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Research Article

The Evolution of Digital Reading Research: A Bibliometric Analysis of Attention, Engagement, Literacy and Learning Outcomes

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ABSTRACT

The rapid integration of digital technology in education has transformed students on how to read, access information, and engage with learning. While online text, multimedia resources, and interactive learning platforms has become essential to education practice, digital reading progress as a significant area of inquiry. Even though it is a growing importance, the intellectual advancement and thematic structure of the field remain disintegrated. This study investigated the evolution of digital reading research utilizing bibliometric analysis of 562 English-language publications indexed in Scopus from 1992 to 2025. The publications were retrieved using search key related to digital reading, education, attention, engagement, comprehension and learning outcomes. Publication trend analysis, bibliographic coupling and co-word analysis were performed using VOSviewer. The findings revealed a marked increase in research output, particularly in 2020, presenting the expanding role of digital learning environments in education. Bibliographic coupling recognized five major search streams: digital reading engagement and self-regulation, technology-enhanced comprehension, online reading literacy and information evaluation, screen-versus-print reading, and reading modality with digital distractions. Co-word analysis showed four thematic domains covering technology-mediated learning, cognitive and behavioral mechanisms, digital literacy and strategic reading, and online reading comprehension within the New Literacies framework. Generally, the findings specified that digital reading research has advanced beyond print-versus-screen comparisons toward a broader emphasis on digital literacy, self-regulated learning, attention management, and information evaluation. The study presents a comprehensive overview of the intellectual landscape field and recognize the emerging directions, including artificial intelligence, learning analytics, adaptive reading technologies, and digital literacy development, offering insights for researchers, educators, curriculum developers and policy makers.

Keywords: *Artificial Intelligence, Bibliometric Analysis, Digital Literacy, Digital Reading, Educational Technology, Learning Analytics, New Literacies, Online Reading, Reading Comprehension, Self-Regulated Learning*

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Introduction

The increasing use of digital technology in education has changed how learners' access and engage with information. Over the years, digital reading has become an important part of learning as students rely more on smartphones, tablets, e-books, learning management systems, and AI powered platforms. This shift has encouraged research to examine how digital reading affects comprehension, literacy development, engagement, attention, and learning outcomes (Segers et al., 2025; Clinton-Lisell & Litzinger, 2026). Unlike traditional print reading, digital reading takes place in information-rich environments that often contain hyperlinks, multimedia elements, and personalized content. However, they can also introduce distractions and increase cognitive demands on learners, which may affect their ability to concentrate and comprehend information effectively (Shen, 2025; Luo et al., 2025). As a result, researchers have increasingly explored how learners manage their attention, evaluate information, and navigate complex digital spaces while reading. Recent studies recognized digital reading as multidimensional literacy practice that involves cognitive, motivational, technological, and social processes (Liu et al., 2025; Dang & Habók, 2026). To read effectively in digital environments, learners are expected to identify relevant information, evaluate the credibility of sources, synthesize information from different platforms, and communicate ideas effectively while demonstrating critical thinking and self-regulation. Moreover, contemporary research has shifted beyond screen-versus-print comparisons to examine digital literacy, online reading comprehension, engagement, attention management and technology-enhanced learning environments (Tang et al., 2024; Yu et al., 2025). Despite the growing body of literature, the overall structure and development of digital reading research remain unclear. To address this gap, the present study maps the intellectual structure and thematic evolution of digital reading research through a bibliometric analysis of Scopus-indexed publications. The study addresses the following research questions:

1. How has digital reading research evolved overtime in terms of publication trends and scholarly development?
2. What intellectual structures and major research streams characterized the field of digital reading research?
3. What intellectual patterns and knowledge domains emerge from the co-occurrence of keywords in digital research?
4. What future research directions can be identified from the evolving intellectual landscape of digital of digital reading studies?

By synthesizing the field's development, this study provides a comprehensive understanding of digital reading research and identifies emerging directions for scholarship in increasingly digital and AI-mediated learning environments.

Methodology

Bibliometric Approach

A bibliometric approach was used to examine the intellectual structure, thematic evolution, and research trends of digital reading scholarship. By analyzing publication and citation data, bibliometric analysis helps identify influential studies, emerging themes, and knowledge patterns within a research field (Misuraca, 2026; Lyu et al., 2026). Following a science-mapping perspective (Ballesteros-Ballesteros, 2025), bibliographic coupling and co-word analysis were conducted to identify major research streams and conceptual relationships through shared references and keyword co-occurrence patterns (Acuña-Muñoz & Carvajal-Trujillo, 2026; Thuy, 2026).

Research Design and Data Collection Procedure

Scopus database was selected as bibliographic data source due to its comprehensive coverage of peer-reviewed publications, robust citation-tracking ability and standardized metadata. These structures make it one of the most reliable databases and widely used for bibliometric study (Misuraca, 2026; Lyu et al., 2026). Data retrieval was performed on June 6, 2026, using this search string: TITLE-ABS-KEY (("digital reading" OR "electronic reading" OR

"online reading" OR "screen reading" OR "e-reading") AND (" student" or "learner" OR "learner" or "education") AND ("attention" OR

"distraction" OR "engagement" OR "learning outcomes" OR "comprehension")).

Table 1. Search String of Digital Reading in Scopus Database

No	Keywords	Justification
1	TITLE-ABS-KEY (	Limits the search to terms appearing in the title, abstract, and author keywords, thereby increasing the relevance of retrieved publications.
2	("digital reading" OR "electronic reading" OR "online reading" OR "screen reading" OR "e-reading")	Captures the major terminologies used to describe reading activities conducted through digital devices and online environments.
3	AND (student* OR learner* OR education)	Restricts the search to educational contexts and learner populations. The wildcard (*) enables retrieval of variations such as student, students, learner, learners.
4	AND ("attention" OR "distraction" OR "engagement" OR "learning outcomes" OR "comprehension")	Represents the primary cognitive, behavioral, and educational constructs associated with digital reading research.

To ensure relevance and consistency of the dataset, it applies inclusion English-language publications criteria published between 1992

and 2025. The original retrieved dataset was 625, which were reduce to 562 publications after filter.

Table 2. Database Extraction and Filtering Process

Stage	Number of Documents
Initial Scopus Results	625
After English Language Filter	587
After Publication Year Filter (1992-2025)	562
Final Dataset for Analysis	562

Data Analysis Procedure

VOSviewer 1.6.20 is a widely accepted tool for constructing and visualizing bibliometric networks (Lyu et al., 2026; Ballesteros-Ballesteros, 2025). For this reason, it was implemented to analyze the bibliographic records retrieved from Scopus database and were exported in a CSV format. Three coordinating analysis were conducted to characterize the field of digital reading research. First, is the analysis for publication trend which assessed the historical growth of publications between 1992-2025. Second, is the bibliographic coupling analysis was utilized to examine the field's intellectual structure by identifying publications that shared common cited references (Acuña-Muñoz & Carvajal-Truejillo, 2026; Thuy, 2026). A minimum threshold of 49 citations was applied, produced a coupling network of 60 publications. Lastly, co-word

analysis was performed to draw the conceptual structure of the field by examining keyword co-occurrence patterns. Of the 2,515 keywords extracted 66 publications met the inclusion criteria of at least 8 occurrences and were retained for analysis.

Network Interpretation

To improve the interpretability of the bibliometric maps, an inductive thematic approached was utilized. Instead of relying solely on automated clustering outputs, cluster names were developed with iterative examination of representative publications and the semantic relationship with the keywords (Ballesteros-Ballesteros, 2025; Misuraca, 2026). This process eased the identification of the thematic domains, intellectual foundations, and emerging discretion of digital reading research.

Findings and Discussions

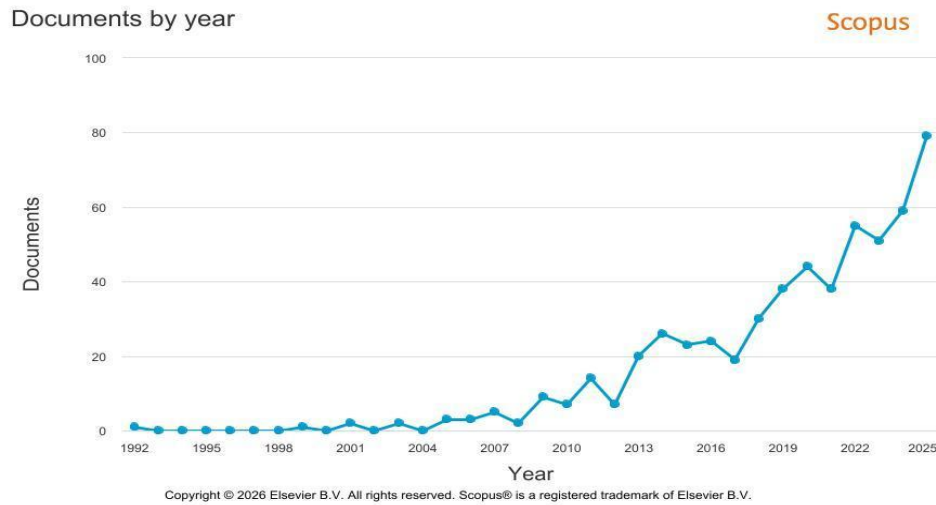


Figure 1. Annual Publication Trends in Digital Reading Research (1992–2025)

Figure 1 shows a temporal evolution of the digital reading research 1992-2025. Even though the earliest publications discovered in 1992, research output remained relatively low until the late 2000s revealing the limited adoption of digital reading technologies during the early stage of digital transformation. A constant increase in publication activity developed after 2010, coinciding with the widespread availability of mobile devices, eBooks, and online learning platforms. From 2013 to 2019, the annual research output increased consistently, ranging from 20 to 38 publications, indicating a growing scholarly interest in digital reading and its education applications. A more prominent increasing trend was observed from 2020 onwards, with the publication from 44 in 2020 to 55 in 2022 before remaining consistently high in 2023 with 51 publications. This acceleration likely to reflect the increasing expansion of digital learning environments during and after the COVID-19 pandemic, which strengthen the use of online education resources and digital reading technologies. The highest publication production was recorded in 2024 with 59 publications and 79 publications in 2025, it demonstrate the

continued expansion of the field and emphasizing digital reading as an increasingly significant area of interdisciplinary and educational research.

Bibliographic Coupling

Bibliographic coupling analysis was applied to identify the intellectual structure of research in digital reading. Unlike co-citation analysis, which maps foundational studies, bibliographic coupling shows current trends and emerging directions by analyzing the shared references of publications (Thuy 2026; Acuña-Muñoz & Carvajal-Trujillo, 2026). Of the 562 publications included in the dataset, 60 met the minimum threshold of 49 citations and were included in the coupling network. The yielded five (5 clusters representing the central scholarship domains in this area. Based on the total link strength (TLS), the most influential publications were Coiro, 2011(TLS 111); Singer and Alexander, 2017 (TLS 108); and Leu et al., 2015 (TLS 106). Their central location in the network suggestions high interlinkages with several research areas within digital reading. Table 3 shows the 10 most influential publications based on bibliographic coupling.

Table 3. Top 10 Documents in Bibliographic Coupling Analysis of Digital Reading

Rank	Publication	Citation	Total Link Strength
1.	Coiro, J. (2011). Predicting reading comprehension on the Internet: Contributions of offline reading skills, online reading skills, and prior knowledge. <i>Journal of Literacy Research</i> , 43(4), 352–392. https://doi.org/10.1177/1086296X11421979	242	111
2.	Singer, L. M., & Alexander, P. A. (2017). Reading across mediums: Effects of reading digital and print texts on comprehension and calibration. <i>The Journal of Experimental Education</i> , 85(1), 155–172. https://doi.org/10.1080/00220973.2016.1143794	224	108
3.	Leu, D. J., Forzani, E., Rhoads, C., Maykel, C., Kennedy, C., & Timbrell, N. (2015). The new literacies of online research and comprehension: Rethinking the reading achievement gap. <i>Reading Research Quarterly</i> , 50(1), 37–59. https://doi.org/10.1002/rrq.85	243	106
4.	Lee, Y.-H., & Wu, J.-Y. (2013). The indirect effects of online social entertainment and information seeking activities on reading literacy. <i>Computers & Education</i> , 67, 168–177. https://doi.org/10.1016/j.compedu.2013.03.001	84	94
5.	Wu, J.-Y. (2014). Gender differences in online reading engagement, metacognitive strategies, navigation skills and reading literacy. <i>Journal of Computer Assisted Learning</i> , 30(3), 252–271. https://doi.org/10.1111/jcal.12054	73	93
6.	Kannianen, L., Kiili, C., Tolvanen, A., Aro, M., & Leppänen, P. H. T. (2019). Literacy skills and online research and comprehension: Struggling readers face difficulties online. <i>Reading and Writing</i> , 32(9), 2201–2222. https://doi.org/10.1007/s11145-019-09944-9	65	92
7.	Wu, J.-Y., & Peng, Y.-C. (2017). The modality effect on reading literacy: Perspectives from students' online reading habits, cognitive and metacognitive strategies, and web navigation skills across regions. <i>Interactive Learning Environments</i> , 25(7), 859–876. https://doi.org/10.1080/10494820.2016.1224251	50	90
8.	Dahan Golan, D., Barzillai, M., & Katzir, T. (2018). The effect of presentation mode on children's reading preferences, performance, and self-evaluations. <i>Computers & Education</i> , 126, 346–358. https://doi.org/10.1016/j.compedu.2018.08.001	65	89
9.	Kiili, C., Leu, D. J., Utriainen, J., Coiro, J., Kannianen, L., Tolvanen, A., Lohvansuu, K., & Leppänen, P. H. T. (2018). Reading to learn from online information: Modeling the factor structure. <i>Journal of Literacy Research</i> , 50(3),	62	87

Rank	Publication	Citation	Total Link Strength
	304–334. https://doi.org/10.1177/1086296X18784640		
10.	Lee, Y.-H., & Wu, J.-Y. (2012). The effect of individual differences in the inner and outer states of ICT on engagement in online reading activities and PISA 2009 reading literacy: Exploring the relationship between the old and new reading literacy. <i>Learning and Individual Differences</i> , 22(3), 336–342. https://doi.org/10.1016/j.lindif.2012.01.007	99	74

Figure 2 shows the bibliographic coupling network of digital reading research. Five interconnected clusters emerged, illustrating the major research streams within the field. Cluster labels were assigned through an iterative review of highly connected publications based on

their shared research focus and theoretical perspectives, and research fields. Similar science-mapping studies have illustrated that cluster analysis is best for examining the intellectual organization and thematic development of research fields (Ballesteros-Ballesteros, 2025; Tang et al., 2024).

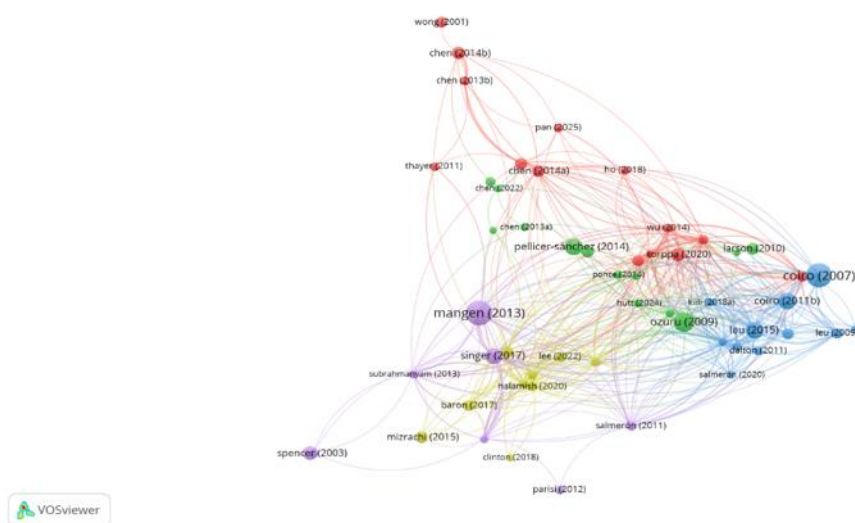


Figure 2. Network Visualization of Digital Reading Bibliographic Coupling

Cluster 1 (Red): Digital Reading Engagement, Self-Regulation, and Reading Performance

Cluster 1 focuses on reading performance-related factors within a digital environment, namely engagement, self-regulation, attention and technology mediation of reading practices. Publication aggregated in this cluster underline the online reading behavior, navigation skills, metacognitive strategies, and information-seeking

processes are pivotal contributors to reading achievement. Consistently, studies by Lee and Wu (2012, 2013), Wu (2014), Wu and Peng (2017), and Ho and Lau (2018) show that learners displaying higher levels of engagement in digital reading tasks also demonstrate relatively high levels of reading achievement. Next, another central theme that emerged is the role of digital technologies in enhancing self-regulated learning. Chen et al. (2013, 2014a, 2014b,

2020) have identified annotation systems, collaborative, collaborative reading platforms, attention-based mechanisms, and gamified environments as conducive to active participation and learner ownership over heightened comprehension and reading performance. These findings suggest that digital tools afford better outcomes when they scaffold strategic engagement rather than passive consumption of content. Related to this are wider concerns highlighting literacy development. Several studies exploring leisure reading, extracurricular reading activities, and reading modality by Wong (2001), Thayer et al. (2011), and Pfost et al. (2013), and more recent interest in home and digital reading by Torppa et al. (2020) find that reading performance is derivative of both digital and traditional reading experiences. In a more contemporary domain, Pan et al. (2025) explore that the implications of GenAI-supported reading environments, indicating a burgeoning interest in intelligent systems underpinning engagement and self-regulation. Overall, this environment depends on technology and the capability of the learner to strategically engage, regulate process, and interact with digital texts.

Cluster 2: Cognitive Processes and Technology-Enhanced Reading Comprehension

Cluster 2 focuses on the cognitive process of fundamentals of digital reading the modes on technology-enhanced environments comprehension support, information processing, vocabulary development and learner attention. Three interconnected themes emerge from this cluster. First focuses on cognitive foundations of reading comprehension. Research by Ozuru et al. (2009), Ponce and Mayer (2014), Pellicer-Sánchez (2016), and Suk (2017) features the roles of prior knowledge, text cohesion, cognitive processing, vocabulary acquisition and

reading strategies in stimulating successful comprehension. These studies recommend that effective digital reading depends on learners' ability to actively construct meaning from text. The second theme focuses on the educational value of digital reading technologies. According to Larson (2010), Wright et al. (2013), Chen and Yen (2013), Lim et al. (2021), and Chen et al. (2022) prove that e-books, collaborative annotation system, hypertext annotations and inquiry-based digital environments can enhance reading comprehension and information literacy. These technology-enhanced tools promote interactive and personalized learning experiences engaging learners to involved more deeply with digital text. The third theme reveals the growing interest in learners' attention and developing digital learning environments. Hutt et al. (2024) investigated the use of the technology that uses eye-tracking to recognize mind wandering a comprehension difficulty, while Reiber-Kuijpers et al. (2021) assessed digital reading in second-language context. Bruan et al. (2020) and Hwang et al. (2023) further prolonged this line of research by investigating critical thinking and immersive education technologies. Taken as a whole, this cluster specifies that digital reading outcomes are shaped by the relationship between cognitive process and technology-supported learning tools. As digital environments remain to grow, research has shifted beyond measuring solely comprehension toward understanding how technology can support attention, foster critical thinking, and ultimately enhance learning outcomes.

Cluster 3: Online Reading Literacy, Information Evaluation and New Literacies

Cluster 3 shows the foundation context of research that conceptualizes digital reading as multipart literacy practice that requires learners to pinpoint, evaluate, incorporate and communicate information in online environments. The publications covered in this cluster converge around their interconnected themes that

mutually explain the evolution of digital reading as distinct literacy domain. The first theme focuses on the emergence of online reading comprehension as a distinct form of literacy. According to Coiro and Dobler (2007), Leu et al. (2009), Coiro (2011a, 2011b), and Dalton et al. (2011) contend that reading in digital environments cover beyond traditional comprehension processes. Instead, it requires planned navigation, critical evaluation of online information, and the capacity to construct meaning from different interconnected sources. Collectively, these studies established the theoretical underpinnings of the New Literacies framework, in which has turn out to be the central to under to understanding literacy in digital mediated contexts. The second them highlights information evaluation and online inquiry skills. The studies by Kiili et al. (2018a, 2018b), Kannianinen et al. (2019), and Salmerón et al. (2020) states that effective digital reading depends on learners' ability to evaluate the credibility, association and quality of information drawn from different online and multimodal sources. The findings revealed that struggling readers experience much difficulty in assessing digital information, focusing on the need for instructional approached that explicitly develop critical evaluation and online inquiry skills. The third theme reflects the used of digital reading across different educational contexts. Huang e al. (2009) examined online reding strategies with learners of English as a foreign language, on the other hand, Leu et al. (2015) enriched the discussion by connecting the online research and comprehension skills to educational equality and persistent achievement gaps. Taken together, this research portrays digital reading as multidimensional literacy competency developed by strategic, cognitive, and evaluative processes. Instead of viewing comprehension as an isolated outcome, this body of literature set the digital reading as an integrated component of competencies that capacitate learners to critically evaluate, navigate and synthesis information with increasingly complex digital environments. Accordingly, this cluster provides the conceptual foundation upon which much of the contemporary scholarship on digital reading continues to build.

Cluster 4: Screen Versus Print Reading Preferences and Comprehension Outcomes

Cluster 4 presents the comparative effectiveness of digital and print reading, emphasizing on reading media influence comprehension, engagement and learner's preferences, and the overall learning experience. The discussion within this cluster converges around three interrelated themes. The first theme observes the cognitive and the effects in the performance of learners on reading across different media. Dahan Golan et al. (2018), Stole e al. (2020), and Halamish and Elbaz (2020) examine the influence of reading mode in comprehension, meta comprehension and self-evaluation. While digital texts provide greater accessibility and convenience, this research consistently describe that print based text is often associated with deeper comprehension and more accurate monitoring of understanding, specifically to young learners. The second them concentrates on the continued preference for print materials even with the widespread availability of digital technologies. Mizrachi (2015), Baron et al. (2017), and Loh and Sun (2019) found that many students favor print for academic reading because it promotes information retention, concentration and fewer distractions. These findings suggest that reading preferences are formed not only by technological accessibility but also by the cognitive experiences in relation to different reading formats. The final theme considers the developing role of digital learning environments. Dobler (215) investigated whether e-textbooks function primarily as personalized learning tools or as possible sources of distraction, on the other hand, Clinton (2018) examine the education implications of open-source digital textbooks. Lee (2022) described this perspective by comparing augmented reality and print-based game environments. Collectively, the evidence points to that the question is no longer about digital reading should replace print, but under what circumstances each medium best supports learning. Reading effectiveness gives the impression that it depends on the interaction among medium characteristics, learner preferences, and cognitive demands, underscoring the requirement to balance technological innovation along with sustained attention and deep comprehension.

Cluster 5: Reading Modality, Cognitive Processing and Digital Distraction

Cluster 5 focuses on how reading modality form cognitive processing, comprehension and learning outcomes in digital learning environments. Three related themes were formed from this literature. The first theme concerns differences in reading performance between print and digital media. Mangen et al. (2013), Singer and Alexander (2017) discovered reading medium influences comprehension accuracy, metacognitive calibration and information retention. Their findings consistently point that print reading often encourages a more profound comprehension and more accurate self-monitoring while digital reading may support more superficial processing. The second them highlights on attention and cognitive engagement in digital environments. Salmerón and Garcia (2011) demonstrated that applicable navigation of hypertext needs strategic reading skills, whereas Subrahmanyam et al. (2013) described hat screen-based reading and multitasking place additional cognitive requirement for the learners. Viewed together, these studies suggests that digital reading needs readers to allocate attention efficiently while managing hyperlinks, multiple information source and varying destructions. The final theme widens the discussion to elements that promote cognitive development. Parisi et al. (2012) emphasized the contribution of education and intellectually stimulating activities cognitive functioning, while Maciejewski (2016) examine instructional approaches that utilized technology to enhance learning. Spencer et al. (2003) offer complementary insights to literacy development and comprehension with diverse learners. This cluster presented the effectiveness of digital reading depends less on technological access that on learners' capability to regulate attention and engage in profound cognitive processing. Overall, the five clusters demonstrated the evolution of digital reading research grom comparisons of print and digital media to a multidimensional field including literacy development, cognitive processing, self-regulated learning, technology-enhanced comprehension, and digital destructions. This structure aligns with recent evidence that digital reading research

increasingly focuses on online literacy, learner engagement, digital competencies, and technology-enhanced learning (Tang et al., 2024; Segers et al., 2025).

Synthesis of the Intellectual Structure of Digital Reading Research

The five clusters presented the evolution of digital reading research from a specialized focus on print-versus screen comparison to a wider investigation of digital literacy, information evaluation, self-regulated learning, cognitive engagement and technology enhances reading environments. This development reflects a growing recognition that digital reading incorporates a complex interplay for cognitive, pedagogical, and technological factors. Consistent with Tang et al. (2024), recent research has shifted its attention to understanding how learners navigate, interpret, and construct meaning from growing complex digital text. In the same way that Segers et al. (2025), focused on the importance of attention management, comprehension process, and the integration of emerging technologies as supplementary to learning. Overall, these developments demonstrate that digital reading is no longer viewed simple as a change in reading medium but as a multidimensional research domain that incorporates perspective from literacy studies, cognitive science, educational technology, and the learning sciences.

Co-word Analysis

Co-word analysis was performed to map the conceptual structure of thematic organization of digital reading research by investigation relationships among frequently co-occurring keywords. From the same dataset, 66 of the 2,515 keywords suffice the minimum threshold of eight occurrences, forming four thematic clusters. Table 4 presents the fifteen influential keywords in the network. The most prominent terms were reading comprehension (109 occurrences; TLS= 276), digital reading (102; TLS =216), students (88; TLS =377), reading (55; TLS = 289), and comprehension (49; TLS=236). Their standing indicates that the field primarily investigates how learners comprehend, process, and engage with digital text within educational context.

Table 4. Top 15 Keywords in the Co-occurrence of Digital Reading Keywords Analysis

Rank	Keyword	Occurrences	Total Link Strength
1	reading comprehension	109	276
2	digital reading	102	216
3	students	88	377
4	reading	55	289
5	comprehension	49	236
6	e-learning	44	172
7	online reading	38	94
8	human	34	288
9	education	30	151
10	learning system	26	94
11	reading strategies	26	68
12	article	25	219
13	teaching	25	129
14	humans	24	209
15	online readings	24	100

Figure 3 presents the keyword co-occurrence network, illustrates strong connections among literacy, cognition, and educational technologies. Central terms which are reading comprehension and digital reading links to multiple research themes, reflecting the

increasingly inter disciplinary nature of digital reading research covering education, cognitive psychology, information literacy, and educational technology.

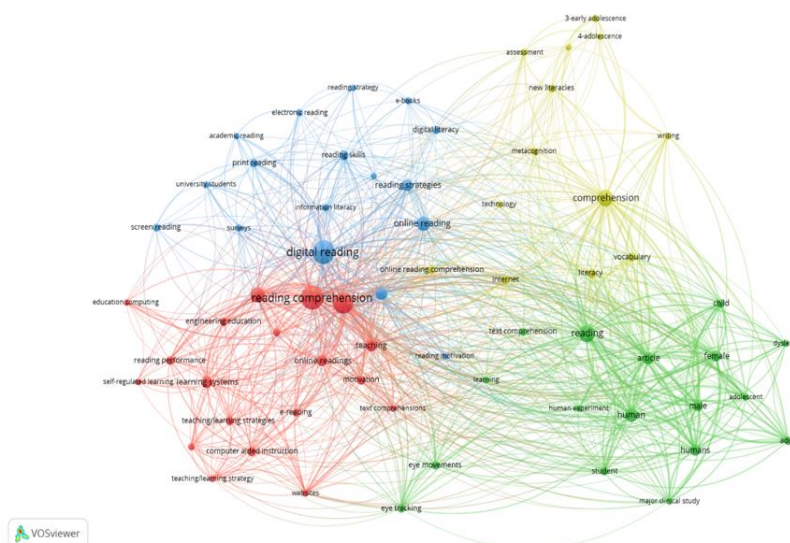


Figure 3. Network Visualization of Co-word Analysis on Digital Reading

Cluster 1 (Red): Digital Reading as a Technology-Mediated Learning Process

The first cluster characterizes a research stream that summarizes digital reading as a technology-mediated learning process formed by learner agency and pedagogical design. The prominence of the keywords students, reading comprehension, e-learning, learning systems, teaching and online reading specifies that

reading outcomes are increasingly understood as developing from the interaction between learners, instructional practices, and digital learning environments. Similarly, the co-occurrence of human-computer interactions, computer-aided instruction, teaching and learning strategies, motivation, and self-regulated learning reveals growing attention to how educational technologies can foster meaningful

learning experiences, same with the recent work on instructional design, digital learning (Salinas, 2012; Yang et al., 2025). The network suggests that the effectiveness of digital reading depends less on technology itself than on how technology incorporated with instruction. Pedagogical scaffolding, collaborative learning, adaptive feedback and learning analytics have been recognized as methods making the student engagement strong with digital text and improve learning outcomes (Wang, 2023; Yang et al., 2025; Adhya & Panda, 2026). In this conceptual structure, reading comprehension functions as the central node linking technology-oriented and learner-centered constructs, while motivation and self-regulated learning emphasize the importance of learners' capacity to manage attention, solutions engagement, and learning strategies. Latest studies consistently associate self-regulation in online and blended learning environments (Hashmi et al., 2026; Shafiee Rad, 2025; Zhang et al., 2026; Wang, 2023). Altogether, this cluster portrays digital destruction as an instructional challenge that be lessened through effective pedagogical design, adaptive learning systems and metacognitive support rather than through effective pedagogical way alone (Adhya & Panda, 2026; Shao et al., 2026).

Cluster 2 (Green): Cognitive and behavioral Mechanisms of Digital Reading

The second cluster investigates the cognitive and behavioral methods that underpin digital reading. The dominance of keywords such as eye movements, eye tracking, text comprehension, learning, and dyslexia reveals increasing interest in how readers allocate attention, process information and construct meaning from digital text. However, Cluster 1, which emphasizes instructional design, this cluster highlight the cognitive processes and reading behaviors that form comprehension, consistent with latest research on attention, reading behaviors, and individual variation in digital reading (Papadopoulos et al., 2026; Louwen et al., 2026). The presence of demographic descriptors such as child, adolescent, adults, female, and male suggest that development and individual variations are central to understating reading performance. Eye tracking research have presented that reading patterns

vary differs across age groups and cognitive profiles, influencing attention allocation, information processing, and text comprehension (Bucci et al., 2022; Louwen et al., 2026). The presence of dyslexia further highlights efforts to understand how digital environments affect learners with varying literacy needs. Research illustrates that eye-tracking measures provide significant evidence of reading efficiency, cognitive load, and processing difficulties that are often overlooked by conventional assessments (Gran Ekstrand et al., 2021; Diotaiuti et al., 2025; Martinez-Perez et al., 2026). Examining the behavior of the learners' reading behaviors also capacitate researchers to identify situations that foster attention and comprehension in digital context (Cutumisu & Turgeon 2026; Ding, 2026). This cluster reveals a shift from measuring reading outcomes to explaining the cognitive conditions that shape comprehension, focusing the interplay between attentional control, cognitive processing, and reader characteristics in increasingly complex digital environments (Papadopoulos et al., 2026; Diotaiuti et al., 2025; Berget & Fagernes, 2021).

Cluster 3: Digital Reading as a Multidimensional Literacy Practice

The third cluster conceptualizes digital reading as a literacy practice that encompasses reading text to outspread information evaluation, strategic learning, and digital competence. The co-word occurrence of digital reading, reading strategies, online reading, digital literacy, information literacy and academic reading recommend that successful engagement with digital text lies on a broad set of cognitive and strategic skills. Coupled with comprehension, learners must navigate multiple information sources, evaluate credibility, regulate attention, and apply purposeful reading strategies to formulate meaning from increasingly complex digital content (Dang & Habók, 2026; Pecini et al., 2024). These reveals a shift from traditional print-oriented perspective toward broader literacy frameworks that incorporate critical thinking and digital competence. The link between education, higher education and reading motivation further directs that digital reading is viewed as a key to competency of learning information-rich environments. As digital text becomes essential to

academic learning, effective reading necessitates learners to allocate, synthesize, and apply information from various sources (Tella & Oladokun, 2026; Sulyman, 2026). Studies in the same way show that strategic reading, digital literacy, and information evaluation are closely related and jointly contribute to successful learning outcomes (Pongsophon., 2026; Rutar & Baloh, 2026). The inclusion of e-books, electronic reading, and screen reading also reveals growing interest on how learners adapt to digital media, mostly when navigating hyperlinked and multimodal texts that needs greater metacognitive awareness (Dang & Habók, 2026). In summary, this cluster frames digital distraction as both a literacy and genitive challenge. Effective digital reading depends on strategic information management, critical evaluation and self-directed engagement rather than technical proficiency alone (Pecini, et al., 2023; Nurtanto et al., 2026). Thus, this research stream redefines reading as in integrated literacy practice that associate comprehension, information management, critical evaluation and digital competence preparing learners to participate effectively in present day digital societies (Al-Jarf, 2026; Dang & Habók, 2026; Tella & Olandokun, 2026).

Cluster 4 (Yellow): Online Reading Comprehension and New Literacies

The fourth cluster conceptualizes reading comprehension as a multilayered literacy process situated in digital and networked environments. The close relationship between comprehension, online reading comprehension, literacy, new literacies and metacognition indicates that comprehension is increasingly observed as dynamic process that needs learners to navigate, evaluate, integrate, and reflect on online information. Same with the New Literacies paradigm, current studies argue that digital reading cover beyond traditional decoding and interpretation to include information search, source evaluation, synthesis of multiple texts, and metacognitive monitoring (Dang & Habók, 2026; Jia et al., 2026). The connection among internet literacy, digital literacy, media literacy, technology, and assessment further recommends growing attention to how learners develop and demonstrate literacy

information-rich environments. Research highlights that successful online reading needs evaluation of the credibility and relevance of information while dealing multiple sources and format of digital content (Pecino et al., 2024; Pongsophon, 2026). The presence of vocabulary and writing reinforces the view that comprehensions is closely linked to a broader literacy development, where reading, writing, communication, and knowledge construction function as complementary competencies (Sabatini et al., 2023; von Davier & Kennedy, 2024). Developmental considerations also surface through keywords connected to early adolescence and adolescence, reflecting growing interest in how young learners obtain the valuable and metacognitive skills necessary to engage critically with digital information (Pecini et al., 2024; Chuenban & Chinwonno, 2026). In summary, the cluster recommends that meaningful digital reading lies more than access to information. In distraction-rich environments, comprehension depends on critical evaluation, metacognitive, regulation, and the ability to synthesize diverse sources of information (Liu & Zhang, 2026; Jia et al., 2026). Thus, digital reading is increasingly understood as combined literacy practice that incorporates comprehension, digital literacy, information literacy, and reflective thinking to support independent learning and informed participation in modern digital societies (Dang & Habók, 2026; Nurtanto et al., 2026; von Davier & Kennedy, 2024).

Thematic Convergence and Evolution of Digital Reading Research

Within the four clusters, digital reading research has advanced from investigation technology to adoption to developing a more inter-related understanding of literacy, cognition and learning in digital environments. Cluster 1 highlights technology-mediated learning. Cluster 2 focus on cognitive and behavioral mechanisms, Cluster 3 explore on digital literacy and strategic reading, and Cluster 4 highlights online reading comprehension with the New Literacies framework. Even with this distinct prominence, the clusters are interrelated through recurring concepts, which are reading comprehension, literacy, learning, metacognition, and digital engagement. With these,

reading comprehension operates as the conceptual core connecting the thematic domains, whereas digital literacy, online reading, and self-regulated learning strengthen the link between them. This structure recommends that effective digital reading lies on the integration of cognitive, technological, and literacy-related competencies (Salinas, 2021; Wang, 2023; Dang & Habók, 2026). The findings also specify a shift from concerns about reading media toward understanding how learners regulate attention, evaluate information, and construct

meaning in increasingly complex digital environment. Developing themes such as self-regulated learning, eye-tracking analytics, and AI-supported reading, further point to future research directions with the goal of enhancing learning within multimodal and intelligent digital ecosystems (Papadopoulos et al., 2026; Shafiee Rad, 2025; Yang et al., 2025).

A summary of the co-word analysis is presented in table 5, comparing cluster number and color, cluster labels, number of keywords, and representative keywords.

Table 5. Summary of Co-word Analysis on Digital Reading

Cluster No and Color	Cluster Label	Number of Key-words	Representative Keywords
1 Red	Digital Reading as Technology-Mediated Learning Process	19	reading comprehension, students, e-learning, learning systems, teaching, online readings, computer aided instruction, motivation, reading performance, teaching/learning strategies, engineering education, e-reading, online learning, human computer interaction, websites, self-regulated learning, text comprehensions, education computing, teaching/learning strategy
2 Green	Cognitive and Behavioral Mechanisms of digital Reading	17	reading, human, article, humans, female, male, eye tracking, child, student, adult eye movements, text comprehension, adolescent, dyslexia, human experiment, major clinical study, learning
3 Blue	Digital Reading as a Multidimensional Literacy Practice	17	digital reading, online reading, education, reading strategies, reading skills, print reading, digital literacy, screen reading, information literacy, e-books, electronics reading, surveys, higher education, reading motivation, academic reading, reading strategy, university students
4 Yellow	Online Reading Comprehension and New Literacies	13	comprehension, literacy, online reading comprehension, vocabulary, internet, new literacies, assessment, 3-early adolescence, metacognition, digital/media literacies, technology, 4-adolescence, writing

Implications

Theoretical Implications

The findings states that digital reading research has advanced beyond comparisons of print and screen media toward in the direction a more comprehensive examination of digital literacy, self-regulated learning, cognitive engagement, and technology-enhanced learning. This development is consistent with current evidence showing that the field progressively prioritizes learner engagement, digital literacy,

and online reading competencies over the reading medium itself (Tang et al., 2024; Segers et al., 2025). The results also emphasize the New Literacies perspective by highlighting effective digital reading needs learners to locate, evaluate, synthesize and communicate information across multiple sources and formats (Tang et al., 2024). In addition, the prominence of self-regulated learning, metacognition, and reading strategies covers Self-Regulated Learning theory by presenting importance of

attentional control and strategic information management in digital context (Dang & Habók, 2026; Xei, 2026). The emergence of themes connected to learning analytics, attention monitoring, and AI-supported learning further shows the convergence of literacy studies, cognitive psychology, the learning sciences, and educational technology. Current research recommends that AI-supported systems and metacognitive scaffolds can support learner engagement, self-regulation, and digital learning outcomes (Ko, 2026; Wu et al., 2026). In summary, these findings strengthen the shift toward learner-centered and process-oriented frameworks that explain how meaning is constructed in an increasingly complex digital environment.

Practical Implications

The findings highlight the importance of extending reading instruction beyond comprehension to incorporate information evaluation, metacognitive monitoring, and self-regulated reading strategies. Evidence shows that reading proficiency is closely related with learners' self-regulation and metacognitive awareness (Dang & Habók, 2026). For developers of curriculum, the increasing growing emphasis on digital literacy and online reading comprehension emphasizes the requirement to integrate these competencies across disciplines. Modern digital literacy covers not only understanding digital text but also evaluating information credibly, synthesizing ideas, and engaging responsibly with digital content (Tang et al., 2024; Ko, 2026). Education institution leaders can support these initiatives by offering professional development that for teachers that will help them incorporate digital reading, self-regulated learning and technology-enhanced instructional practices into the classroom. Similarly, educational technology developers should design adaptive reading systems that offer personalized feedback, foster metacognitive reflection, and sustain learner engagement. AI-supported learning environments provide evidence in strengthening self-regulation and improving learning outcomes when merged with appropriate instructional scaffolds (Wu et al., 2026). At the policy level, these findings underscore the requirement for education frameworks that prioritize digital

literacy, critical thinking and responsible use of technology, with a guarantee that the investments in digital infrastructure are accompanied by initiatives that develop learners' ability to critically navigate, evaluate and apply digital information (Tang et al., 2024 Ko, 2026).

Limitations

There are limitations that should be considered interpreting this study's findings. First, the exploration was limited to publications indexed in Scopus database, eliminating relevant studies available only in other sources such as Web of Science, ERIC, Dimensions or Google Scholar. Thus, the result may not acquire the full scope of digital reading research. Second, only English-language publications published between 1992 – 2025 were covered. While this criterion improved consistency in keyword interpretation and thematic analysis. It may have excepted valuable evidence from non- English publications, in this manner, it may limit the representation of regional and local perspective. Third, the dataset was generated using a pre-specified keyword-based search strategy. While considering capturing concepts related to digital reading, attention, engagement, and learning outcomes, studies utilizing alternative terminologies may not have been retrieved. Therefore, the identified themes are prompted by the scope and specificity of the of the selected keyword. Lastly, bibliometric analysis is structured to investigate publication trends, intellectual structures, and thematic relationships rather than evaluate the methodological quality of each study or determine causal relationships. The resulting clusters therefore present patterns in literature and should be interpreted as evidence of the field's knowledge structure rather than definitive conclusions concerning effectiveness of digital reading interventions.

Future Research Avenues

The findings discover several priorities for future digital reading research. First, the increasing adoption of Artificial Intelligence (AI) and generative AI shows opportunities to investigate how intelligent reading systems influence comprehension, critical evaluation, metacognitive monitoring, and learner autonomy in growing personalized learning

environments (Pan et al., 2025; Yang et al., 2025). Second, emerging themes connected to eye tracking, attention, monitoring, and cognitive processing permit further investigation through the incorporation of eye-tracking analytics, learning analytics, and multimodal data to better describe how attention influences comprehension and learning outcomes (Hutt et al., 2024; Papadopoulos et al., 2026). Third, more concentration should be placed on younger learners by conducting longitudinal studies that investigate the development of digital literacy, online reading comprehension, and metacognitive skills over different stages of learning (Pecini et al., 2024; Chuenban & Chinwonno, 2026). Future research should also examine digital reading in multimodal learning environments, specifically the effects of videos, augmented reality, interactive media, and hyperlinked content on comprehension and cognitive load (Lee, 2022; Hwang et al., 2023). Lastly, studies should continue to address the concerns of equity, accessibility, and digital inclusion (Leu et al., 2015; Kannianen et al., 2019) while advancing unified theoretical frameworks that incorporate digital literacy, self-regulated learning, and online reading comprehension (Dang & Habók, 2026; Wang, 2023; Shafiee Rad , 2025). This work will strengthen understanding of reading and learning increasingly AI-mediated environments.

Conclusion

This study investigated the intellectual structure and thematic evolution of digital reading research utilizing bibliometric analysis of 526 Scopus-indexed publications published from 1992 to 2025. The findings present a sustained growth in scholarly interest, specifically following the expansion of digital learning technologies and the wider digital transformation of education. Bibliographic coupling recognized five interconnected research streams: digital reading engagement and self-regulation, technology-enhanced comprehension, online reading literacy and information evaluation, screening-versus-print reading, and reading modality and digital distraction. Accompanying these results, the co-word analysis presented four thematic domains covering technology-mediated learning, cognitive and

behavioral mechanisms, digital literacy, and strategic reading and online reading comprehension in New Literacies framework. Collectively, these findings present that digital reading has developed into an interdisciplinary field that incorporates literacy studies, cognitive psychology, educational technology, and the learning sciences. They should also include a shift from comparing reading media in understanding how learners regulate attention, evaluate information, and construct knowledge in increasingly complex digital environments (Tang et al., 2024; Segers et al., 2025; Dang & Habók, 2026). Reading comprehension improved as the central concept connecting literacy, cognition, and technology, highlighting the importance of self-regulation, metacognition, and digital literacy. As AI-mediated learning environments progress, future research should examine adaptive reading technologies, attention analytics, and digital literacy to advance both theoretical understanding and educational practice (Yang et al., 2025; Papadopoulos et al., 2026; Shafiee Rad, 2025).

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