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Mapping the Intellectual Territory of Digital Capability in Higher Education: A Bibliometric Review of the Literature, 2002–2026

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Abstract

Digital capability has moved from the periphery of higher education (HE) policy to its centre, reshaped by the spread of information and communication technologies, the COVID-19 emergency pivot to online learning, and the sudden emergence of generative artificial intelligence. This article presents a bibliometric review of scholarship on digital capability in HE, understood as an umbrella construct encompassing digital literacy, digital competence, and digital skills. Drawing on a CiteSpace-based analysis of a corpus spanning 2002–2026, we synthesize four complementary networks: a 439-keyword co-occurrence map, a document co-citation structure comprising ten knowledge-base clusters, a sequence of citation bursts across 24 terms, and the co-cited author and institutional landscape. The results show (i) that digital literacy and higher education are the two structural hubs that bind the field together; (ii) that research attention has shifted through three waves—an early Web 2.0 and social media wave, a 2018–2022 information literacy and skills wave, and a post-2021 turn toward human–AI interaction, generative AI, and student engagement; (iii) that the knowledge base rests on a durable "digital literacies / critical literacy" foundation (2007), while its fastest-growing frontier is an AI-literacy cluster (2022, silhouette 0.88); and (iv) that the field is globally distributed but increasingly led by Chinese, Spanish, and Northern European institutions. We argue that the literature is undergoing a reconceptualization, moving from discrete, measurable "skills" toward a broader, critical, and AI-aware "capability." The article concludes with implications for curriculum design, measurement, equity, and future research.

Keywords:

digital capability; digital literacy; digital competence; higher education; bibliometric analysis; CiteSpace; generative artificial intelligence

Introduction

For more than two decades, higher education has repeatedly grappled with the question of what students, academics, and institutions should be able to do with digital technologies. Once framed as "computer literacy" for a small group of specialists, this capacity has become a general graduate attribute, a condition of employability, and—since 2020—a precondition for the continuity of teaching itself. The vocabulary used to describe this capacity, however, remains stubbornly plural: scholars write about digital literacy, digital com-

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petence, digital skills, digital readiness, and, increasingly, digital capability. In this review, we adopt digital capability as the umbrella term, following the intuition—well supported by the data we analyse—that the field is consolidating around a capacious construct that extends beyond operational skill to include critical, creative, collaborative, ethical, and now AI-mediated dimensions.

The pace of this agenda's development has been dramatic. The COVID-19 pandemic forced an unprecedented emergency pivot to remote teaching, while the release of large language models has, since late 2022, destabilised long-settled assumptions about writing, assessment, and the role of the university. In such a rapidly changing terrain, narrative literature reviews struggle to keep pace, and the risk of recirculating the same citations increases. A bibliometric approach is therefore not a luxury but a necessity: it enables us to map, using quantitative evidence, where the field has been, where it is heading, and which works and ideas hold it together.

This article addresses three questions. First, what is the macrostructure of the literature on digital capability in HE—its growth, hubs, and clusters? Second, how has attention shifted over time, as revealed by citation bursts? Third, what does the co-citation and authorship landscape reveal about the field's knowledge base, influential voices, and geography of collaboration? We address these questions through a multi-network scientometric analysis and then discuss the field's conceptual trajectory and practical implications.

2. Materials and Methods

The evidence base for this review is a bibliometric dataset exported from a CiteSpace workflow (Chen, 2006; Chen, Ibekwe-SanJuan, & Hou, 2010) configured to examine the intersection of digital capability and higher education. The corpus comprises documents published between 2002 and 2026 and was built around the keyword family digital literacy / digital competence / digital skills / digital capability combined with higher education / university / college. Four analytically distinct but mutually reinforcing networks were produced and are used throughout the article:

Keyword co-occurrence (CO-DESC). A network of 439 keywords, clustered into 12 themes using latent semantic indexing (LSI), log-likelihood-ratio (LLR) labelling, and modularity-based clustering. Centrality is reported using degree and betweenness centrality, while silhouette scores indicate cluster coherence.

Document co-citation analysis (DCA). A network of 677 cited references, clustered into 10 knowledge-base clusters and used to reconstruct the field's intellectual foundation.

Citation-burst detection. Kleinberg's (2002) burst-detection algorithm was applied to keywords, identifying the 24 terms with the strongest citation bursts across the period and thus capturing the shifting research front.

Co-cited author and institutional networks. Networks of approximately 700 co-cited authors and 283 organisations, used to identify the field's most influential voices and its geography of collaboration.

Methodologically, our reporting follows the conventions of systematic scientometric reviews (Chen & Song, 2019). We treat centrality and burst as complementary signals: centrality marks a node that holds the network together, whereas burst marks a node that is rapidly gaining attention. Clusters are interpreted quali-

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tatively in light of their LLR labels and the references they co-cite. We do not claim that cluster membership is definitive; rather, clusters serve as analytic lenses for organising a large and messy literature.

3. Results

3.1 Macro-level growth and intellectual hubs

The keyword co-occurrence map reveals a field organised around two dominant structural hubs. Digital literacy is the most central keyword (degree centrality 0.42; co-occurrence frequency 208), while higher education is the most frequent node overall (frequency 222; centrality 0.29). These two terms form the network's gravitational centre: nearly every thematic sub-field orbits them. The next tier of hubs—information literacy (frequency 38), technology (60), digital competence (32), digital skills (40), online learning (19), skills (42), students (39), and education (49)—confirms that the field focuses on the intersection of pedagogy, literacy, and technology, primarily in universities.

Two observations about the periphery are telling. First, the appearance of artificial intelligence (frequency 39), AI literacy (15), generative AI (7), and generative artificial intelligence (12) among the co-occurring terms—several of which have very recent first-appearance years (2021–2026)—signals the speed with which AI has been absorbed into the digital-capability conversation. Second, the presence of digital divide (21), digital inclusion (4), and educational equity (3), alongside digital self-efficacy and techno-eustress, shows that the field is as concerned with the social and psychological conditions of capability as with its technical content. This dual focus—competence plus context—is a defining feature of the corpus.

Wave 1 (≈2011–2016): Web 2.0, social media, and new literacies. The earliest bursts—web (begins 2011), facebook (2012), and new literacies (2013)—reflect a period when digital capability was understood through the lens of participatory culture and social platforms. This was the era of the "digital natives" debate and new-literacy studies, when the pressing question was whether a generation raised on social media possessed capabilities that schools did not yet recognise.

Wave 2 (≈2018–2022): information literacy, skills, and the pandemic pivot. A second cluster of bursts—information literacy (2018), skills (2018), community and online (2020), strategy and students (2020), followed by teachers, framework, and perceptions (2021)—coincides with two convergent forces: a maturing policy push for measurable digital competence, exemplified by the DigComp and DigCompEdu frameworks, and the COVID-19 emergency, which made online learning (burst 2022) and literacy / competence (2022–2024) suddenly operational necessities. The emergence of ehealth literacy (2021) and knowledge (2021) illustrates how digital-capability discourse diffused into professional and disciplinary sub-fields.

Wave 3 (≈2021–2026): human–AI interaction, generative AI, and engagement. The most recent bursts—digital competence (2023), ict (2023), user acceptance (2024), and student engagement (2024)—mark a third wave in which artificial intelligence becomes the organising problematic. Notably, ict and user acceptance remain open bursts extending to 2026, indicating that this frontier is still accelerating rather than settled. The pairing of student engagement with AI-related terms is especially significant: it suggests that the field is no longer asking only whether students can use AI, but also whether AI-mediated learning can sustain the deeper

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engagement that capability frameworks aspire to.

3.2 Document co-citation clusters: the knowledge base

The document co-citation analysis (DCA) reconstructs the field's intellectual foundation as ten clusters (Table 1). Their mean publication years and silhouette scores provide a basis for assessing both the age of each sub-field and its internal coherence.

Table 1. Document co-citation clusters of the digital-capability-in-HE literature.

Cluster	Size	Silhouette	Mean year	LLR label (abridged)
0	105	0.665	2018	ict; digital skills; digital competence; artificial intelligence; ai literacy
1	87	0.880	2022	ai literacy; artificial intelligence; generative artificial intelligence; ai adoption; human–ai interaction
2	84	0.744	2020	digital literacy; higher education; online learning engagement; techno-eustress; learning motivation
4	31	0.918	2012	multimedia/hypermedia systems; research trends; readiness; digital learning; cluster analysis
5	30	0.924	2020	covid-19; emergency remote teaching; post-pandemic teaching; teacher digital literacy; sustainability mindset
6	29	0.873	2009	qualitative; adolescence; think-aloud protocols; sociocultural; digital
7	19	0.960	2007	literacies; critical literacy; higher education; digital literacy
8	19	0.945	2015	digital content creation; young adults; scoping review; teenagers; ict
9	18	0.997	2017	institutional factors; higher education teachers skills; basic digital skills; model; learning activities
12	11	0.966	2008	new literacy studies; youth cultures; pedagogy; digital literacy/literacies; social networks

Three clusters form the foundation. Cluster 7 (2007, silhouette 0.96)—labelled "literacies; critical literacy; higher education; digital literacy"—is the oldest and one of the most coherent. It connects the field to the long tradition of literacy studies and to the critical turn, which insists that digital capability is not a neutral technique but a contested cultural practice. Cluster 12 (2008), centred on "new literacy studies" and "youth cultures," extends this foundation to participatory and socially networked conceptions of literacy. Together, these clusters explain why a critical-literacy sensibility persists in the literature, even as its vocabulary has shifted toward "competence" and "capability."

The middle of the timeline is dominated by Cluster 2 (2020, "digital literacy; higher education; online learning engagement") and Cluster 5 (2020, "covid-19; emergency remote teaching"). With its exceptionally high silhouette (0.924), Cluster 5 captures a tightly knit response to the pandemic and is co-cited with works such as the now-canonical distinction between emergency remote teaching and online learning by Hodges, Moore, Lockee, Trust, and Bond (2020). This cluster offers a vivid bibliometric footprint of a historical rup-

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ture.

The frontier is unambiguous. Cluster 1 (2022, silhouette 0.88, 87 documents) is the largest of the recent clusters and is labelled "ai literacy; artificial intelligence; generative artificial intelligence; ai adoption; human–ai interaction." It co-cites a new wave of scholarship on GenAI in education (e.g., Kasneci et al., 2023; Ng et al., 2021) and sits at the leading edge of the citation-burst sequence. The fact that the newest cluster, and one of the most coherent, focuses on AI literacy confirms that the field's centre of gravity has moved decisively toward human–AI capability.

3.3 Keyword co-occurrence clusters: the thematic landscape

The 12 descriptor clusters identified in the keyword co-occurrence network (Table 2) provide a thematic map that complements the co-citation view. They are best understood as the practical and empirical faces of the field—what researchers actually study, rather than the works they cite.

Table 2. Keyword co-occurrence clusters (thematic landscape).

Cluster	Size	Silhouette	Mean year	Dominant LLR theme
0	89	0.262	2023	academic self-efficacy; ai-enhanced entrepreneurship education; school administrator
1	49	0.592	2019	metaverse-based blended english learning; self-perceived digital competence
2	44	0.766	2015	networking skill; cultural capital; independent online learning
3	40	0.631	2020	technology adoption; digital learning activities; digital profile
4	35	0.644	2018	information literacy; mobile information literacy; emerging field
5	31	0.878	2015	critical digital literacy; game-design learning; discovery-based program
6	29	0.652	2022	blended learning; prompt engineering; undergraduate business student
7	26	0.848	2017	college student; mediating role; project-based learning activity
8	21	0.805	2019	european universities; digital competence; sustainable student engagement; learning agility
9	20	0.781	2019	web-use skill; digital readiness; students achievement
10	20	0.962	2015	online forum; transcultural digital literacies; cross-border connection
11	13	0.882	2018	health literacy assessment; 21st-century skill; critical thinking

Several themes stand out. Measurement and scale development are concentrated in Clusters 0 (2023, "academic self-efficacy," "measuring teacher"), 8 ("digital competence," "learning agility"), and 11 ("health liter-

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acy assessment," "21st-century skill"). This reflects a strong empirical turn toward instrument validation—an essential step if "capability" is to be more than a slogan. Critical and transcultural literacy feature in Cluster 5 ("critical digital literacy"; silhouette 0.878) and Cluster 10 ("transcultural digital literacies," silhouette 0.962). The latter is the most coherent cluster in the entire keyword network and signals an important move beyond Western-centric competence models. AI in teaching and learning is evident in Cluster 0 (ai-enhanced entrepreneurship education), Cluster 6 ("prompt engineering," mean year 2022), and Cluster 3, which focuses on technology adoption. Student experience and wellbeing run through Cluster 7 ("mediating role," "college student") and Cluster 8 ("sustainable student engagement," "techno-eustress"). The relatively low silhouette of the largest cluster (Cluster 0, 0.262) is itself informative: the newest, fastest-growing area remains in flux, with AI-enhanced education, entrepreneurship, self-efficacy, and school administration not yet coalescing into a stable subfield—a sign of an emerging, contested frontier.

3.4 Influential authors, works, and the geography of collaboration

The co-cited author network highlights the field's most influential voices and the theoretical scaffolding underpinning empirical work. Among the authors with the highest centrality or burst strength are van Deursen (degree 33; burst strength 3.91, 2017–2022), whose work on the layered digital divide anchors the equity dimension; Hargittai (burst 5.93, 2012–2022), who problematised the "digital native" assumption by documenting fine-grained variation in skills; Bennett (burst 4.99, 2012–2020) and Prensky (burst 5.29, 2010–2022), central to the digital-natives debate; and Ferrari and Spante (both burst 3.82, 2020–2024), who codified digital-competence frameworks. More recent authors with rising burst strength include Zhao (5.03, 2023–2024), Tondeur (4.15, 2020–2026), Hodges (5.63, 2021–2023, emergency remote teaching), and Chen and Audrin (both 3.51, 2024–2026).

These authors draw on the field's theoretical and methodological anchors. Capability is repeatedly modelled using Bandura's self-efficacy, Davis's technology acceptance model (TAM), and Venkatesh's unified theory of acceptance and use of technology (UTAUT), all of which are associated with high-degree co-cited authors. Empirical studies rely heavily on Hair's multivariate/partial-least-squares methods, Creswell's mixed-methods framing, and Braun's thematic analysis. At the policy level, the field is structured by the European DigComp and DigCompEdu frameworks (Vuorikari et al., 2022; Redecker, 2017), the SCONUL and ACRL information-literacy frameworks, and UNESCO's ICT-competency framework for teachers.

The institutional network, comprising 283 organisations, reveals a genuinely global field. Spanish universities—Granada, Extremadura, and the Open University of Catalonia—are strongly represented, consistent with Spain's leadership in digital-competence and assessment scholarship. Northern Europe (UCL, the Open University UK, Oxford) and North America (Stanford, Florida State, Northwestern) provide a stable backbone. Particularly striking is the rapid rise of Chinese institutions—Beijing Normal University, Zhejiang University, Xiamen University, the Chinese University of Hong Kong, the Education University of Hong Kong, Nanjing University, and Minzu University of China—which, together with Saudi, Malaysian, and Turkish universities, signal a clear shift in quantitative output toward Asia and the Global South. This geographical shift matters: as leadership in volume moves eastward and southward, the field's conceptual centre is diversifying beyond its Anglo-European origins, a point to which we return in the discussion.

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4. Discussion

4.1 From literacy to capability: a conceptual shift

Taken together, the hub analysis, burst sequence, and cluster structure depict a field undergoing a conceptual migration. The vocabulary remains anchored in "digital literacy" (the highest-centrality keyword and the oldest co-citation cluster), while the research front is shifting toward "digital competence" (burst 2023) and, most recently, "capability" in an AI-saturated environment. We interpret this shift as more than a change in terminology. Historically, "literacy" implied reading and critiquing texts, while "competence" implied a checklist of demonstrable abilities. "Capability," in the tradition of Sen and Nussbaum's capability approach, implies the real freedom to achieve valued functionings with technology. The data support this interpretation: the co-occurrence of critical digital literacy, transcultural digital literacies, student engagement, self-efficacy, techno-eustress, and AI literacy points to a field that increasingly treats digital capability as a holistic, context-sensitive, and value-laden capacity rather than a narrow technical skill. The emergence of Cluster 1 (AI literacy, 2022) as the largest new cluster provides the clearest evidence that "capability" must now include the ability to collaborate with, critique, and be augmented by artificial intelligence.

4.2 Measurement, frameworks, and the persistence of the divide

A second theme is the field's struggle to measure what it champions. The prominence of scale-development clusters (0, 8, 11) and frameworks (DigComp, DigCompEdu, SCONUL, ACRL, UNESCO) indicates that, having established that capability matters, the field is now preoccupied with developing valid instruments. This is a healthy development, but the continued co-occurrence of digital divide, educational equity, and digital inclusion—and the foundational status of van Deursen's and Hargittai's scholarship on the divide—serves as a warning. Capability frameworks risk becoming instruments of stratification unless they are accompanied by attention to who lacks access, who lacks the cultural capital to turn access into use, and whose languages and contexts the frameworks themselves exclude. The exceptional coherence of the "transcultural digital literacies" cluster (silhouette 0.962) suggests that a corrective is already underway: a move toward plural, culturally situated models of capability.

4.3 The generative-AI disruption and the question of engagement

The third discussion point concerns the most recent burst frontier: user acceptance (2024), student engagement (2024), and ICT (2023, open to 2026). The juxtaposition of AI adoption and student engagement presents the field's central puzzle. Early GenAI scholarship treated AI literacy as a defensive skill, focused on detecting machine-generated text and preventing cheating. The burst data suggest a more constructive reframing: capability now means designing AI-mediated learning that preserves and deepens engagement rather than eroding it. The fact that this frontier remains open-ended (with bursts extending to 2026) is appropriate; we are at an early stage in what will likely be the defining chapter of the digital-capability literature.

5. Conclusion and Implications

This bibliometric review of the digital-capability-in-higher-education literature from 2002 to 2026 yields

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four conclusions. (1) The field is structurally unified by digital literacy and higher education, but is broadening toward a genuinely multidimensional construct of "capability." (2) Its focus has evolved through three waves: Web 2.0 and new literacies; an information-literacy-and-skills push amplified by the pandemic; and a current frontier centered on human–AI interaction and engagement. (3) Its knowledge base rests on a durable critical-literacy foundation and is being extended by a fast-growing, coherent AI-literacy cluster. (4) Its centre of gravity is shifting geographically toward Asia and the Global South, even as its theoretical scaffolding remains Anglo-European and its methods remain wedded to established acceptance and self-efficacy theories.

For policy and curriculum, national and institutional capability frameworks should be redesigned around the broader construct, integrating AI literacy, criticality, wellbeing (techno-eustress), and equity rather than listing discrete skills. For measurement, the field should continue and accelerate the validation of culturally adaptable instruments, while resisting the temptation to treat a single Western framework as universal. For research, the data reveal three gaps: comparatively limited engagement with the Global South's own conceptions of capability; underdeveloped links between digital capability and disciplinary curricula, especially in non-STEM fields; and a need for longitudinal studies of how AI actually reshapes student learning and engagement, rather than merely its acceptance. Addressing these gaps will determine whether digital capability becomes, as its most ambitious proponents hope, a genuine expansion of human freedom in higher education—or merely a new layer of unequal credentialing.

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