



RESEARCH TRENDS ON DIGITAL LITERACY IN HIGH SCHOOLS: INSIGHTS DERIVED FROM SCOPUS DATABASE (2007 – 2024)

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Abstract

In response to the increasing importance of digital literacy in secondary education, this study presents a bibliometric analysis of research on digital literacy in high schools published between 2007 and 2024. Based on 187 peer-reviewed documents indexed in the Scopus database, the study employs Biblioshiny and VOSviewer to examine publication trends, influential authors, leading institutions, primary publication sources, and thematic developments within the field. The results indicate a clear upward trend in scholarly output, with an average annual growth rate of 23.86% and a marked increase during the COVID-19 pandemic. This period appears to have intensified academic attention to digital learning and digital competencies. Although the United States and Indonesia account for the highest number of publications, countries such as Italy, Australia, and Canada show higher citation impact, suggesting differences between research productivity and scholarly influence. Thematic mapping highlights dominant research foci on digital competence, online learning, and media literacy, while areas such as computational thinking, identity formation, and robotics remain comparatively underexplored. Overall, the study outlines the evolving intellectual landscape of digital literacy research in high schools and points to several gaps that may inform more focused and methodologically diverse future research in increasingly digitalized educational settings.

Keywords: digital literacy, high school education, bibliometric analysis, Scopus database, educational technology

Introduction

Digital literacy has increasingly been recognised as a core competence in contemporary secondary education, as digital technologies continue to shape learning processes, modes of communication, and patterns of social participation. At the high school level, digital literacy is commonly understood as a multidimensional construct that goes beyond the acquisition of technical skills to include knowledge, dispositions, and critical engagement with digital environments. The rapid digitalisation of education - particularly during and in the aftermath of the COVID-19 pandemic- appears to have further intensified expectations placed on students, teachers, and education systems to develop and sustain adequate digital literacy capacities. Against this background, examining how digital literacy has been conceptualized and investigated within high school education is necessary for tracing the development of the field, identifying prevailing research orientations, and highlighting areas that remain underexplored.

The integration of digital technologies into socio-economic life has been shown to reshape not only physical environments but also human behaviour and cognitive practices (Draganac et al., 2022). In recent decades, the emergence of new technologies has accelerated the uptake of digital tools across nearly all domains of everyday life (Reddy et al., 2023). Within such a digitally mediated context, individuals are increasingly expected to possess digital literacy (DL) to function effectively in information- and knowledge-based societies. The COVID-19 pandemic, with its far-reaching consequences for education systems worldwide, appears to have further amplified the salience of DL in formal schooling (Zhao et al., 2021). In this regard, DL has been formally recognised as one of the eight key competences for lifelong learning by the Council of the European Union (2018), alongside communication, mathematical competence, scientific literacy, and civic engagement.

Although the concept of digital literacy has been discussed for several decades, its meaning and scope have evolved considerably over time (Lim & Newby, 2021). The literature reflects the emergence of a range of related constructs, including “digital competence” (Rahmawati et al., 2022) education, health, and environment. Various digital competence measurements and frameworks had been developed to ensure that someone has an advance digital skill and one of those is DigComp 2.1 by European Commission. Many previous studies had been studied about teachers’ digital competence levels influenced by some factors such as age, gender, working period, and educational background. However, it is infrequently analysed that the advance digital competence (ADC, “digital capability” (Nguyen et al., 2023), and context-specific interpretations of “digital literacy” itself (Zulkarnain et al., 2024). In this study, DL is understood as a holistic capability encompassing knowledge, skills, attitudes, and personal attributes that enable individuals to interact effectively within digital environments. Early definitions proposed by Gilster (1997), Law et al., (2018), and Ferrari (2012) conceptualised DL primarily as the ability to read, write, and communicate through digital technologies, particularly those associated with information technology and the Internet. Subsequent work has extended this view, suggesting that DL also involves the ability to access, evaluate, and generate information using digital tools, as well as to engage in problem-solving, critical thinking, and communication in digitally mediated contexts (Reddy et al., 2020).

From this perspective, DL encompasses both technical proficiencies and dispositional elements such as motivation, interest, and self-confidence. Digital tools encompass software, applications, and hardware that facilitate information processing, communication, content creation, and learning activities. DL can therefore be viewed as a foundational competence in secondary education, especially at the high school level. For students, the development of DL is widely considered necessary for adapting to contemporary labour markets and for participating meaningfully in increasingly globalised and digital societies (Reddy et al., 2020). For teachers, DL is closely linked to their capacity to respond to pedagogical innovation and

to support students' learning effectively (Jiménez-Hernández et al., 2020; Rahmawati et al., 2022). Similarly, school leaders with limited DL may encounter difficulties in promoting online education or cultivating a digitally supportive school culture. At the same time, parents' digital competencies play a role in guiding and safeguarding students' engagement with digital media (Pons-Salvador et al., 2022).

In response to the growing prominence of DL, an expanding body of research has addressed its definitions, conceptual frameworks, and pedagogical applications. Nevertheless, comprehensive syntheses that systematically map research trends, thematic emphases, and emerging directions of DL studies at the high school level remain relatively limited. To address this gap, the present study adopts a scientometrics (bibliometrics) approach to examine the existing literature. Bibliometric methods offer quantitative insights into publication volume, growth patterns, and scholarly influence, while also enabling the identification of research priorities and broader knowledge structures within a field (Pritchard, 1969; Waltnam & Noyons, 2018). Such approaches have been demonstrated to be effective in tracing intellectual developments and thematic shifts over time (Ha et al., 2020; Pham-Duc et al., 2022).

Accordingly, this study conducted a bibliometric analysis of peer-reviewed publications indexed in the Scopus database, a widely used platform in social science research (Mongeon & Paul-Hus, 2016) namely for research evaluation. Most bibliometric analyses have in common their data sources: Thomson Reuters' Web of Science (WoS). The analysis seeks to identify publication trends, influential contributors, and major thematic patterns in digital literacy research at the high school level. Specifically, the study addressed the following research questions.

RQ1. What are the overall publication trends in DL research in high schools from 2007 to 2024?

RQ2. Who are the most influential contributors in this field in terms of countries, institutions, authors, and publication sources?

RQ3. What are the major thematic trends and research hotspots in high school DL research?

By providing a macro-level overview of the DL research landscape, this study aims to inform future scholarly work and policy discussions in secondary education. It also seeks to clarify how digital literacy is conceptualised and operationalised within academic discourse, while drawing attention to areas where further empirical and theoretical development appears necessary. In this study, "digital literacy" is employed as an overarching construct. Related terms, such as "digital competence" or "digital skills," are reported only when they accurately reflect the terminology used in the original publications and do not imply conceptual equivalence.

Research Methodology

Design

This study employed a bibliometric research design to examine the development of digital literacy research in high school education over time, its current structure, and the evolution of its central themes. A bibliometric approach was considered appropriate because it enables a systematic and transparent examination of a large volume of academic publications, allowing for the tracing of publication trends, identification of influential contributors, and mapping of dominant thematic patterns across the field. To enhance methodological clarity and replicability, the research process was organized into three main stages: data collection, data screening, and data analysis.

Data Source and Search Strategy

The data were retrieved from the Scopus database, which is commonly regarded as one of the most comprehensive sources of peer-reviewed literature in the social sciences and education. A structured search strategy was employed using Boolean operators and advanced search functions to construct a dataset that was both focused and relevant. The core search terms included “digital literacy”, “digital competenc*”, and “digital capability”, each combined with the educational level descriptor “high school”. These terms were applied to the title, abstract, and keyword fields to ensure that the retrieved publications explicitly addressed digital literacy within the context of secondary education.

To maintain academic consistency, the search was restricted to peer-reviewed journal articles and conference papers published in English. The whole search query implemented in Scopus was as follows:

TITLE-ABS-KEY ((“digital literacy” OR “digital competenc” OR “digital capability”) AND “high school”) AND (LIMIT-TO (DOCTYPE, “ar”) OR LIMIT-TO (DOCTYPE, “cp”)) AND (LIMIT-TO (LANGUAGE, “English”))*

As of December 15, 2024, this search strategy resulted in an initial set of 293 documents.

Data Screening and Selection

Following retrieval, the dataset was exported to Microsoft Excel for manual screening and preliminary processing. Duplicate records were removed, along with publications that lacked essential metadata, including titles, abstracts, or author information. A consensus-based screening procedure was then conducted to further refine the dataset. The screening process was conducted independently by at least two researchers, followed by a discussion to resolve discrepancies and reach consensus on inclusion and exclusion decisions. Publications were excluded if they did not directly address digital literacy in high school settings, focused primarily on higher education, or referred to digital literacy only in a marginal or incidental manner. Studies that discussed general digital trends without a clear connection to high school students, teachers, or educational practices were also removed. After completing this screening process, a final corpus of 187 publications was retained for detailed analysis.

Data Analysis

The metadata of the finalized dataset were subsequently exported from Scopus in CSV format for bibliometric analysis. Two primary analytical tools were used. Biblioshiny, the web-based interface of the Bibliometrix package in R, was employed to generate descriptive statistics, examine publication productivity, and analyse collaboration patterns across authors, institutions, and countries. VOSviewer was used to construct and visualize bibliometric networks, particularly keyword co-occurrence patterns and thematic clusters.

In addition, Microsoft Excel supported statistical calculations, data organization, and the presentation of tabular summaries. Taken together, these analytical procedures enabled a systematic exploration of publication trends, influential contributors, and the evolving intellectual and thematic structure of digital literacy research in high school education.

Research Results

Publication Output and Growth Trend

The dataset on research related to the digital competence of high school students, indexed in the Scopus database, spanned the period from 2007 to 2024 and included a total of 187 documents. The annual growth rate of publications was 23.86%. The average age of the papers was 3.41 years, while each document was cited 9.83 times on average. The dataset comprised contributions from 146 different sources, including journals, books, and conference proceedings, with a cumulative total of 7,817 references. In terms of content, 480 Keywords Plus and 647 Author’s Keywords were identified.

The publications involved 550 authors, of whom 33 contributed single-authored documents, resulting in a total of 38 single-authored papers. Collaboration played a significant role, with an average of 3.14 co-authors per document; however, only 12.3% of the papers involved international co-authorship. Regarding document types, journal articles constituted the majority with 137 publications, followed by 50 conference papers, indicating a balance between journal-based and conference-based dissemination. Overall, these results highlighted the dynamic and collaborative nature of research on digital competence in high school students, reflecting a growing trend in scholarly output and sustained academic attention.

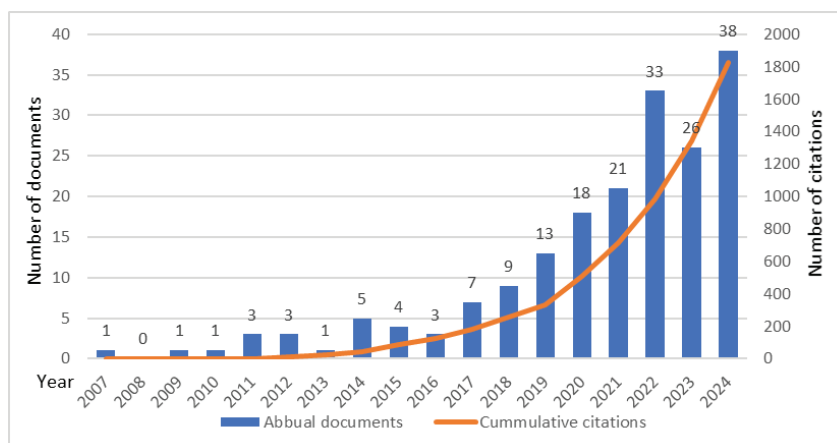
Table 1
General Information About Publication Collection

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2007-2024
Sources (Journals, Books, etc)	146
Documents	187
Annual Growth Rate %	23.86
Document Average Age	3.41
Average citations per doc	9.829
References	7817
DOCUMENT CONTENTS	
Keywords Plus (ID)	480
Author’s Keywords (DE)	647
AUTHORS	
Authors	550
Authors of single-authored docs	33
AUTHORS COLLABORATION	
Single-authored docs	38
Co-Authors per Doc	3.14
International co-authorships %	12.3
DOCUMENT TYPES	
Article	137
Conference paper	50

The growth trend in the number of publications and cumulative citations from 2007 to 2024 is illustrated in Figure 1. Based on the chart, the number of research publications on DL in high schools show a significant upward trend over the period from 2007 to 2024. In 2007, only one publication was recorded, and between 2008 and 2010, there was little to no change in the number of documents published. However, starting from 2011, the volume of publications began to increase steadily, with a particularly sharp rise observed after 2018. The peak was reached in 2022, with 33 publications. Nevertheless, 2023 witnessed a decline, with the number of publications dropping to 26. Projections for 2024 indicated a strong recovery, with 38 publications expected, marking the highest number across the entire period.

Figure 1

General Information About Publication Collection



Contribution by Nations

According to Scopus data, authors from 54 countries contributed to research on digital literacy in high schools. The top nine countries with the highest number of publications are presented in Table 2, revealing notable differences in productivity and research impact.

The United States recorded 44 publications and accumulated 1,012 citations, corresponding to an average of 23.0 citations per paper. This pattern suggests a combination of relatively high research productivity and substantial scholarly influence. Indonesia, although producing the most significant number of publications with 45 papers, accumulated a total of 217 citations, resulting in a lower average citation rate ($TC/TP = 4.8$). This contrast highlights differences in citation visibility, rather than publication volume alone. Italy presents a different profile, achieving the highest TC/TP value of 24.3 with only eight publications, which indicates a strong citation performance relative to output. Australia and Canada also show comparatively high impact, with TC/TP values of 12.5 and 9.4 based on six and five publications, respectively, suggesting a more balanced relationship between productivity and citation influence. By contrast, countries such as Croatia, Greece, and Turkey, each contributing five publications, display lower average citation rates ($TC/TP = 2.2, 1.4, \text{ and } 2.8$, respectively), reflecting more limited citation reach within the dataset.

Table 2

Top 9 Most Productive Countries Ranked by Number of Publications

Rank	Country	TP	TC	TC/TP
1	United States	44	1012	23.0
2	Indonesia	45	217	4.8
3	Spain	13	80	6.2
4	Italy	8	194	24.3
5	Australia	6	75	12.5
6	Croatia	5	11	2.2
7	Canada	5	47	9.4
8	Greece	5	7	1.4
9	Turkey	5	14	2.8

Note: TP: Total publications; TC: Total citations; TC/TP: citation per paper.

Contribution by Institutions

A total of 11 institutions contributed three or more publications on digital literacy in high schools, as presented in Table 3. The institutional rankings reveal noticeable differences in publication output and citation performance across universities worldwide.

Table 3

Top 11 Most Productive Institutions Ranked by Number of Publications

Rank	Affiliation	Country	TP	TC	TC/TP
1	Universitas Pendidikan Indonesia	Indonesia	9	102	11.3
2	Universitas Negeri Yogyakarta	Indonesia	6	75	12.5
3	Universitas Negeri Malang	Indonesia	6	14	2.3
4	University of Maryland, College Park	United States	4	116	29.0
5	Rutgers University–New Brunswick	United States	4	116	29.0
6	New Mexico State University	United States	4	62	15.5
7	Universitas Negeri Padang	Indonesia	4	3	0.8
8	The University of Rhode Island	United States	3	90	30.0
9	Universidad de Granada	Spain	3	38	12.7
10	The University of British Columbia	United States	3	30	10.0
11	Monash University	United States	3	17	5.7

Note: TP: Total publications; TC: Total citations; TC/TP: citation per paper.

Universitas Pendidikan Indonesia recorded the highest number of publications, with nine papers and a total of 102 citations (TC/TP = 11.3), indicating a relatively substantial contribution in terms of both output and citation visibility. Universitas Negeri Yogyakarta and Universitas Negeri Malang, both based in Indonesia, published a total of six papers each. However, their citation performance differs markedly, with Universitas Negeri Yogyakarta achieving a TC/TP of 12.5, compared to a considerably lower value of 2.3 for Universitas Negeri Malang. This contrast points to variations in citation influence among institutions operating within the same national context.

Among institutions based in the United States, both the University of Maryland, College Park, and Rutgers University – New Brunswick published four papers each, accumulating 116 citations, resulting in a TC/TP value of 29.0. These figures indicate a high level of citation visibility for their respective contributions. New Mexico State University also demonstrated a notable citation performance, with a TC/TP of 15.5, further reflecting the prominent role of U.S. institutions in this research area.

With only three publications, the University of Rhode Island achieved the highest average citation rate (TC/TP = 30.0), suggesting a powerful citation performance relative to its output. Similarly, Universidad de Granada in Spain published three papers and attained a TC/TP of 12.7, reflecting a more balanced relationship between publication volume and citation impact.

By contrast, Universitas Negeri Padang in Indonesia produced four publications but received only three citations, corresponding to a TC/TP of 0.8. Taken together, these findings illustrate substantial variation in institutional citation performance, both across countries and within individual national contexts. While U.S. institutions tend to display consistently higher citation rates, Indonesian institutions show comparatively higher productivity accompanied by more uneven citation outcomes.

Sources Publishing

Table 4 presents the seven most productive publication sources in terms of research on digital literacy in high schools. These sources comprise both academic journals and conference proceedings, each showing different publication patterns and levels of citation visibility.

Table 4
Top 7 Most Frequently Published Sources Ranked by Number of Publications

Rank	Source	Type	TP	TC	Scopus Quartile	CiteScore 2023*	SJR 2023*	Time of publication
1	AIP Conference Proceedings	CP	7	2	-	0.5	0.152	2022-2023
2	Journal of Adolescent and Adult Literacy	JN	4	116	Q2	2.2	0.481	2010, 2018, 2019
3	International Journal of Learning Teaching and Educational Research	JN	4	12	Q3	2.1	0.287	2020-2024
4	Ceur Workshop Proceedings	CP	3	47	-	1.1	0.191	2017, 2020
5	Mathematics	JN	3	38	Q2	4.0	0.48	2020-2023
6	Journal of Physics: Conference Series	CP	3	17	-	1.2	0.18	2020-2022
7	Education and Information Technologies	JN	3	2	Q1	10.0	1.301	2024

* Data from the Scopus dated 10/12/2024.

Note: CP: Conference Proceeding, JN: Journal, TP: Total publications; TC: Total citations

AIP Conference Proceedings ranked first with seven publications, most of which appeared during the period 2022 – 2023. This concentration suggests that the outlet has been frequently used to disseminate recent research findings, particularly through conference-based channels. At the same time, the low citation count, with only two citations, points to a relatively limited level of academic visibility for these publications. The Journal of Adolescent and Adult Literacy published four articles in 2010, 2018, and 2019, indicating an irregular

publication pattern in this area. Despite this, it recorded the highest citation count among the listed sources, with 116 citations, and was classified as a Q2 journal in Scopus. These indicators suggest that articles published in this journal tend to receive substantial scholarly attention. The International Journal of Learning, Teaching, and Educational Research also published four articles, distributed consistently from 2020 to 2024. Although the total citation count remained modest at 12 citations and the journal was categorized as Q3, the continuity of its publication output suggests a stable contribution to this research field. CEUR Workshop Proceedings accounted for three publications, with publication years listed as 2020 and 2027. The appearance of 2027 is likely due to a database inconsistency. As a conference proceedings outlet, CEUR Workshop Proceedings was more actively used in earlier years, particularly in 2020, while gaps in later years appear to have reduced its prominence as a dissemination channel for DL research. Between 2020 and 2023, the journal Mathematics published three articles and ranked fifth among the listed sources. As a Q2 journal with a CiteScore of 4.0 and a total of 38 citations, it demonstrated a comparatively strong citation performance. The relatively steady publication activity during this period supports its role as a reliable outlet for research related to digital literacy.

Similarly, the Journal of Physics: Conference Series published three articles between 2020 and 2022. While it is a well-established venue for conference papers, its citation count of 17 suggests a more moderate level of academic recognition in this specific research area. Education and Information Technologies published three articles in 2024. As a Q1 journal with a CiteScore of 10.0, it shows considerable potential for disseminating high-impact research. However, at the time of analysis, the citation count remained low, with only two citations, which is likely related to the recent publication of these articles.

Overall, the findings indicate distinct differences in the roles played by journals and conference proceedings within DL research. Conference proceedings, such as AIP Conference Proceedings and CEUR Workshop Proceedings, appear to support the rapid dissemination of emerging studies. In contrast, academic journals, including the Journal of Adolescent and Adult Literacy, Mathematics, and Education and Information Technologies, tend to offer greater publication stability and higher citation visibility, as reflected in their Scopus quartile rankings, CiteScores, and citation metrics. These patterns underscore the importance of selecting a suitable publication venue in shaping the reach and influence of research in this field.

Contribution by Authors

Among the 550 authors contributing to research on digital literacy in high schools, one author produced six publications, one author published four, 26 authors contributed two publications each, and the remaining authors authored a single paper. The most prolific contributors were Sarah McGrew and Rick Marlatt, with six and four publications, respectively. Sarah McGrew also recorded the highest citation count, receiving a total of 367 citations, which corresponds to an average of 61.2 citations per publication. Her work appeared in high-impact Q1 journals such as the Journal of Educational Psychology and Reading Research Quarterly, suggesting a high level of academic visibility and scholarly influence. Her studies primarily examined high school students' ability to understand, evaluate, and utilize online information, particularly in contexts involving misinformation and fake news. To address these issues, McGrew employed a variety of research approaches, including survey-based studies, experimental designs, and quantitative data analysis (McGrew, 2021a, 2021b, 2022; McGrew et al., 2018; Wineburg et al., 2022).

Rick Marlatt's publications were distributed across three journals, namely Journal of Adolescent & Adult Literacy, Reading & Writing Quarterly, and Literacy Research and Instruction, all of which are classified within Q1 or Q2 in Scopus. His research focused on developing digital literacy through instructional practices and cultivating digital skills in

classroom settings. In particular, Marlatt explored how technology could be meaningfully integrated into teaching and how educators might support students in acquiring essential digital competencies through targeted learning activities (Marlatt, 2018a, 2018b, 2019b, 2019a).

Both McGrew and Marlatt showed an apparent inclination toward independent authorship. Marlatt authored all four of his publications as a sole author, while McGrew independently authored three of her six publications. This pattern of authorship suggests that their contributions to the field were mainly driven by individual research agendas, highlighting their distinct and sustained influence on scholarship related to digital literacy in high school education.

The Most Influential Articles

Table 5 summarizes the top ten most cited articles in the field of digital literacy in high schools, ranked by total citations (TC) and average citations per year (TC/Year). These results provide insights into the academic influence and level of scholarly attention that individual studies have received within this research area.

The most frequently cited article was “Can Students Evaluate Online Sources? Learning From Assessments of Civic Online Reasoning” by McGrew et al. (2018), published in *Theory and Research in Social Education* (Q1). By July 2021, the study had accumulated 302 citations, corresponding to an average of 50.3 citations per year since publication. The article examined students’ critical thinking abilities, particularly their capacity to evaluate online information, an issue that has become increasingly salient in information-dense digital environments. The substantial citation count suggests that this work played a central role in shaping subsequent discussions and empirical investigations related to digital literacy and critical thinking.

The second most cited publication was “Digital skills of Internet natives: different forms of digital literacy in a random sample of Northern Italian high school students” by Gui and Argentin (2011), which appeared in *New Media and Society* (Q1). This study received 176 citations, averaging 13.5 citations per year. It investigated multiple forms of digital literacy among high school students in Northern Italy, a context that had previously received limited empirical attention. The study’s early contribution appears to have provided a foundation for later research examining digital literacy across different regional and cultural settings.

Ranked third was the study by Garcia et al. (2015), titled “The Council of Youth Research: Critical Literacy and Civic Agency in the Digital Age,” published in the *Reading and Writing Quarterly* (Q1). This article accumulated 94 citations, averaging 10.4 citations per year. The research explored how digital technologies could support the development of critical literacy and civic agency among young people. Its findings pointed to a close relationship between digital competencies and civic participation, reinforcing the relevance of digital literacy within citizenship education.

Table 5
Top 10 Most Cited Papers

CR	Document Title	Journal Title	TC	T C / Year	Scopus Quartiles	APA Citation
1	Can Students Evaluate Online Sources? Learning From Assessments of Civic Online Reasoning	Theory and Research in Social Education	302	50.3	Q1	(McGrew et al., 2018)
2	Digital skills of Internet natives: Different forms of DL in a random sample of northern Italian high school students	New Media and Society	176	13.5	Q1	(Gui & Argentin, 2011)
3	The Council of Youth Research: Critical Literacy and Civic Agency in the Digital Age	Reading and Writing Quarterly	94	10.4	Q1	(Garcia et al., 2015)
4	Learning to engage: how positive attitudes about the news, media literacy, and video production contribute to adolescent civic engagement	Educational Media International	78	7.1	Q2	(Hobbs et al., 2013)
5	Lateral Reading on the Open Internet: A District-Wide Field Study in High School Government Classes	Journal of Educational Psychology	69	34.5	Q1	(Wineburg et al., 2022)
6	Difficulties in implementing 21st century skills competence in vocational education learning	International Journal of Evaluation and Research in Education	66	22.0	Q3	(Mutohhari et al., 2021)transformations of technology-based learning and non-cognitive skills need. This situation makes it difficult for teachers of Indonesian vocational education apply 21st century skills. This study aimed to analyze the level of difficulty of teachers and students in vocational education and analyzing the differences in the difficulties faced in vocational education. This research used survey research with a quantitative approach. A total of 178 people participated in the study consisting of two public vocational high schools and two private vocational schools with the distribution of respondents consisting of 155 students and 23 teachers. Collecting data using a questionnaire in the form of a statement of difficulties faced by teachers and students, including creativity skills, critical thinking, problem solving, communication, collaboration, and digital literacy or information and communication technology (ICT

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7	A space called home: An immigrant adolescents DLpractices	Journal of Adolescent and Adult Literacy	57	4.1	Q2	(McLean, 2010)
8	The Australian digital technologies curriculum: Challenge and opportunity	Conferences in Research and Practice in Information Technology Series	51	5.1	-	(Falkner et al., 2014)and the need to empower youth as producers, as well as consumers, of technology. ICT curriculum in previous incarnations tended to focus on ICT as a tool, with the development of digital literacy as the key requirement. Areas such as computer science (CS
9	Technologies of distance learning for programming basics on the principles of integrated development of key competences	CEUR Workshop Proceedings	39	9.8	-	(Shokaliuk et al., 2020)
10	Adolescents' Web-Based Literacies, Identity Construction, and Skill Development	Literacy Research and Instruction	38	3.2	Q2	(Alvermann et al., 2012)

Note: TP: Total publications; TC: Total citations; CR: Citation ranking

The study by Hobbs et al. (2013), published in Educational Media International (Q2), received 78 citations, with an average of 7.1 citations per year. This research investigated the role of news engagement, media literacy, and video production activities in promoting adolescents' civic involvement. The study offered insights that informed practical recommendations for promoting civic engagement through the purposeful use of digital media in educational contexts.

More recent work, such as "Lateral Reading on the Open Internet: A District-Wide Field Study in High School Government Classes" by Wineburg et al. (2022), has attracted scholarly attention at a relatively rapid rate. Published in the Journal of Educational Psychology (Q1), this article garnered 69 citations, corresponding to an average of 34.5 citations per year. The study introduced lateral reading as an instructional strategy to help students assess the credibility and accuracy of online information. The pace of citation growth reflects increasing academic concern with information evaluation skills in digital and communication technology contexts.

In addition, the article by Mutohari et al. (2021) transformations of technology-based learning and non-cognitive skills need. This situation makes it difficult for teachers of Indonesian vocational education apply 21st century skills. This study aimed to analyze the level of difficulty of teachers and students in vocational education and analyzing the differences in the difficulties faced in vocational education. This research used survey research with a quantitative approach. A total of 178 people participated in the study consisting of two public vocational high schools and two private vocational schools with the distribution of respondents consisting of 155 students and 23 teachers. Collecting data using a questionnaire in the form of a statement of difficulties faced by teachers and students, including creativity skills, critical thinking, problem solving, communication, collaboration, and digital literacy or information and communication technology (ICT, published in the International Journal of Evaluation and Research in Education (Q3), was cited 66 times, averaging 22 citations per year. This study addressed challenges associated with implementing 21st-century skills in vocational education and highlighted the relevance of digital literacy beyond traditional academic pathways, particularly for vocational students.

Other influential, though less frequently cited, studies included McLean (2010) examination of digital literacy practices among migrant learners in the Journal of Adolescent and Adult Literacy (Q2) and Falkner et al. (2014)and the need to empower youth as producers, as well as consumers, of technology. ICT curriculum in previous incarnations tended to focus on ICT as a tool, with the development of digital literacy as the key requirement. Areas such

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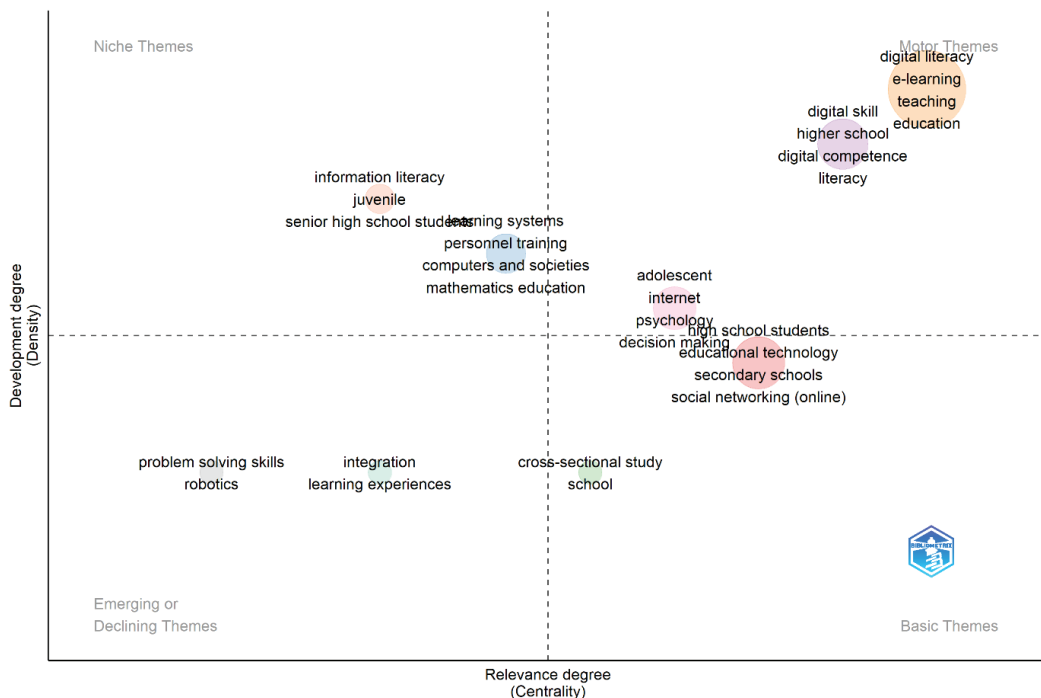
The green cluster concentrates on digital competence and media literacy. Keywords such as digital divide, civic online reasoning, media literacy, and civic education suggest that studies within this cluster primarily address how individuals, particularly students, engage with digital information and evaluate it critically. This line of research reflects ongoing concerns about narrowing the digital divide and fostering critical thinking skills that enable learners to participate effectively in a digital society. The blue cluster draws attention to adolescents and their Internet use. It includes keywords such as adolescents, schools, humans, Internet, and surveys, indicating a focus on young people's behaviours, media exposure, and the developmental implications of Internet use. This cluster points to the continued importance of examining how adolescents interact with digital technologies and online content. The purple cluster centers on high school students and their relationship with technology. Keywords including ICT, digital natives, learning process, and technology reflect research exploring students' adoption of digital tools and the role of digital literacy in shaping learning processes. This cluster focuses on technology-supported learning environments and the unique educational experiences of digital natives.

The yellow cluster represents a smaller and more specialized area of research related to digital media literacies and identity. Keywords such as writing, identity, adolescence, and digital or media literacies indicate a growing scholarly interest in the ways digital literacy influences identity formation, communication practices, and self-expression, especially among adolescent learners.

The map also illustrates the strength of relationships between keywords through the thickness of the connecting lines, which indicate frequent co-occurrence. For example, digital literacy is strongly linked to digital competence and education, highlighting the close conceptual relationship among these terms in existing studies. Smaller nodes, such as computational thinking and virtual reality, point to emerging topics that are attracting increasing attention, although they have not yet become central within the broader research landscape.

Figure 3 presents a thematic map of research on digital literacy in high schools, structured around four quadrants: Basic Themes, Motor Themes, Niche Themes, and Emerging or Declining Themes. The horizontal axis represents centrality, indicating thematic relevance, while the vertical axis reflects density, corresponding to the level of thematic development. This framework offers an overview of dominant research directions and clarifies the relative positioning of different themes within the field.

Figure 3
Thematic Map of Research on DL in High Schools



(Source: Authors' own elaboration, using VOSviewer)

Motor Themes are both highly relevant and well developed, which suggests their central position in research on digital literacy in upper secondary education. Located in the upper-right quadrant, this group includes keywords such as digital literacy, e-learning, teaching, education, and digital competence. These themes represent well-established and dominant lines of inquiry in the field. Research within this cluster primarily focuses on the development of students' digital literacy skills, the integration of technology into teaching practices, and the implementation of online learning in secondary education. Their prominence reflects the increasing role of digital literacy in supporting students' academic learning within digitally mediated educational settings.

Basic Themes are characterized by high relevance but a lower level of development and often function as foundational elements for broader research agendas. In this quadrant, keywords such as educational technology, social networking (online), secondary schools, and high school students are prominent. Studies in this category typically explore the use of educational technologies and social networking tools in students' learning activities. These themes provide a crucial conceptual foundation for more comprehensive investigations and illustrate the gradual shift from traditional learning environments to technology-supported and online learning contexts.

Specialized themes exhibit a high degree of development but comparatively limited relevance to the broader research field. Situated in the upper-left quadrant, this group includes keywords such as information literacy, e-learning systems, personnel training, and mathematics education. These themes are associated with in-depth studies that focus on specific subject areas or particular target groups. For instance, research on information literacy development or the use of e-learning systems in mathematics education illustrates how digital technologies are applied within distinct domains of secondary education.

Emerging or declining themes, positioned in the bottom-left quadrant, are defined by both low centrality and low density. Keywords such as problem-solving skills, robotics, integration, and learning experiences fall into this category. These themes may indicate research directions that are still in their early stages and not yet fully developed, or areas that are receiving reduced scholarly attention. Nonetheless, they remain valuable for exploring innovative approaches and for identifying potential future directions in digital literacy education research.

Discussion

The evolution of research on digital literacy (DL) in high schools reflects broader transformations in educational systems driven by digitalization and global disruptions. The first Scopus-indexed study addressing DL in high school contexts appeared in 2007, focusing on teacher training through Moodle in Portugal (Pedrosa, 2007). This early work framed DL primarily as a technical and instructional competence linked to professional development. Over time, however, the scope of DL research has expanded considerably, incorporating pedagogical, cognitive, and civic dimensions. The pronounced growth in both publication volume and citation counts between 2020 and 2022 corresponds closely with the COVID-19 pandemic, which forced education systems worldwide to adopt online and technology-mediated learning at an unprecedented scale. Rather than merely accelerating existing trends, this period functioned as a structural shock that repositioned digital literacy from a supplementary skill to a core educational requirement at the secondary level. As noted by Anthonysamy et al. (2020), emergency remote teaching exposed substantial gaps in students' and teachers' digital competencies, thereby intensifying scholarly attention to DL-related issues such as online learning readiness, digital assessment, and information evaluation. The decline in publications observed in 2023 should not be interpreted as a loss of relevance of DL research, but rather as a normalization following the exceptional research surge during the pandemic. As schools gradually returned to face-to-face instruction, the urgency of crisis-driven digital learning research diminished, and scholarly attention diversified toward post-pandemic educational priorities (Aristovnik et al., 2023; Zhou et al., 2023). Importantly, the projected rebound in 2024 suggests that DL remains a sustained research agenda rather than a transient response to external disruption. This indicates a maturation of the field, in which DL is increasingly studied as an integral component of secondary education rather than as an emergency solution.

A notable finding of this study concerns the disparity between publication productivity and scholarly impact across countries. Although Indonesia slightly surpasses the United States in terms of publication count, the U.S. demonstrates substantially higher citation impact, positioning it as the most influential contributor to DL research at the secondary level. This discrepancy cannot be explained by productivity alone; instead, it reflects deeper structural differences in research ecosystems, funding mechanisms, and academic publishing cultures. The United States benefits from long-standing investment in digital citizenship, media literacy, and civic education, which supports theoretically grounded, longitudinal, and large-scale studies. Such research designs tend to generate broader academic uptake and higher citation rates. Publication and citation practices further reinforce this imbalance. U.S.-based scholars are more frequently represented in high-impact Q1 journals that serve as central nodes in global academic communication. In contrast, much of the Indonesian research is disseminated through regional journals or conference proceedings, which, while highly relevant for local educational contexts, often receive less international visibility within citation-driven databases such as Scopus. This pattern aligns with existing critiques of global knowledge production, where researchers embedded in dominant academic networks enjoy a structural citation advantage, sometimes described as a "Matthew effect" in scholarly publishing. Differences in thematic orientation also contribute to variations in impact. Highly cited U.S. studies often propose

transferable conceptual frameworks-such as Civic Online Reasoning McGrew et al., 2018)-that can be readily adapted across national and curricular contexts. In contrast, studies from developing countries frequently emphasize context-specific implementation, teacher practices, or institutional constraints. While these contributions are pedagogically valuable, their localized focus may limit their citation reach despite addressing pressing educational challenges. This finding highlights a persistent tension in DL research between theoretical generalizability and contextual relevance. At the institutional level, the prominence of U.S. universities such as the University of Rhode Island further illustrates the role of research quality over quantity. Despite a relatively modest number of publications, the institution achieves the highest citation-per-paper ratio, underscoring the influence of interdisciplinary approaches that integrate literacy studies, media engagement, and adolescent identity development. The work of McLean (2010), for example, demonstrates how digital literacy functions not only as a technical skill but also as a socio-cultural practice shaping identity formation among immigrant youth. Such theoretically rich and socially grounded studies tend to resonate across disciplines, thereby enhancing their scholarly impact. Individual authorship patterns reinforce these observations. Sarah McGrew emerges as the most influential scholar in the field, not merely due to her publication volume but because of her conceptual leadership in redefining DL as a critical civic competence. Her work shifts the focus from functional digital skills toward evaluative reasoning in online environments, particularly in contexts of misinformation and disinformation. The widespread adoption of the Civic Online Reasoning framework illustrates how individual scholars can shape research trajectories by offering theoretically robust and practically applicable models. In this sense, McGrew's contributions extend beyond confirmatory alignment with existing literature; they actively reorient the field's conceptual foundations. The keyword co-occurrence and thematic maps further reveal the interdisciplinary nature of DL research in high schools. Core themes such as digital literacy, education, teaching, and e-learning dominate the research landscape, reflecting the centrality of pedagogical integration. At the same time, emerging themes related to identity, media literacy, and civic engagement indicate a gradual shift toward understanding the broader social and ethical implications of digital participation. Rather than representing peripheral interests, these themes suggest a paradigmatic transition in which DL is increasingly framed as a multidimensional competence encompassing technical, cognitive, and civic domains. From a theoretical perspective, the findings reaffirm that digital literacy in secondary education cannot be reduced to technological proficiency alone. Instead, it must be understood as a form of critical engagement with digital information, aligning with contemporary perspectives that position DL at the intersection of education, citizenship, and democratic participation. The concentration of highly cited studies on information evaluation and critical reasoning reflects this shift and underscores the growing recognition of DL as a foundational competency for navigating complex digital societies. Practically, the experiences of leading countries and institutions offer valuable insights for educational systems in developing contexts. High-impact DL research appears to benefit from interdisciplinary collaboration, strong theoretical grounding, and alignment with global academic discourse. These observations suggest that future efforts to enhance DL research impact should not focus solely on increasing publication volume, but also on strengthening conceptual frameworks, methodological rigor, and international visibility.

Overall, this study provides a comprehensive and critical overview of DL research in high schools, highlighting not only dominant themes and influential contributors but also structural inequalities in global knowledge production. By moving beyond descriptive patterns to interpretive analysis, the findings contribute to a deeper understanding of how digital literacy research evolves within-and is shaped by-broader educational, institutional, and geopolitical contexts. These insights lay a foundation for future research on curriculum design, teacher education, and digital competency assessment in secondary education amid ongoing digital transformation.

Conclusions and Implications

This study provides a comprehensive bibliometric overview of research on DL in high school education over the period from 2007 to 2024. By systematically analysing 187 publications indexed in the Scopus database, the study maps the intellectual structure, developmental trajectory, and thematic evolution of DL research at the secondary level. The combined use of Biblioshiny and VOSviewer enables both macro-level trend analysis and fine-grained thematic exploration, offering a holistic understanding of how the field has developed and where it is heading.

The findings indicate that DL research in high schools has evolved from a peripheral topic into a central area of educational research, particularly following the global expansion of digital and online learning during and after the COVID-19 pandemic. While research productivity has increased substantially across countries and institutions, the analysis reveals imbalances between publication volume and scholarly impact. These differences suggest that the influence of DL research is shaped not only by output quantity but also by structural factors such as research ecosystems, funding mechanisms, publication strategies, and the ability to produce transferable theoretical frameworks. Thematically, DL research remains strongly anchored in education, teaching practices, and digital competence development, while emerging strands related to identity formation, computational thinking, and immersive technologies are gaining visibility but remain comparatively underexplored.

Beyond documenting dominant patterns, this study identifies several important gaps in the existing literature. In particular, there is limited empirical evidence examining how digital literacy is systematically embedded within subject-specific teaching at the high school level. In addition, longitudinal and cross-national research designs remain scarce, constraining understanding of how DL develops across time, educational systems, and socio-cultural contexts. These gaps indicate that the field has not yet fully transitioned from descriptive mapping toward more explanatory and impact-oriented research.

From a theoretical perspective, the findings reaffirm that digital literacy extends beyond technical proficiency to encompass critical thinking, information evaluation, and civic reasoning. Highly cited studies emphasize students' abilities to assess the credibility of online information and to engage responsibly in digital environments, reflecting a shift toward integrating ethical, social, and civic dimensions into DL research. From a practical and policy perspective, the experiences of highly influential countries, institutions, and authors highlight the value of interdisciplinary approaches that bridge education, technology, and the social sciences in strengthening DL implementation in secondary education.

This study suggests three priority directions for future research:

1. Empirical classroom-based studies examining how DL can be embedded into subject-specific pedagogies, particularly in subjects such as mathematics, literature, and history;
2. Exploratory research on emerging technologies such as robotics, artificial intelligence, and extended reality, and their pedagogical potential in fostering DL;
3. Interdisciplinary and comparative studies examining how educational policy, infrastructure, and teacher competencies shape the implementation of DL across diverse cultural and national contexts.

By mapping the current state of the field and identifying both strengths and omissions in the literature, this study offers a solid empirical foundation for advancing digital literacy research and practice in secondary education. It provides valuable insights for researchers, educators, and policymakers seeking to design more coherent, equitable, and forward-looking digital literacy initiatives in high schools worldwide.

Limitations

During the research process, the authors focused exclusively on literature written in English, which may have influenced the results. Although English is the predominant language of international scientific publications, a substantial body of relevant research is published in other languages. As a result, studies disseminated in native languages-particularly in European and Asian contexts-may not have been fully captured, potentially affecting the geographical representation of the findings.

In addition, the data were sourced exclusively from the Scopus database. While Scopus is a widely recognized and reputable database for bibliometric research, reliance on a single data source inevitably limits coverage. Relevant studies indexed in other major databases, such as Web of Science (WoS) or ERIC, may therefore have been excluded from the analysis.

Furthermore, the search strategy was restricted to the use of the term “high school” to define the educational level. Although this term is commonly used in international literature, it may not fully encompass studies employing alternative descriptors such as “upper secondary education”, “lyceum”, or “grades 9-12”. Consequently, some publications addressing equivalent educational contexts may have been overlooked.

Moreover, the study relies on bibliometric indicators such as total citations and citations per publication to examine scholarly influence. While these indicators are widely used to assess research visibility and academic impact, they do not directly reflect the intrinsic quality, methodological rigor, or educational effectiveness of the underlying studies. Therefore, highly cited publications, authors, or institutions should be interpreted as influential within the research landscape rather than necessarily superior in terms of research validity or pedagogical outcomes.

Finally, certain records in the dataset lacked complete metadata, including missing keywords, abstracts, author information, or titles, which may have further constrained the analysis. The authors utilized Bibliometrix and VOSviewer software for data processing and visualization; however, some inherent limitations of the Scopus database-such as the absence of information on authors’ gender and occasional delays in updating publication records-may also affect the accuracy of the results. These limitations should be taken into account when interpreting the findings and point to directions for improving future bibliometric studies.

Declaration of Interest

The authors declare no competing interests.

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