single large interconnected network as typically found in more established fields (compare the bacterial-persister author network in Ju et al., 2023, which forms a large cluster centred on several key researchers), productive authors in the digital-information literacy field instead form numerous small, isolated clusters (dyads and triads) that rarely interconnect. The largest identified cluster comprises only about five authors (Fernández-Pascual R., Pinto M., Sales D., and their collaborators), indicating that cross-group collaboration in this field still needs strengthening.

3.5 Source Distribution and Impact

Journal of Information Literacy is the most prolific source (99 articles), followed by Communications in Information Literacy (71) and Journal of Academic Librarianship (48) — all three being library and information science journals, underscoring that the intellectual roots of information-literacy research in higher education remain firmly tied to the library science discipline (Table 6). Nevertheless, in terms of impact (local h-index), Journal of Academic Librarianship records the highest value (17), surpassing two journals with higher article counts, suggesting relatively deeper per-article citation quality. Bradford's Law analysis identifies 15 core journals accounting for the majority of the field's literature, with Journal of Information Literacy, Communications in Information Literacy, and Journal of Academic Librarianship forming the top three in Zone 1.

Rank	Journal	N Articles	Local h-index
1	Journal of Information Literacy	99	16
2	Communications in Information Literacy	71	16
3	Journal of Academic Librarianship	48	17
4	Evidence Based Library and Information Practice	36	–
5	Education Sciences	30	11
6	Sustainability (Switzerland)	30	13
7	College and Research Libraries	27	13
8	Cogent Education	26	–
9	Frontiers in Education	26	–
10	BMC Medical Education	24	–

Table 6. Ten most productive journals and their local impact

Table 6 shows two groups of outlets. Five of the ten journals are library and information science titles (Journal of Information Literacy, Communications in Information Literacy, Journal of Academic Librarianship, Evidence Based Library and Information Practice, and College and Research Libraries) and together publish 281 articles, while the other five are general education or multidisciplinary outlets (Education Sciences, Sustainability, Cogent Education, Frontiers in Education, and BMC Medical Education) and contribute 136. The ten journals as a whole account for 417 articles, about 26% of the corpus, so the literature is spread over many other outlets as well. Local impact does not simply follow volume: Sustainability (30 articles; h-index 13) exceeds Education Sciences (30 articles; h-index 11), and the highest h-index belongs to the third-ranked Journal of Academic Librarianship (17).

3.6 Keyword Co-occurrence and Trend Topics

Author-keyword co-occurrence analysis (Figure 5a) identifies "digital literacy" (477 occurrences) and "information literacy" (478 occurrences) as the two largest, closely positioned nodes, surrounded by "higher education" (340), "academic libraries" (90), and "academic literacy" (90). The network divides into three main clusters: a red cluster (information literacy, digital literacy, academic libraries, library instruction, generative AI, AI literacy, chatgpt) the largest and densest cluster; a blue cluster (academic literacy, higher education, student, teaching, curriculum, artificial intelligence) oriented toward curriculum and teaching; and a green cluster (human, humans, psychology, questionnaire, young adult) related to methodological and demographic aspects of the research.

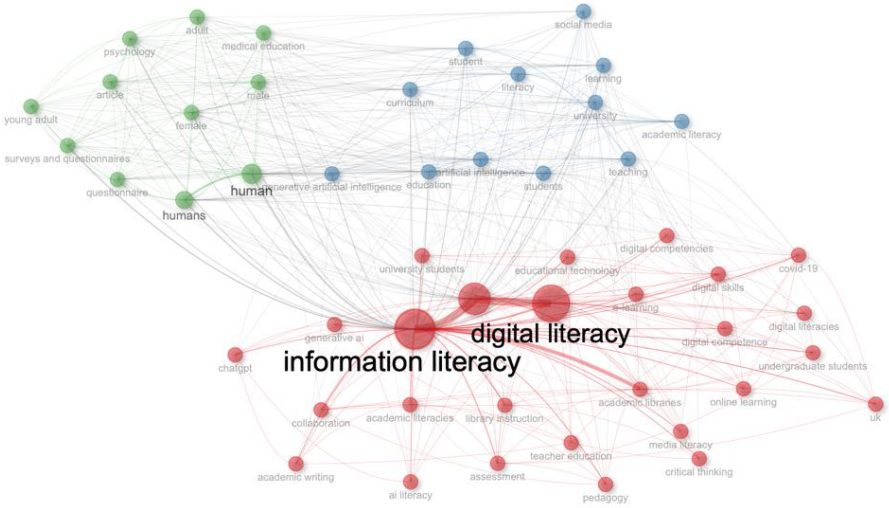


Figure 5a. Author-keyword co-occurrence network

As Figure 5a shows, the very large, closely positioned nodes for "information literacy" and "digital literacy," indicate that the two constructs are routinely studied together and share much of their vocabulary. Generative-AI-related terms ("generative ai," "chatgpt," and "ai literacy") sit at the periphery of the red cluster, connected mainly to the information-literacy core, whereas "artificial intelligence" and "generative artificial intelligence" are placed in the education-oriented blue cluster.

This placement suggests that AI-related research is attaching itself to existing literacy discourse from two directions, the library-instruction tradition and the teaching-and-learning tradition, rather than forming a separate cluster of its own.

Trend Topics analysis (Figure 5b) confirms a sharp thematic shift: “library instruction,” “undergraduate students,” and “librarian” dominated 2016–2019; “information literacy” and “academic libraries” became mainstream in 2019-2022; while “digital literacy,” “higher education,” and “digital skills” peaked in 2022-2024. Most significantly, the keyword cluster “artificial intelligence,” “generative AI,” “generative artificial intelligence,” and “AI literacy” emerged simultaneously since 2023 and shows the fastest growth trend toward 2025-2026, consistent with the citation-surge finding in Section 3.1 regarding generative-AI-themed articles. This pattern confirms that digital-information literacy research in higher education is undergoing a paradigm shift from a library-based information-literacy emphasis toward digital literacy integrated with artificial intelligence.

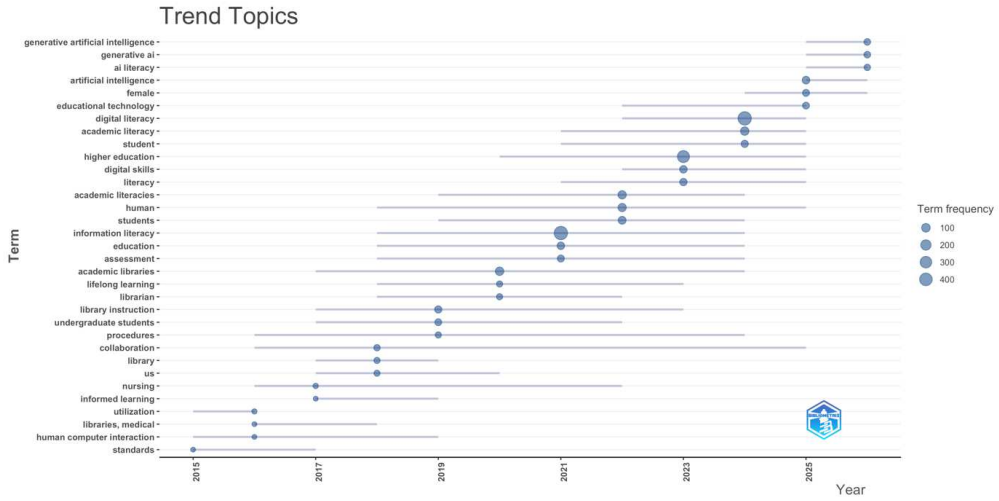


Figure 5b. Keyword trend topics by average year of appearance

Figure 5b also shows how established each theme is. Bubble size, which reflects term frequency, is largest for “information literacy,” “digital literacy,” and “higher education,” and these terms span long periods (roughly 2018–2024, 2022–2025, and 2020–2025, respectively). By contrast, the AI-related terms have the shortest spans, beginning only around 2025, and small bubbles. They are therefore recent, rapidly emerging themes whose weight in the field's accumulated vocabulary is still limited, even though their growth is the fastest in the period.

3.7 Thematic Map and Intellectual Base

The thematic map (Figure 6b) places “information literacy,” “digital literacy,” and “higher education” in a single large cluster at low centrality and low density, in the lower-left area that Biblioshiny labels emerging or declining themes. Because these are the most frequent keywords in the corpus (Figure 6a), this position should not be read as a decline of the core themes; it may instead reflect

that the map identified only two clusters, so that the dominant literacy vocabulary is grouped into one broad, loosely connected cluster rather than into distinct, internally cohesive sub-fields. Meanwhile, the "human," "humans," and "education" cluster occupies the motor-theme quadrant (high centrality and density), signifying a methodologically mature theme (typically associated with survey/experimental research designs) that remains central to the field. No theme appears in the niche-theme or basic-theme quadrants, indicating that digital-information literacy in higher education has not yet developed a sub-specialization fully isolated from the mainstream. The dominant keywords underlying these themes are shown in the treemap in Figure 6a.

[Insert Figure 6a here]

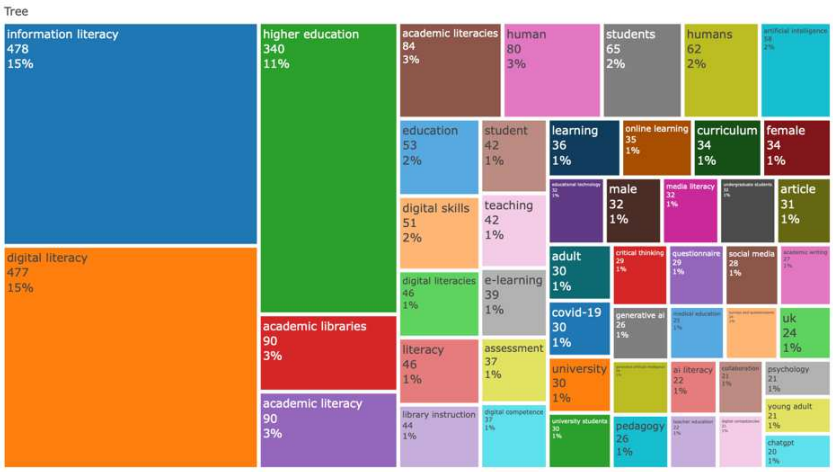


Figure 6a. TreeMap of dominant keywords

Figure 6a shows how concentrated the field's vocabulary is. The three largest rectangles, "information literacy" (478 occurrences; 15%), "digital literacy" (477; 15%), and "higher education" (340; 11%), together occupy about 41% of the area, followed by "academic libraries" and "academic literacy" (90 each; 3%), "academic literacies" (84; 3%), and "human" (80; 3%). The AI-related keywords remain small in absolute terms ("artificial intelligence," 58 occurrences, 2%; "generative ai," 26; "ai literacy," 22; "chatgpt," 20), which is consistent with their very recent appearance in the corpus.

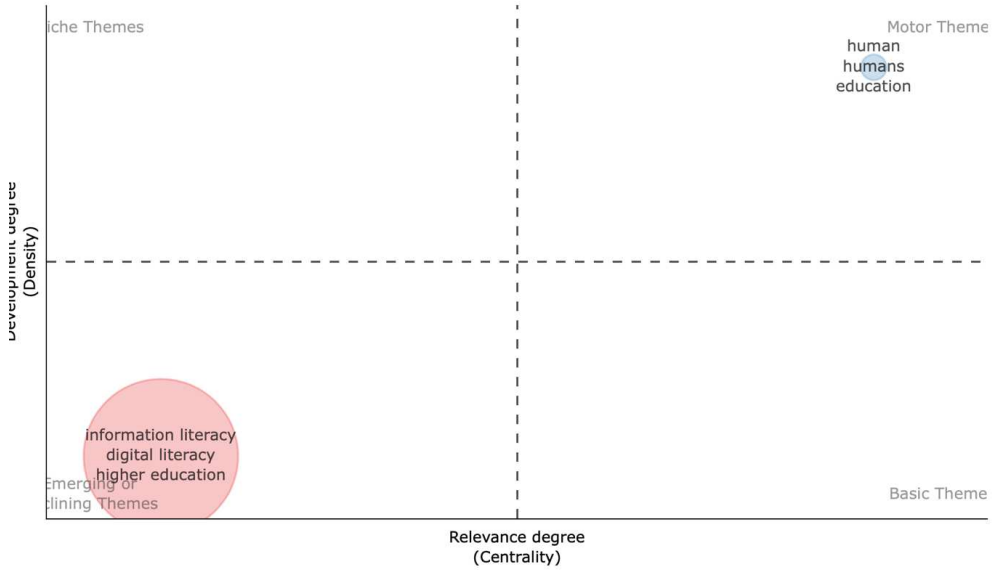


Figure 6b. Thematic Map: motor theme, basic theme, niche theme, and emerging/declining theme

Figure 6b plots two clusters. The first, "human," "humans," and "education," lies in the upper-right corner with high centrality and high density, the position of a motor theme. The second, much larger cluster, "information literacy," "digital literacy," and "higher education," lies at low values on both axes, in the lower-left area that the figure labels "Emerging or Declining Themes," and its large bubble reflects the many keyword occurrences it contains. Only two clusters are identified, so the map mainly separates the methodologically oriented "human" vocabulary from the field's core literacy vocabulary, and this contrast should be interpreted together with the keyword network in Figure 5a.

The field's intellectual base is evident from the analysis of most locally cited references (Table 7), dominated by formal frameworks such as the Framework for Information Literacy for Higher Education (ACRL, 2015 and 2016) and the Information Literacy Competency Standards for Higher Education (ACRL, 2000), together with Gilster's (1997) classic conceptual work on digital literacy. This dominance of institutional framework documents rather than individual empirical research articles is consistent with the strong grounding of the information-literacy field in library-profession standards, also reflected in the dominance of library and information science journals shown in Table 6.

Rank	Most Locally Cited Reference	Local Citations
1	Framework for Information Literacy for Higher Education (ACRL, 2015)	118
2	Information Literacy Competency Standards for Higher Education (ACRL, 2000)	97
3	Gilster, P. (1997) – Digital Literacy	72
4	Framework for Information Literacy for Higher Education (ACRL, 2016)	66
5	Clarke, V. (2006)	52
6	Ng, W. (2012)	42

Rank	Most Locally Cited Reference	Local Citations
7	Street, B.V. (1998)	35
8	Scott, M. (2007)	31
9	Cohen, J. (1988)	23
10	Presidential Committee on Information Literacy: Final Report (1989)	22

Table 7. Ten most locally cited foundational references in the research corpus

Table 7 shows that the field's intellectual base rests on practice standards and a few conceptual works rather than on empirical studies of the AI era. The three ACRL documents (the 2015 and 2016 versions of the Framework and the 2000 Standards) together account for 281 of the 558 local citations in the table, just over half, and a 1989 Presidential Committee report on information literacy also appears. Gilster's work on digital literacy and the entry attributed to Street represent the conceptual strand, while two entries (those attributed to Clarke and Cohen) are likely methodological references on qualitative analysis and statistical power rather than literacy theory. Nothing published during the generative-AI period appears among the ten most locally cited references.

4. DISCUSSION

This section does not merely summarize the findings but critically tests them against comparable published bibliometric research, to gauge the extent to which this study's findings converge with, diverge from, or even correct conclusions already circulating in the literature.

4.1 Publication Growth: Convergence or an Artefact of Construct Scope?

The finding of consistent publication growth without a meaningful decline (Section 3.1) does not fully align with Latifah, Winoto, and Khadijah (2024), who used the single keyword combination “digital literacy” AND “higher education” across 646 documents (2014-2023) and instead reported a sharp decline in 2022 (from 116 to 99 publications, roughly -15%) before recovering in 2023. This study, with a broader construct scope (covering information, academic, and AI literacy, not only “digital literacy”), instead recorded positive continued growth in 2022 (AGR 9.68%). Two possible explanations merit weighing against each other: first, the decline reported by Latifah et al. may simply be an artefact of a smaller sample (646 documents), making it more sensitive to random annual fluctuation or Scopus indexing lag; second, and more substantively, a decline specific to the “digital literacy” construct in 2022 may indeed have occurred, but was masked by continued growth in information- and academic-literacy constructs within the same period, as reflected in this study's corpus. If the second interpretation holds, then the use of a single keyword in prior bibliometric studies risks misleading readers about the true direction of the broader higher-education literacy field, since different sub-constructs can move in opposite directions within the same year.

4.2 The Productivity Impact Paradox: A Recurring Pattern Across Countries

This study's country ranking (the United States leading with 175 documents and 1,979 citations) differs from Latifah et al. (2024), who ranked the United Kingdom first (74 documents, 1,150 citations), followed by Spain (64 documents) and only then the United States in third place (59 documents). This ranking shift deserves critical scrutiny: the most plausible explanation is that "digital literacy" as a standalone construct has stronger historical roots in Europe tied to the European Commission's DigComp framework and UK JISC initiatives whereas the "information literacy" construct that dominates this study's corpus (708 of 1,579 articles; Section 2.3) is historically more closely associated with the United States' library tradition via the ACRL standards. In other words, the "leading" country in bibliometric literacy research depends heavily on which literacy sub-construct the search strategy emphasizes a methodological finding that cautions readers against generalizing country rankings from a single, narrow-keyword bibliometric study as a definitive representation of the global landscape.

A more concerning pattern emerges at the Indonesian level. The data show Indonesia contributing the world's single most productive institution (Universitas Negeri Padang, 38 publications; Section 3.3) and three of the top ten most productive institutions, yet in terms of citation impact, Indonesia ranks only seventh globally with 494 citations far behind Hong Kong (844 citations), whose document count is substantially smaller. This "productive but low-impact" pattern strikingly mirrors the finding of Ju et al. (2023) in the bacterial-persister research field, where China ranked second in publication output (231 papers) yet only fifth in h-index and sixth in total citations a gap the original authors explicitly attributed to an academic evaluation system emphasizing publication quantity over long-term impact. The parallel between Indonesia in the digital-information literacy field and China in clinical microbiology suggests that the "quantity without impact" phenomenon is not a single-field anomaly but a structural symptom potentially linked to publish-or-perish pressures in developing countries, warranting further qualitative investigation whether driven by indexing/citation lag disadvantaging non-Western-region scholarship (as Ding et al. (2013) postulate in the Chinese context), or by genuinely lower methodological quality and theoretical novelty.

Similar caution should be applied to the sudden productivity surges observed at two other institutions outside Indonesia North Eastern Mindanao State University (Philippines) and Prince Abubakar Audu University (Nigeria) which jumped from zero to 32 and 27 publications respectively within just one to two years (Section 3.3, Figure 3). This pattern contrasts sharply with University of Granada's gradual, organic growth over eight years (2018–2026). Without prejudging the underlying motives, such abrupt surges commonly associated with special journal issues or institutional pressure to climb university rankings should be treated differently from sustained research growth when interpreting the "global research strength map" of this field, since both can produce identical raw counts despite vastly different sustainability and scholarly depth.

4.3 Collaboration Fragmentation: Benchmarking Field Maturity

A direct comparison with Ju et al. (2023) selected as the structural reference for this study offers a sharp benchmark for assessing the maturity stage of digital-information literacy research in higher education. In the bacterial-persister field, the most productive author (Ying Zhang) published 54 documents over two decades, and the most influential author (Kim Lewis) alone accumulated 12,295 citations, with a collaboration network forming a large, interconnected cluster spanning institutions. By comparison, the most productive author in the digital-information literacy field (Pinto M.) published only 15 documents less than a third of the peak productivity in the microbiology field and this study's author collaboration network (Figure 4a) fragments into dozens of small, isolated clusters rather than one large network. A gap of this magnitude cannot be explained solely by field age (bacterial persisters have been studied since 2001, versus 2015 for this corpus a 14-year difference), but also points to a fundamental difference in research culture: the life-sciences/biomedical field tends to form large research laboratories with long-term grant funding that generate continuous publication series from the same groups, whereas digital-information literacy research in higher education is more often conducted as individual projects or small teams working on institutional case studies, so knowledge accumulation tends to occur horizontally (many parallel, small-scale studies) rather than vertically (a sustained series of in-depth studies from the same research group).

4.4 Tension Between Classic Conceptual Foundations and the Accelerating AI-Era Empirical Wave

The findings in Section 3.7 reveal a paradox worth debating: the ten most locally cited references in this corpus are entirely classic frameworks and concepts the Framework for Information Literacy for Higher Education (ACRL, 2015/2016), the Information Literacy Competency Standards (ACRL, 2000), and Gilster (1997) ranging from roughly 10 to nearly 30 years old at the time of this study. None of the generative-AI or AI-literacy-themed works that are in fact driving the fastest topical growth in 2023-2026 (Section 3.6) including Lo's (2023) CLEAR path framework or Naamati-Schneider and Alt's (2024) evolving-user-skills concept have yet entered the list of locally most influential references. This time lag between the empirical volume explosion in AI-literacy research and the consolidation of a new conceptual framework mature enough to be widely cited suggests the field is experiencing what might be called a “race without a map”: researchers are rapidly producing empirical studies on generative-AI literacy, yet no new conceptual consensus has emerged to sufficiently update the ACRL 2015 framework for the AI context. This is consistent with concerns raised in integrative reviews of AI literacy in higher and K-12 education, which explicitly note the absence of a clear conceptual boundary between “AI literacy” and “generative AI literacy” as of mid-2024 risking a proliferation of overlapping empirical studies without a solid, unified theoretical foundation. This implies that theoretical-conceptual contributions integrating classic information literacy with contemporary AI-literacy demands represent one of the field's most urgent research needs going forward, beyond merely adding new empirical studies.

4.5 Implications for Policy and Practice

Several practical implications follow from pitting these findings against one another. First, for Indonesian research-policy managers, the high institutional productivity unmatched by citation impact (Section 4.2) signals the need to shift research incentives away from mere publication counts toward methodological quality and conceptual novelty, to avoid the same pattern already identified in Chinese research by Ju et al. (2023). Second, the weak collaboration network connectivity (Section 4.3) points to a strategic opportunity for research-funding bodies and university consortia to deliberately facilitate cross-institutional and cross-country collaboration in this field, rather than allowing research to continue developing in fragmented fashion. Third, the conceptual gap in the AI era (Section 4.4) underscores the urgency for academic librarians, curriculum developers, and AI researchers to collaborate in formulating a next-generation literacy framework that explicitly integrates critical reasoning about generative-AI outputs into established information-literacy standards, rather than waiting for such a framework to emerge organically from scattered empirical accumulation.

5. LIMITATIONS

This study has several limitations that should be considered when interpreting its findings. First, data were sourced solely from Scopus and do not include Web of Science, Google Scholar, or national databases such as Garuda/Sinta, introducing potential database-coverage bias. Second, the inclusion-exclusion screening process was rule-based, matching terms in titles, abstracts, and keywords, rather than manual assessment by human reviewers, so misclassification risk remains despite multi-tiered screening. Third, 2026 data are partial (through mid-September), so that year's growth trend cannot yet be finally assessed. Fourth, the sudden productivity surges at several institutions (Section 3.3) require further qualitative verification to confirm they do not stem from data anomalies or special-issue publications that do not reflect sustainable institutional research capacity.

6. CONCLUSION

This bibliometric study mapped 1,579 digital and information literacy research articles in higher education from 2015-2026, rigorously screened from 2,449 initial Scopus records. Publications in this field grew consistently, peaking in 2025 (260 articles), dominated by contributions from the United States, United Kingdom, and Spain, with Indonesia emerging as a significant contributor through three institutions ranking among the top ten most productive. Author and institutional collaboration patterns remain highly fragmented, indicating that this field is at a relatively young developmental stage and has yet to establish the large, mature research groups typically found in more established scientific fields. The field's knowledge structure is firmly rooted in classic information-literacy frameworks (ACRL, Gilster), yet is visibly shifting toward AI-literacy and generative-AI themes since 2023, a trend projected to continue dominating the field's future direction. These findings recommend strengthening

cross-institutional and cross-country research collaboration, along with the explicit integration of AI-literacy competencies into higher-education curricula and digital-literacy policy.

FUNDING

The authors received no specific funding for this work.

COMPETING INTERESTS

The authors declare no competing interests.

ETHICS DECLARATION

Ethics declaration: not applicable.

REFERENCES

Anson, D. W. J. (2024). The impact of large language models on university students' literacy development: a dialogue with Lea and Street's academic literacies framework. Higher Education Research and Development, 43(7), 1465–1478. https://doi.org/10.1080/07294360.2024.2332259

Aydınlar, A., Mavi, A., Kütükçü, E., Kırımlı, E. E., Alış, D., Akın, A., & Altıntaş, L. (2024). Awareness and level of digital literacy among students receiving health-based education. BMC Medical Education, 24, Article 616. https://doi.org/10.1186/s12909-024-05025-w

Bearman, M., Nieminen, J. H., & Ajjawi, R. (2023). Designing assessment in a digital world: an organising framework. Assessment & Evaluation in Higher Education, 48(4), 291–304. https://doi.org/10.1080/02602938.2022.2069674

Beckman, K., Apps, T., Howard, S. K., Rogerson, C., Rogerson, A., & Tondeur, J. (2025). The GenAI divide among university students: A call for action. Internet and Higher Education, 67, Article 101036. https://doi.org/10.1016/j.iheduc.2025.101036

Budiman, R., & Syafrony, A. I. (2023). The digital literacy of first-year students and its function in an online method of delivery. Asian Association of Open Universities Journal, 18(2), 176–186. https://doi.org/10.1108/AAOUJ-01-2023-0017

Cabero-Almenara, J., Gutiérrez-Castillo, J. J., Palacios-Rodríguez, A., & Guillén-Gámez, F. D. (2023). Digital competence of university students with disabilities and factors that determine it. A descriptive, inferential and multivariate study. Education and Information Technologies, 28(8), 9417–9436. https://doi.org/10.1007/s10639-022-11297-w

Chan, C. K. Y., & Lee, K. K. W. (2023). The AI generation gap: Are Gen Z students more interested in adopting generative AI such as ChatGPT in teaching and learning than their Gen X and millennial generation teachers? Smart Learning Environments, 10, Article 60. https://doi.org/10.1186/s40561-023-00269-3

Chen, A., Xiang, M., Zhou, J., Jia, J., Shang, J., Li, X., Gašević, D., & Fan, Y. (2025). Unpacking help-seeking process through multimodal learning analytics: A comparative study of ChatGPT vs human expert. Computers & Education, 226, Article 105198. https://doi.org/10.1016/j.compedu.2024.105198

Deroncele-Acosta, A., Palacios-Núñez, M. L., & Toribio-López, A. (2023). Digital transformation and technological innovation on higher education post-COVID-19. Sustainability, 15(3), Article 2466. https://doi.org/10.3390/su15032466

Ding, Z.-Q., Ge, J.-P., Wu, X.-M., & Zheng, X.-N. (2013). Bibliometrics evaluation of research performance in pharmacology/pharmacy: China relative to ten representative countries. Scientometrics, 96(3), 829–844. https://doi.org/10.1007/s11192-013-0977-5

Farias-Gaytan, S., Aguaded, I., & Ramirez-Montoya, M. S. (2023). Digital transformation and digital literacy in the context of complexity within higher education institutions: a systematic literature review. Humanities and Social Sciences Communications, 10, Article 386. https://doi.org/10.1057/s41599-023-01875-9

Feng, L., & Sumettikoon, P. (2024). An empirical analysis of EFL teachers' digital literacy in Chinese higher education institutions. International Journal of Educational Technology in Higher Education, 21, Article 30. https://doi.org/10.1186/s41239-024-00474-1

González-Mujico, F. D. L. (2024). Measuring student and educator digital competence beyond self-assessment: Developing and validating two rubric-based frameworks. Education and Information Technologies, 29(11), 13299–13324. https://doi.org/10.1007/s10639-023-12363-7

Gravett, K., & Carless, D. (2024). Feedback literacy-as-event: relationality, space and temporality in feedback encounters. Assessment & Evaluation in Higher Education, 49(2), 142–153. https://doi.org/10.1080/02602938.2023.2189162

Gu, M. M., Huang, C. F., & Lee, C.-K. J. (2023). Investigating university students' digital citizenship development through the lens of digital literacy practice: A translingual and transemiotizing perspective. Linguistics and Education, 77, Article 101226. https://doi.org/10.1016/j.linged.2023.101226

Guillén-Gámez, F. D., Gómez-García, M., & Ruiz-Palmero, J. (2024). Digital competence in research work: predictors that have an impact on it according to the type of university and gender of the higher education teacher. Pixel-Bit, Revista de Medios y Educación, 69, 7–34. https://doi.org/10.12795/pixelbit.99992

Haroud, S., & Saqri, N. (2025). Generative AI in higher education: Teachers' and students' perspectives on support, replacement, and digital literacy. Education Sciences, 15(4), Article 396. https://doi.org/10.3390/educsci15040396

Hicks, A., McKinney, P., Inskip, C., Walton, G., & Lloyd, A. (2023). Leveraging information literacy: Mapping the conceptual influence and appropriation of information literacy in other disciplinary landscapes. Journal of Librarianship and Information Science, 55(3), 548–566. https://doi.org/10.1177/09610006221090677

Inamorato dos Santos, A., Chinkes, E., Carvalho, M. A. G., Solórzano, C. M. V., & Marroni, L. S. (2023). The digital competence of academics in higher education: is the glass half empty or half full? International Journal of Educational Technology in Higher Education, 20, Article 8. https://doi.org/10.1186/s41239-022-00376-0

James, A. B., & Filgo, E. H. (2023). Where does ChatGPT fit into the Framework for Information Literacy? The possibilities and problems of AI in library instruction. College & Research Libraries News, 84(9), 334–341. https://doi.org/10.5860/crln.84.9.334

Joseph, G. V., Athira, P., Anit Thomas, M., Jose, D., Roy, T. V., & Prasad, M. (2024). Impact of digital literacy, use of AI tools and peer collaboration on AI assisted learning: Perceptions of the university students. Digital Education Review, 45, 43–49. https://doi.org/10.1344/der.2024.45.43-49

Ju, Y., Zhang, F., Yu, P., Zhang, Y., Zhao, P., Xu, P., Sun, L., Bao, Y., & Long, H. (2023). A bibliometric analysis of research on bacterial persisters. BioMed Research International, 2023, Article 4302914. https://doi.org/10.1155/2023/4302914

Kabakus, A. K., Bahcekapili, E., & Ayaz, A. (2025). The effect of digital literacy on technology acceptance: An evaluation on administrative staff in higher education. Journal of Information Science, 51(4), 930–941. https://doi.org/10.1177/01655515231160028

Latifah, S. R., Winoto, Y., & Khadijah, U. L. S. (2024). Analisis bibliometrik: Perkembangan tren penelitian literasi digital di perguruan tinggi dalam database Scopus (2014–2023). IQRA': Jurnal Ilmu Perpustakaan dan Informasi, 18(2), 230–256.

Lo, L. S. (2023). The CLEAR path: A framework for enhancing information literacy through prompt engineering. Journal of Academic Librarianship, 49(4), Article 102720. https://doi.org/10.1016/j.acalib.2023.102720

Mansoor, H. M. H., Bawazir, A., Alsabri, M. A., Alharbi, A., & Okela, A. H. (2024). Artificial intelligence literacy among university students—a comparative transnational survey. Frontiers in Communication, 9, Article 1478476. https://doi.org/10.3389/fcomm.2024.1478476

Maspiroh, I., Rohamtillah, N., & Anggraheni, F. Y. (2026). Digital literacy in higher education: A bibliometric analysis using R-Biblioshiny. Journal of Education Research, 7(3), 1944–1959. https://doi.org/10.37985/jer.v7i3.3887

Muslimin, A. I., Mukminatien, N., & Ivone, F. M. (2023). TPACK-SAMR digital literacy competence, technostress, and teaching performance: Correlational study among EFL lecturers. Contemporary Educational Technology, 15(2), Article ep416. https://doi.org/10.30935/cedtech/12921

Naamati-Schneider, L. (2024). Enhancing AI competence in health management: students' experiences with ChatGPT as a learning tool. BMC Medical Education, 24, Article 1449. https://doi.org/10.1186/s12909-024-05595-9

Naamati-Schneider, L., & Alt, D. (2024). Beyond digital literacy: The era of AI-powered assistants and evolving user skills. Education and Information Technologies, 29, 21263–21293. https://doi.org/10.1007/s10639-024-12694-z

Ndungu, M. W. (2024). Integrating basic artificial intelligence literacy into media and information literacy programs in higher education: A framework for librarians and educators. Journal of Information Literacy, 18(2), 122–139. https://doi.org/10.11645/18.2.641

Nieminen, J. H., Bearman, M., & Ajjawi, R. (2023). Designing the digital in authentic assessment: is it fit for purpose? Assessment & Evaluation in Higher Education, 48(4), 529–543. https://doi.org/10.1080/02602938.2022.2089627

Oncioiu, I., & Bularca, A. R. (2025). Artificial intelligence governance in higher education: The role of knowledge-based strategies in fostering legal awareness and ethical artificial intelligence literacy. Societies, 15(6), Article 144. https://doi.org/10.3390/soc15060144

Saib, M. O., Rajkoomar, M., Naicker, N., & Olugbara, C. T. (2023). Digital pedagogies for librarians in higher education: a systematic review of the literature. Information Discovery and Delivery, 51(1), 13–25. https://doi.org/10.1108/IDD-06-2021-0066

Sarva, E., Lāma, G., Oļesika, A., Daniela, L., & Rubene, Z. (2023). Development of education field student digital competences—student and stakeholders' perspective. Sustainability, 15(13), Article 9895. https://doi.org/10.3390/su15139895

Slimi, Z., Benayoune, A., & Alemu, A. E. (2025). Students' perceptions of artificial intelligence integration in higher education. European Journal of Educational Research, 14(2), 471–484. https://doi.org/10.12973/eu-jer.14.2.471

Smith, E. E., & Storrs, H. (2023). Digital literacies, social media, and undergraduate learning: what do students think they need to know? International Journal of Educational Technology in Higher Education, 20, Article 29. https://doi.org/10.1186/s41239-023-00398-2

Sullivan, M., McAuley, M., Degiorgio, D., & McLaughlan, P. (2024). Improving students' generative AI literacy: A single workshop can improve confidence and understanding. Journal of Applied Learning and Teaching, 7(2), 88–97. https://doi.org/10.37074/jalt.2024.7.2.7

Tondeur, J., Howard, S., Van Zanten, M., Gorissen, P., Van der Neut, I., Uerz, D., & Kral, M. (2023). The HeDiCom framework: Higher education teachers' digital competencies for the future. Educational Technology Research and Development, 71, 33–53. https://doi.org/10.1007/s11423-023-10193-5

Wang, C., & Si, L. (2024). The intersection of public policy and public access: Digital inclusion, digital literacy education, and libraries. Sustainability, 16(5), Article 1878. https://doi.org/10.3390/su16051878