



Exploring Functional Literacy Research in School Education: A Bibliometric Mapping of Trends and Collaborations

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ABSTRACT

This study maps the trends, collaborations, and thematic developments of functional literacy research in school education using a bibliometric approach. Data were retrieved from the Scopus database using targeted queries related to functional literacy, resulting in a final set of 730 documents after data filtering and cleaning. Analyses were conducted using Biblioshiny R and VOSviewer to examine publication trends, author and institutional collaborations, and keyword-based thematic structures. The findings reveal a significant growth in publications on functional literacy since 2018, and 2023–2024 saw their highest levels. Research output over this period has been largely led by scholars from the United States, the United Kingdom, and China, whereas growing contributions from researchers in developing countries have also broadened research perspectives. The majority of publications appear in education journals, as well as substantial contributions in health, economics, and multidisciplinary fields, thus illustrating the cross-sector nature of functional literacy research. Although author and institutional productivity remain relatively dispersed, several highly cited foundational works from health literacy, education, and economics continue to shape the field's conceptual development. Six major clusters emerging from the thematic analysis include education and curriculum, health literacy, socioeconomic contexts, cognitive and developmental issues, adolescent and public health concerns, and epidemiological dimensions of illiteracy. Further, recent research trends point toward evolving areas, such as digital literacy, artificial intelligence, computational thinking, social media, mobile applications, and critical literacy, which underline the growing importance of functional literacy as a core competence for navigating technological change and the demands of 21st-century education. These observed patterns open up opportunities for future interdisciplinary research connecting digital transformation, social inequality, and literacy practices within school education.

KEYWORDS

Bibliometric review; education; functional literacy; literacy; school.

INTRODUCTION

Functional literacy is an individual's capacity to effectively apply reading, writing, numeracy, and critical thinking skills in everyday situations (Dunn & Conard, 2018; Grajo et al., 2020). This concept not only covers basic literacy skills, but it also includes numeracy, navigation, and informed decision-making, especially in settings that require individuals to understand information and act accordingly (Dunn & Conard, 2018). Functional literacy also incorporates socio-cultural responsibility and critical engagement with social realities, thus enabling learners to partake in meaningful interactions within diverse communities (Renwick, 2017; Wearmouth, 2017). Functional literacy in school settings focuses not only on mastering basic skills, but also on students' ability to use those skills in authentic social, economic, and cultural contexts (Cencelj et al., 2019; Johnson, 2016). This perspective signifies that functional literacy is understood as a multidimensional competence which is influenced by pedagogy, culture, and real-world relevance (Moje, 2016).

Functional literacy has become a central competence in 21st-century education because it supports students' adaptability, civic participation, and lifelong learning. It is closely connected to critical thinking, creativity, collaboration, and communication, which help learners navigate increasingly complex global challenges (Afandi et al., 2019; Knowles et al., 2023; Steyn & Vanyoro, 2023). Accordingly, educational systems have incorporated these competencies into curricula to prepare students for changing social and employment contexts (Mahmud & Wong, 2022). Several pedagogical approaches support this integration, including problem-based learning, constructivist instruction, and structured literacy practices (Bayu et al., 2023; Cencelj et al., 2019; Orak & Al-Khresheh, 2021). STEAM education extends these efforts by connecting science, technology, engineering, arts, and mathematics with functional literacy development. Through interdisciplinary activities, students learn to interpret texts, analyze data, communicate ideas, and apply knowledge across subject areas. Digital storytelling offers a complementary approach that connects academic content with students' experiences through multimodal meaning-making (Kim & Jia, 2020; Kim et al., 2021). Together, these approaches position functional literacy as an integral component of disciplinary understanding and complex problem-solving, rather than an isolated set of basic skills (Meseşan & Albulescu, 2019). However, functional literacy cannot be developed through short-term interventions alone. Its development requires sustained instruction, regular reading activities, contextual application, and continuing opportunities for higher-order thinking across varied and meaningful learning situations throughout their schooling (Rachmaningtyas et al., 2022).

It is thus significant to enhance functional literacy in educational institutions, especially in countries where students are still facing persistent learning challenges. Reports from around the world, including Indonesia, show that many students continue to struggle with basic reading, writing, and numeracy skills, particularly in the early stages of schooling (Anwas et al., 2022). These gaps in literacy are detrimental for the long-term growth of human capital and equity in education. To address this issue, a number of programs have been initiated, such as

the School Literacy Movement and literacy culture programs in schools (Marmoah et al., 2022; Nuryana et al., 2020). Nevertheless, evidence suggests that the effectiveness of such initiatives varies considerably as the programs depend on institutional policies, program design, and classroom-level implementation (Habibi et al., 2025). This difference thus highlights the importance of examining how functional literacy is conceptualized and studied across different educational contexts.

Existing research on functional literacy in school education has shown a wide range of perspectives and areas of focus. Some studies have investigated functional literacy within holistic education approaches and STEAM-based curricula (Erbilgin et al., 2024; Meseşan & Albulescu, 2019; Okwara & Henrik Pretorius, 2023) conceptual clarification and definitional consistency (Khramova et al., 2022), and culturally responsive literacy practices in multilingual classrooms (Cavallaro & Sembiante, 2021). A number of studies in Indonesia have also been concerned with functional literacy skills among secondary school students and show how multiple literacies support students' personal and social development (Japar et al., 2023; 2025; Nurgiyantoro et al., 2020). Nonetheless, while these studies offer useful insights, they remain scattered across contexts, disciplines, and methodological approaches.

To date, however, no study has systematically synthesized the global development of functional literacy research in school education using a bibliometric approach. Most existing studies are conceptual, localized, or case-based, which makes it difficult to grasp how the field has evolved more broadly. As a result, a number of key aspects such as publication trends, thematic development, collaboration networks, and emerging research directions have yet to be comprehensively mapped. Thus, to address this gap, the present study utilized bibliometric mapping to analyze global research trends, structural patterns, dominant themes, and future research opportunities in functional literacy within school education. The study responded to the gap by offering a comprehensive bibliometric analysis of scientific publications on functional literacy in school education. Using this approach, it traced research trends, examined patterns of scholarly collaboration, identified key themes, and uncovered emerging directions for future research. Accordingly, the objectives of this study are articulated in the following four research questions:

1. What are the global publication trends of functional literacy research in school education from its early development to 2025?
2. How is the research landscape structured based on journal sources, institutions, countries, prolific authors, and citation analyses?
3. What are the main research themes currently shaping the field?
4. What emerging research themes hold potential for future development?

METHODOLOGY

Research Design

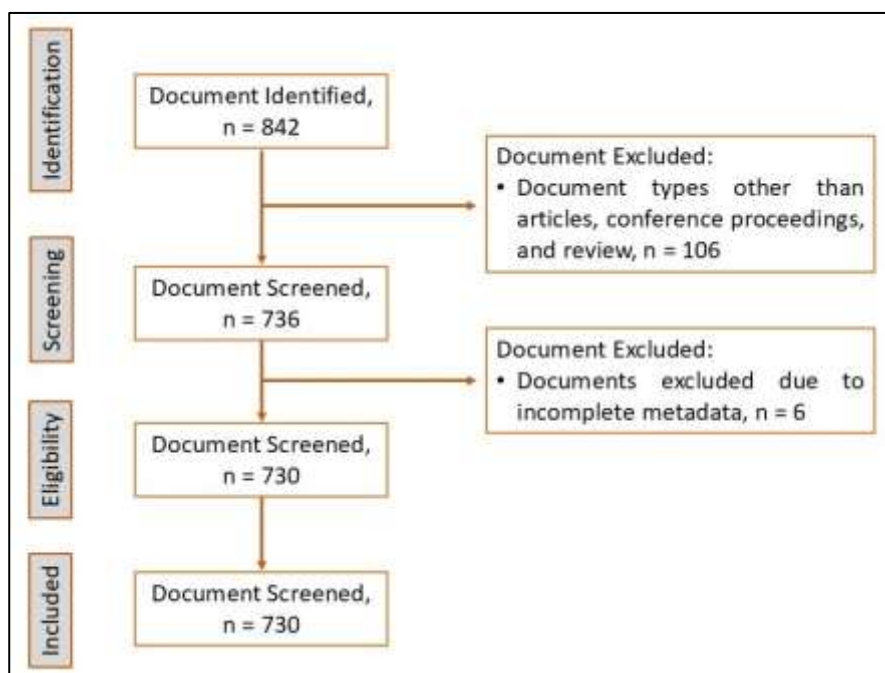
This study used a quantitative descriptive bibliometric approach in order to map research trends, collaboration patterns, and dominant themes in functional literacy within school education. The bibliometric approach was selected because it provides a comprehensive and objective way to understand how the field has developed, based on systematic analyses of metadata from scientific publications (Passas, 2024). This type of analysis identified publication trends, collaboration networks among authors and institutions, and thematic patterns that helped inform future research directions. Bibliometric analysis also helped detect fast-growing research areas, influential researchers and institutions, and emerging directions in the study of functional literacy in school-based education (Ho et al., 2024).

Data Collection

The study retrieved bibliometric data from the Scopus database, managed by Elsevier, because of its wide multidisciplinary coverage, international recognition, and high-quality metadata. The Scopus database was selected because it also includes some of the earliest academic work on literacy and education, thus enabling a longitudinal analysis of the field's development. Data collection followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework (Moher et al., 2009), as shown in Figure 1, to ensure a transparent, replicable, and systematic process for selecting documents.

Figure 1.

PRISMA Workflow



The bibliometric data in this study covered the years 1970 to 2025. This time frame was chosen as it included the earliest works on functional literacy indexed in the Scopus database. Therefore, the study was able to further analyze how research trends, notable scholars, and fundamental theoretical contributions in this area have changed over time. The time frame

made it possible to trace significant publications that have influenced key concepts of functional literacy, as well as more recent research showing how education and technology have evolved in recent years. The search was conducted on July 7, 2025, using the following query: (“functional literacy” OR “basic literacy” OR “practical literacy” OR “essential literacy” OR “everyday literacy”) AND (education OR school).

Figure 1 presents the PRISMA workflow for metadata collection. The initial search yielded 842 documents indexed in Scopus. Metadata filtering was later applied to retain only journal articles, conference proceedings, and review papers, which reduced the dataset to 736 documents. At the eligibility stage, the completeness of metadata, e.g., titles, author names, institutional affiliations, publication years, and author keywords, was manually checked using Microsoft Excel. A total of 730 documents were considered for further analysis after excluding those with incomplete metadata.

The next stage consisted of data cleaning and normalization using OpenRefine, with the aim of improving consistency and removing duplicate records. Differences in spelling and formatting were resolved by reconciling and standardizing author names, institutional affiliations, and keywords referring to the same entities (Hislop et al., 2024). This is a critical step, as it aimed to strengthen the accuracy of collaboration network mapping and thematic co-occurrence analyses. Afterward, the finalized dataset was exported in CSV format to ensure compatibility with bibliometric analysis software. In general, this systematic and transparent procedure was expected to include only high-quality and standardized records for analysis, thereby strengthening the reliability and replicability of the findings of this study.

Data Analysis

The data analysis started with cleaning and standardizing the metadata using OpenRefine, with the aim of improving consistency and accuracy across author names, institutional affiliations, and keywords. This process entailed correcting spelling inconsistencies, combining synonymous terms, and removing duplicate records. Following the data-cleaning process, the dataset was imported into Biblioshiny, a web-based interface of the Bibliometrix package in the R environment, to perform descriptive bibliometric analyses. The analyses concerned the trends in annual publication growth, the distribution of journal sources, leading and influential authors and institutions, patterns of productivity and collaboration across countries, and overall citation performance (Aria & Cuccurullo, 2017). This stage provided a quantitative foundation for understanding the structural evolution and scholarly dynamics of functional literacy research in school education.

The second stage employed VOSviewer to perform network visualization and co-word analyses in order to map conceptual structures and collaborative relationships within the dataset. A thesaurus file was applied to harmonize keywords by consolidating synonymous and semantically equivalent terms, thereby reducing conceptual noise and improving cluster coherence. Keywords deemed irrelevant to the context of functional literacy and school education were excluded prior to analysis. Afterward, to strengthen the analysis and prevent

excessive fragmentation, only keywords appearing at least five times were included in the thematic mapping. This threshold helped ensure that the resulting clusters reflected stable and recurring research themes rather than isolated or marginal topics.

A multi-step validation process was then applied in order to enhance the validity and reliability of keyword clustering and thematic interpretation. First, triangulation was conducted by comparing outputs generated from Biblioshiny and VOSviewer to ensure consistency across analytical tools. Second, the thematic clusters generated by VOSviewer were reviewed independently by three researchers with expertise in literacy and educational research. Each reviewer assessed the semantic coherence of the keywords within each cluster and evaluated their consistency with the broader body of literature. Any divergent interpretations were handled through collective discussion and resolved by consensus, which strengthened inter-coder trust and interpretive reliability. In addition, all analytical parameters, e.g., the search strategy, filtering criteria, and software settings, were clearly documented to support transparency and future replication of the study.

RESULTS

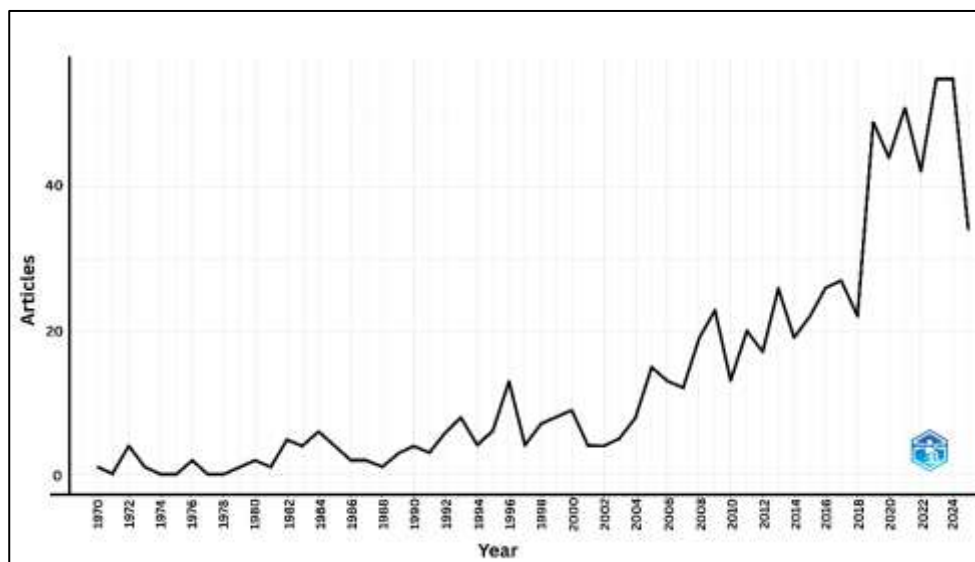
Global publication trends of functional literacy research in school education

Publication trends in functional literacy research within school education from 1970 to 2025 are presented in

Figure 2.

Figure 2.

Annual Publication Trends in Functional Literacy Research (1970–2025)



The annual publication trend shown in

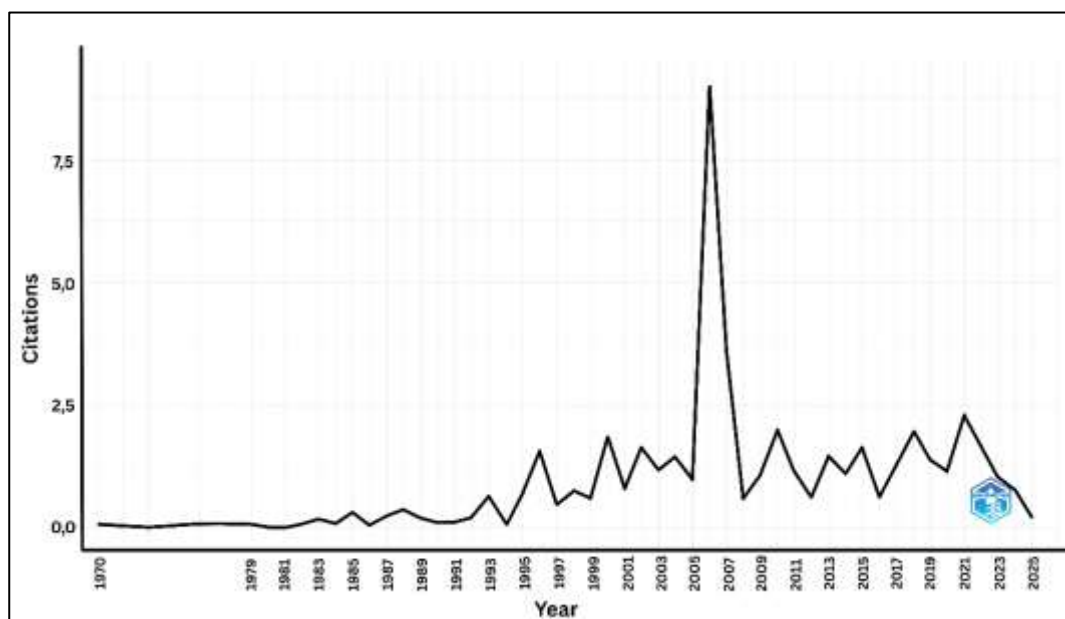
Figure 2 indicates that research on functional literacy in school education remained limited from the 1970s to the early 1990s, with the number of publications per year generally remaining in the single digits. A more stable increase emerged in the mid-1990s, followed by a clearer growth trajectory in the early 2000s. After 2004, publication output increased more

consistently, despite year-to-year fluctuations, which culminated in a sharp acceleration between 2018 and 2021, when annual publications approached fifty articles. The publication volume reached a peak in 2023–2024, with more than 50 articles per year, before declining slightly in 2025. This pattern, in general, reflects a growing level of academic attention to functional literacy within the context of school education, as captured in the bibliometric dataset. An analysis of annual citation patterns related to this topic is presented in Figure 3.

The annual citation profile shown in Figure 3 reveals a pattern that differs from the publication growth pattern. Average citations per year remained very low during the early decades, increased gradually throughout the 1990s and early 2000s, and reached a pronounced peak around 2005–2007. Following this period, citation rates declined to a moderate level, generally remaining below three citations per year, with minor fluctuations observed until 2024. The absence of a citation increase comparable to the publication surge after 2018 suggests that many recent articles have not yet accumulated citations due to their relatively short publication lifespan. The citation peak in the mid-2000s appears to be driven by a small number of highly influential early studies.

Figure 3.

Average Citation Trend per Year in Functional Literacy Research in School Education



Functional literacy research landscape in school education

The results of the analysis of 10 reputable journals relevant to functional literacy research in school education are presented in Figure 4.

The distribution of publication sources in Figure 4 shows that *Literacy* is the most productive journal in this field, contributing a total of 14 documents. The *International Review of Education* ranks second with 10 publications, followed by *Perspektivy Nauki i Obrazovania* with 9 publications. Three other sources—namely, the *International Journal of Educational Development*, the *International Journal of Lifelong Education*, and the *Journal of Physics:*

Conference Series—each contributed 7 publications, indicating a relatively balanced level of contribution among these sources.

Other sources, including *Patient Education and Counseling* and *PLOS ONE*, each published 6 documents, while *E3S Web of Conferences* and *Reading and Writing* each published 5. Overall, this distribution suggests that functional literacy research is not concentrated in a limited number of journals, but rather dispersed across a wide range of academic outlets. These include education-focused journals, lifelong learning publications, multidisciplinary journals, and conference proceedings, underscoring the field's interdisciplinary nature. The results of the analysis of the top contributing countries are presented in Figure 5.

Figure 4.

Top 10 Journal Sources Relevant to Functional Literacy Research in School Education

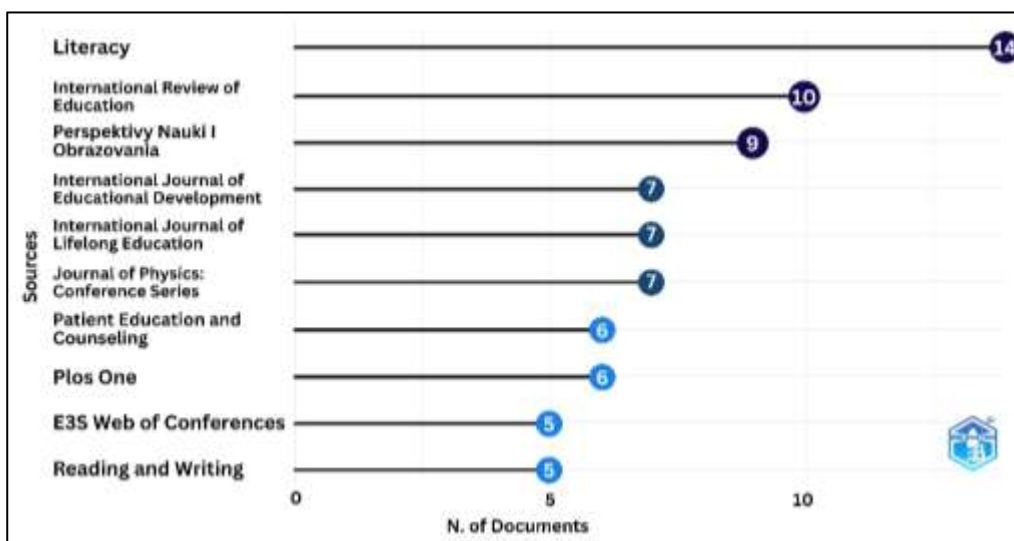


Figure 5.

Top 10 Contributing Countries in Functional Literacy Research in School Education

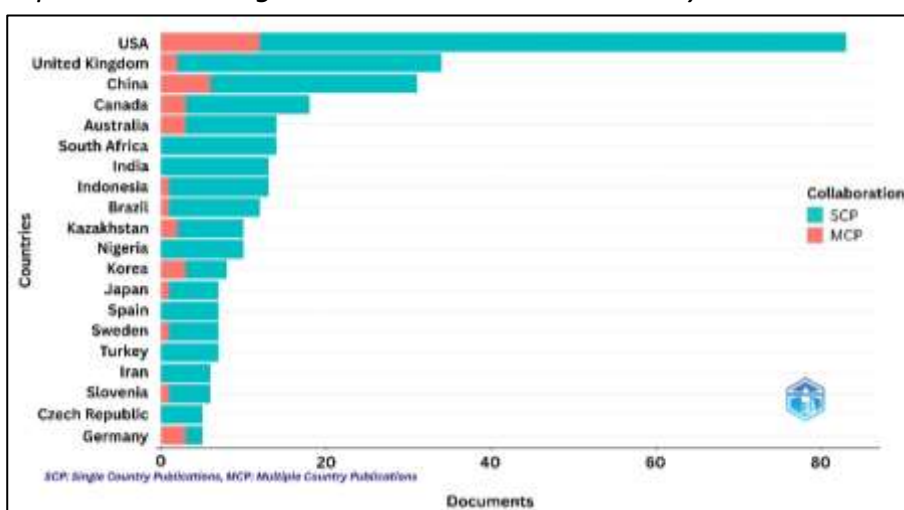
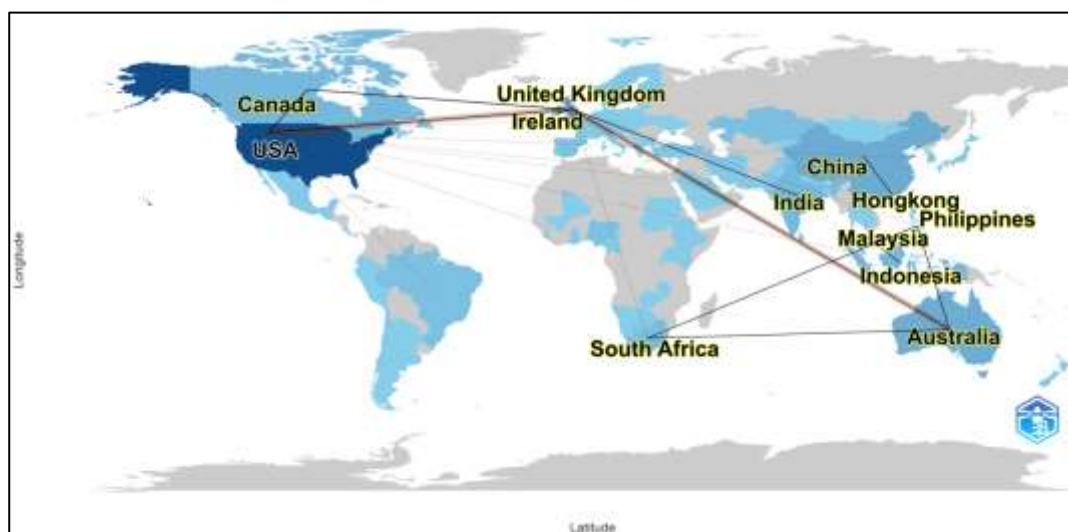


Figure 5 shows that the United States is the leading contributor, producing more than 80 documents and accounting for a substantial proportion of Multiple Country Publications (MCPs). The United Kingdom follows with a high publication output and strong international

collaboration. China ranks third, contributing a moderate number of publications with a smaller share of MCPs. Canada, Australia, and South Africa occupy the next positions, demonstrating consistent productivity and a dominance of Single Country Publications (SCPs). India and Indonesia show moderate publication levels, followed by Brazil, Kazakhstan, Nigeria, Korea, and Japan, each contributing steadily but at lower levels. Countries such as Spain, Sweden, Turkey, Iran, Slovenia, the Czech Republic, and Germany appear in the lower productivity group but continue to contribute to the geographic diversity of functional literacy research. The results of the international collaboration analysis are presented in Figure 6.

Figure 6.

International Collaboration Map of Functional Literacy Research in School Education



The international collaboration network shown in Figure 6 highlights the central role of high-productivity countries in shaping global research partnerships. The United States, the United Kingdom, Canada, and Australia function as major hubs, establishing collaborative links with countries across Asia, Europe, and Africa, including China, India, Malaysia, Hong Kong, the Philippines, Indonesia, and South Africa. Collaborative ties among European countries, such as the United Kingdom, Ireland, and Germany, are also evident. However, they appear less dense than those involving North America and the Asia-Pacific region. Overall, the visualization suggests that countries with higher publication output maintain broader, more diverse collaboration networks. Countries with lower productivity, including Slovenia, the Czech Republic, and Iran, nonetheless play meaningful roles by contributing to the diversity of international research linkages.

Figure 7 presents the institutional affiliation analysis, which shows that The University of Queensland is the most productive institution, contributing 8 publications. The University of British Columbia, the University of Nevada, and the University of Pittsburgh follow closely, each producing 7 publications. Harvard University, Nanyang Technological University, the University of California, the University of Ibadan, and the University of Stirling each contributed 6 publications, indicating a relatively balanced level of productivity among influential institutions.

Abai Kazakh National Pedagogical University recorded 5 publications, the lowest among the top 10 institutions. Overall, these findings illustrate that institutional contributions to functional literacy research are geographically diverse, encompassing institutions from North America, Asia, Europe, and Africa, and reflect the field's global and interdisciplinary nature.

Figure 7.

Top 10 Institutions Contributing to Functional Literacy Research in School Education

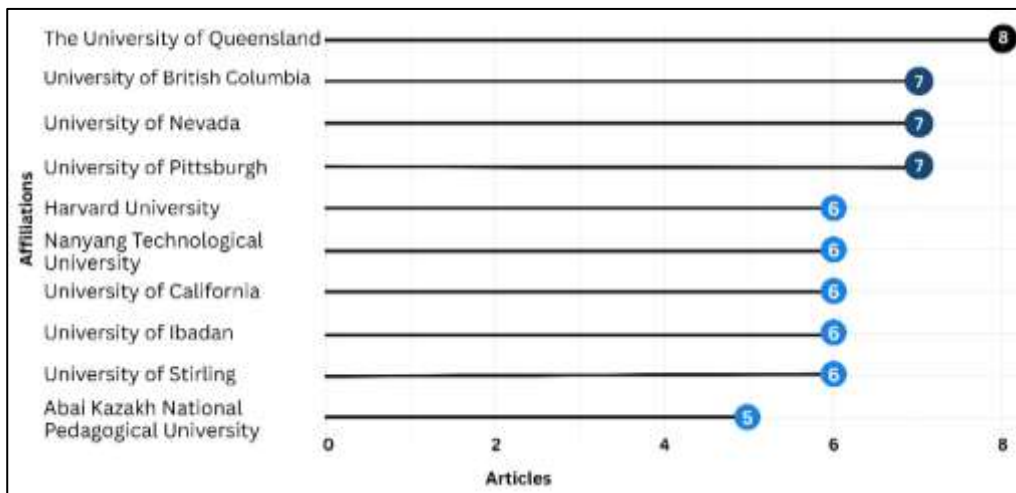
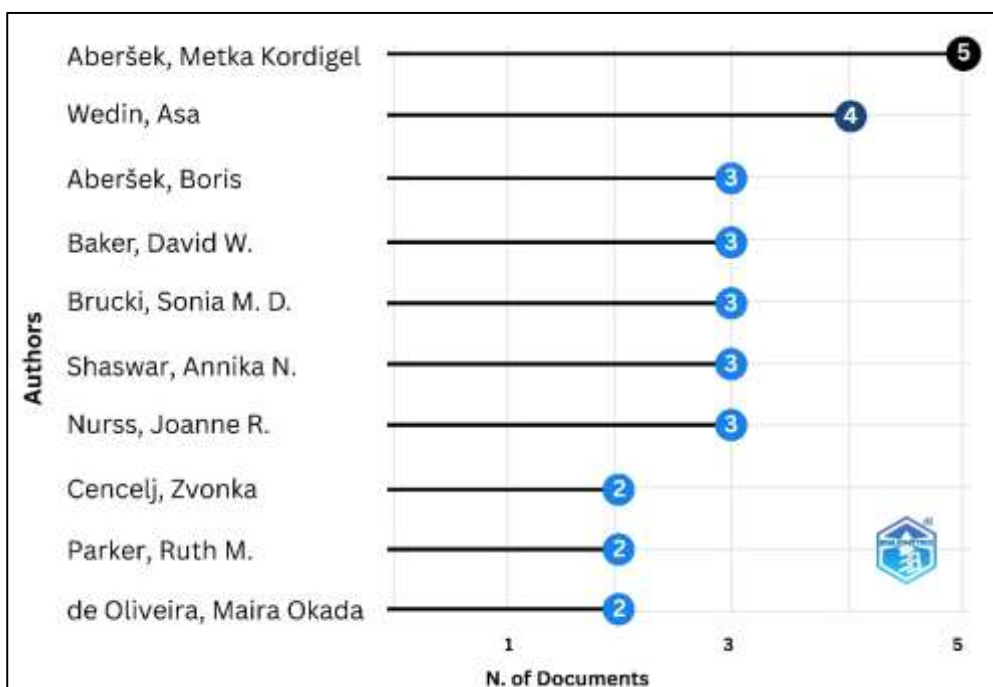


Figure 8.

Top 10 Authors Contributing to Functional Literacy Research in School Education



The author productivity analysis in Figure 8 indicates that Aberšek, M. K. is the most prolific contributor, with 5 publications. Wedin ranks second with 4 publications, reflecting sustained engagement in this research area. Five other authors, specifically Aberšek, B., Baker, Brucki, Shaswar, and Nurss, each contributed 3 publications, positioning them as key

contributors to the field. Meanwhile, Cencelj, Parker, and de Oliveira each contributed 2 publications. Overall, this distribution suggests that functional literacy research is driven by collective scholarly contributions rather than relying on a small number of dominant authors. Further, the results of the analysis of highly cited documents are presented in Table 1.

Table 1.

Top 10 Most Globally Cited Documents in Functional Literacy Research in School Education

Paper	DOI	TC	TC/Y
Norman CD, 2006, J Med Internet Res	10.2196/jmir.8.4.e27	1628	81,40
Banerjee AV, 2007, Q J Econ	10.1162/qjec.122.3.1235	607	31,95
Parikh NS, 1996, Patient Educ Couns	10.1016/0738-3991(95)00787-3	535	17,83
Friedman DB, 2006, Health Educ Behav	10.1177/1090198105277329	414	20,70
Baker DW, 2000, J Gerontol B Psychol	10.1093/geronb/55.6.s368	363	13,96
Sci Soc Sci			
Baydar N, 1993, Child Dev	10.1111/j.1467-8624.1993.tb02945.x	159	4,82
Amin R, 1998, J Dev Areas	Not available	125	4,46
Yadete T, 2021, Vaccines	10.3390/vaccines9121424	123	24,60
Shwartz Y, 2006, Chem Educ Res Pract	10.1039/B6RP90011A	121	6,05
Thompson G, 2013, Int Educ J	Not available	115	8,85

Table 1 lists the 10 documents with the highest global citation counts. Norman and Skinner's (2006) article, published in the *Journal of Medical Internet Research*, ranks first, with 1,628 citations and an average of 81.40 citations per year, underscoring its substantial influence in the areas of functional literacy and digital health. Banerjee et al.'s (2007) publication in the *Quarterly Journal of Economics* ranks second with 607 citations and an average of 31.95 citations per year, highlighting the relevance of economic perspectives in literacy-related discussions. Parikh et al.'s (1996) article in *Patient Education and Counseling* follows with 535 citations and 17.83 citations per year, reflecting its strong impact on health literacy research. Friedman and Hoffman-Goetz's (2006) work in *Health Education & Behavior* recorded 414 citations, with an annual average of 20.70 citations, followed by Baker et al.'s (2000) article in *The Journals of Gerontology: Series B, Psychological Sciences and Social Sciences*, which accumulated 363 citations and 13.96 citations per year.

Additional influential contributions include Baydar et al.'s (1993) article in *Child Development*, with 159 citations and an annual average of 4.82 citations, and Amin et al.'s (1998) study in *The Journal of Developing Areas*, with 125 citations and an annual average of 4.46 citations. More recent publications, such as Yadete et al. (2021) in *Vaccines*, show a high citation rate of 24.60 citations per year despite their relatively short publication period. Shwartz et al.'s (2006) article in *Chemical Education Research and Practice* accumulated 121 citations, averaging 6.05 per year, while Thompson's (2013) publication in the *International Education Journal* ranks

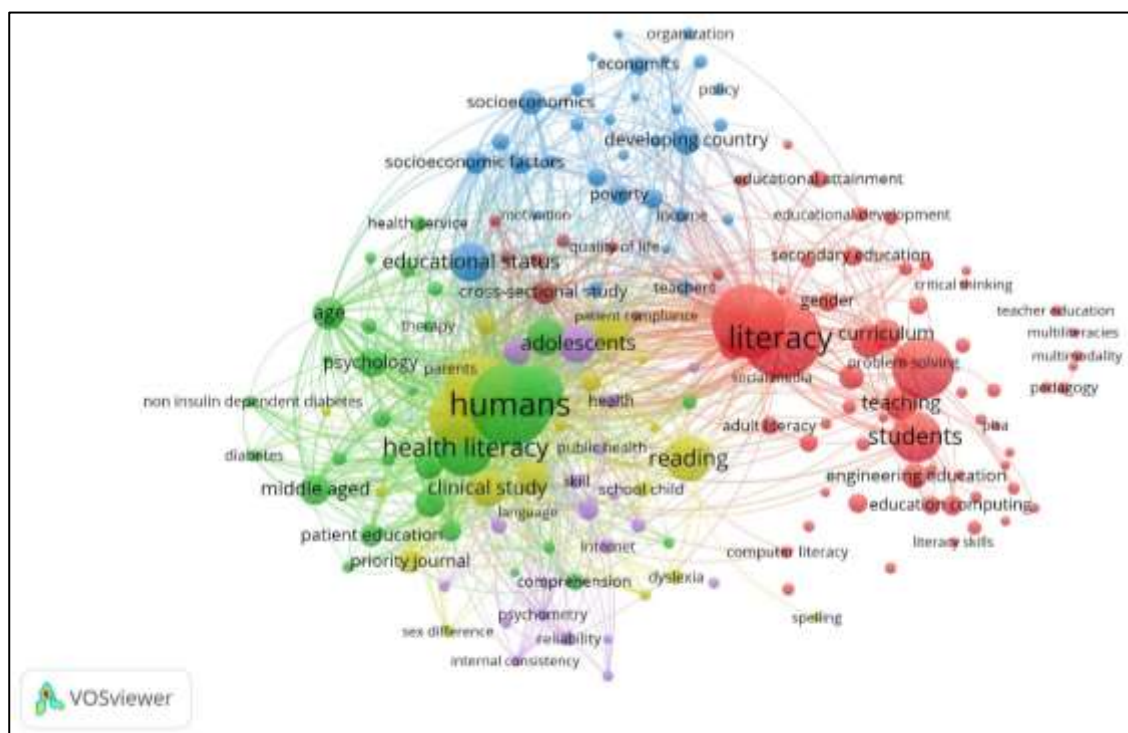
tenth with 115 citations and 8.85 per year. Collectively, these findings demonstrate that the most influential studies in functional literacy originate not only in education but also in health, economics, and community development, reinforcing the field's multidisciplinary nature.

Current research themes in functional literacy research in school education

The analysis of the keyword co-occurrence network visualization reveals six major thematic clusters, as illustrated in Figure 9. These clusters represent the underlying intellectual structure of functional literacy research in school education. Cluster 1 (red) is the largest, comprising 61 keywords and centered on education- and literacy-related themes. It is characterized by dominant terms such as literacy, functional literacy, students, teaching, learning, curriculum, digital literacy, engineering education, adult education, primary education, and secondary education. In addition, this cluster includes keywords associated with educational outcomes and human capital, such as educational attainment, educational development, and gender. Viewed collectively, these terms indicate a strong emphasis on pedagogical practices, institutional contexts, and the development of literacy capacities across formal and non-formal educational settings.

Figure 9.

Results of the Keyword Linkage Analysis in the Network Visualization View



Cluster 2 (green) consists of 31 keywords and focuses on health literacy and psycho-individual dimensions, with prominent terms including humans, health literacy, health education, psychology, age, patient education, health behavior, and health service. Cluster 3 (blue), which also includes 31 keywords, emphasizes socioeconomic and structural dimensions, as shown by the following terms: educational status, developing country, economics, socioeconomic factors, poverty, income, teachers, and employment. Cluster 4 (yellow) contains 21 keywords related to children's cognitive development and basic literacy, such as reading,

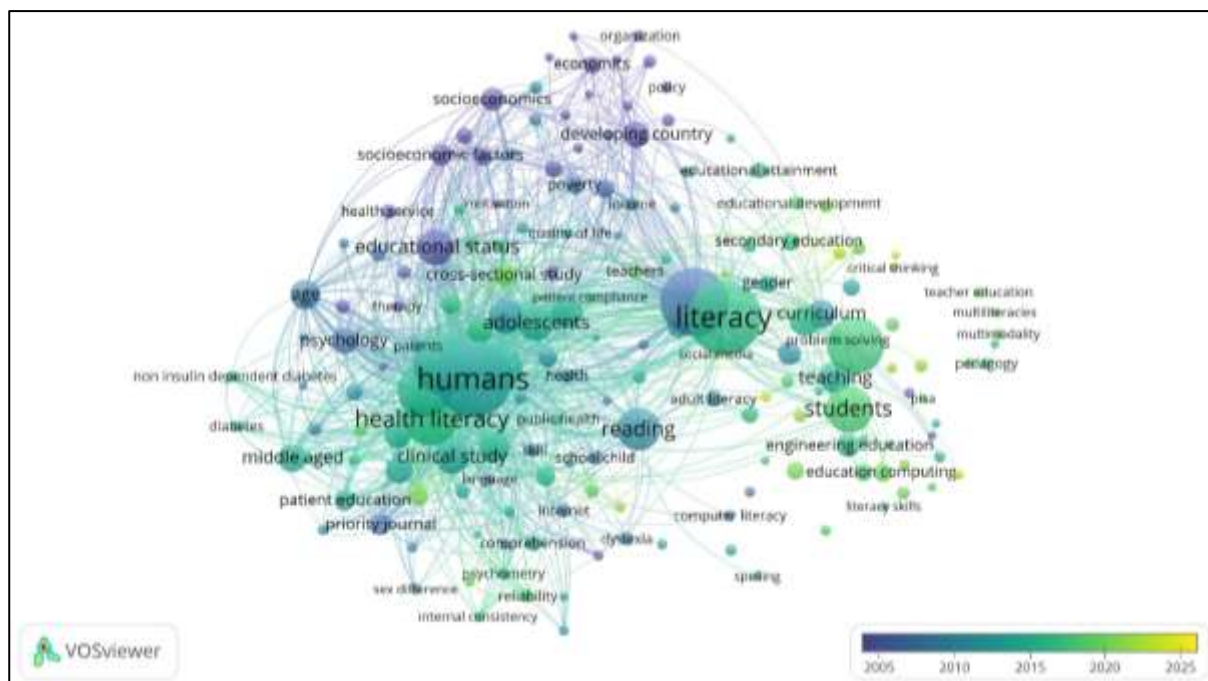
children, school child, language, dyslexia, sex differences, and spelling. Cluster 5 (purple), comprising 20 keywords, reflects adolescents and public health issues, highlighted by terms such as adolescents, youth, public health, health promotion, knowledge, skills, and the internet. Finally, Cluster 6 (brown) is the smallest, consisting of 7 keywords related to epidemiology and literacy outcomes, such as illiteracy, risk factors, prevalence, quality of life, and patient compliance. Overall, the network illustrates strong interconnections among educational, health, and socioeconomic themes within functional literacy research.

Potential research themes for future development in functional literacy research in school education

The overlay visualization analysis conducted using VOSviewer illustrates the temporal dynamics of research themes in functional literacy within school education, based on the average year of keyword occurrence, as shown in Figure 10. During the early phase around 2005, research was dominated by structural and contextual themes. Prominent keywords from this period include education, psychology, educational status, socioeconomic factors, socioeconomic factors, developing country, economics, poverty, schools, social class, and health service. These terms primarily focus on foundational educational and health conditions, as well as socioeconomic determinants influencing literacy, particularly in developing country contexts and general population studies.

Figure 10.

Results of the Keyword Linkage Analysis in the Overlay Visualization View



In the intermediate period, roughly between 2010 and 2015, research attention shifted toward more individual-oriented, practice-based educational themes. This shift is marked by the emergence of keywords such as humans, literacy, functional literacy, students, teaching, learning, primary education, secondary education, engineering education, adults, gender, health literacy, health behavior, patient education, adolescents, children, and human capital.

This phase reflects stronger integration between literacy, formal schooling, and health-related dimensions, while also indicating an expansion of research across multiple age groups and educational levels.

In the most recent period, spanning approximately 2020–2025, research themes are increasingly dominated by technology-oriented approaches and emerging competencies. Keywords such as media literacy, artificial intelligence, computational thinking, social media, financial literacy, reading literacy, basic literacy, mobile applications, higher education, teachers, academic performance, and perception have become more prominent. This pattern indicates a clear shift toward research that situates functional literacy within the context of digital transformation, intelligent technologies, and the competency demands of 21st-century education.

DISCUSSION

Global publication trends of functional literacy research in school education

The rapid growth in publications since the late 2010s indicates a conceptual repositioning of functional literacy from a focus on basic skills to a more complex, contextually grounded competency in school education. In the early phase, literacy was largely understood as a set of foundational abilities in reading, writing, and numeracy. This orientation is reflected in studies of basic literacy and adult education that emphasized functional skills for everyday use (Chadha & Wadhwa, 2018; Oktapiani et al., 2019). Entering the 2020–2021 period, the rapid rise in publications corresponds to a shift toward digital literacy, multiliteracies, and critical literacy. These perspectives highlight student agency, multimodality, and the integration of literacy with educational technologies (Kiss & Mizusawa, 2018; Mizusawa, 2021). In the subsequent stage, particularly between 2022 and 2024, functional literacy came to be viewed increasingly as a cross-sectoral competency linked to artificial intelligence, health, social justice, and sustainable development. This shift is visible in growing attention to health literacy, numeracy literacy, and the integration of smart technologies in education (Borzuoi et al., 2024; Karaali, 2023; Murphy et al., 2024). This broadening scope helps explain the substantial rise in publication volume, as functional literacy has evolved into a strategic issue across multiple disciplines rather than remaining confined to basic education.

The contrast between the rapid expansion of publication output and the more modest annual citation rates reflects the field's ongoing development. The citation peak observed in the mid-2000s was largely driven by foundational conceptual and methodological works, especially in health literacy and technology-mediated literacy. A notable example is the development of the eHealth Literacy Scale by Norman and Skinner (2006), which provided a robust conceptual framework and a widely adopted measurement instrument. This influence is reinforced by Friedman and Hoffman-Goetz's (2006) systematic review of readability and comprehension instruments. These early works continue to serve as cross-temporal references due to their conceptual clarity and methodological stability.

By comparison, more recent studies addressing digitalization, artificial intelligence, and critical literacy have not yet accumulated comparable citation counts. This pattern is likely due to their relatively recent publication and the evolving nature of these research areas. Studies such as those by Dunn and Conard (2018) and Yadete et al. (2021) suggest that functional literacy is increasingly articulated as an adaptive capability related to decision-making, public health, and trust in information. Within this context, lower citation accumulation should not be interpreted as a sign of limited scholarly value. Instead, it reflects a transitional phase toward a more integrative and socially responsive literacy paradigm.

Functional literacy research landscape in school education

The distribution of journal sources indicates that functional literacy research is supported by a diverse, non-centralized publication ecosystem rather than by a single outlet. The prominence of the *Literacy* journal underscores its role as a key platform for conceptual and pedagogical discussions on school-based literacy. Publications concentrated in 2018–2019 emphasize literacy as a social practice closely linked to learners' identities, emotions, and cultural contexts (Burnett & Merchant, 2018; Chetty, 2019; Gadd et al., 2019). The most recent publication in 2025 further illustrates the continuity of this focus by highlighting cultural diversity and representation in children's reading materials. By contrast, the *International Review of Education* shows consistent yet highly selective output, publishing approximately 1 article per year. Its contributions tend to center on lifelong learning and social inclusion, particularly in studies of adult and elderly literacy (Lang, 2021; Ma et al., 2024).

The substantial contribution of *Perspektivy Nauki i Obrazovania* shows the growing importance of regional and pedagogical perspectives in functional literacy research. Articles in this journal consistently link literacy with learning objectives, science, art, and gender dimensions in school education (Belousov et al., 2024; Demeneva et al., 2023; Karpova & Nevzorova, 2023). This orientation positions functional literacy not merely as a basic skill but as a competency embedded within disciplinary knowledge and students' cognitive development. The presence of multidisciplinary journals and conference proceedings among the leading sources further reinforces the cross-disciplinary nature of functional literacy studies.

At the national level, the dominance of the United States signals both its strong research capacity and its strategic focus on pedagogical innovation and educational technology. Research produced in this context frequently associates functional literacy with participatory learning, digital environments, and the development of basic literacy across educational levels (Murphy et al., 2024; Palacios et al., 2024). The involvement of international scholars affiliated with U.S. institutions further signifies the country's role as a hub for global academic collaboration. This pattern expands the geographical reach of functional literacy research while enriching its conceptual diversity. China's position as the second-largest contributor indicates a strong research emphasis on integrating literacy with advanced technologies and data-driven approaches. Studies addressing big data, media critical literacy, and the integration of core literacy in higher education reflect responses to digital transformation and the demands of 21st-

century competencies (Liu, 2024; Luo & Xie, 2025; Teng, 2025). The broader pattern of international collaboration across Asian, European, and African countries affirms that functional literacy research is becoming increasingly global and interconnected. Countries with lower publication output continue to contribute through targeted thematic collaborations, bringing valuable local perspectives to the field.

At the institutional level, the University of Queensland's prominence shapes the conceptual direction of functional literacy research in school education. Its contributions emphasize a shift from skills-based interpretations toward literacy as a social practice connected to identity and learning contexts, especially in secondary science education (Stahl et al., 2024). This perspective aligns with research linking functional literacy to health factors and the social environments of school-aged children, including geographical analyses of functional illiteracy and its determinants (Owada et al., 2019). These studies therefore suggest that highly productive institutions foster cross-disciplinary literacy frameworks that are grounded in real-world educational contexts.

Significant contributions from the University of British Columbia, the University of Nevada, and the University of Pittsburgh further reinforce the field's interdisciplinary nature. Research from the University of British Columbia conceptualizes literacy as a multimodal practice across the lifespan, extending its relevance beyond formal schooling (Heydon et al., 2020). The University of Nevada contributes through studies on health literacy and public communication, highlighting the role of functional literacy in informed decision-making (Yadete et al., 2021). Meanwhile, studies from the University of Pittsburgh situate literacy within debates on language policy, power, and social justice, especially in multilingual settings (Ulysse & Burns, 2022). The remaining institutions in the top 10 display a balanced and geographically diverse pattern of contributions, indicating that functional literacy research is developed across multiple academic centers with complementary thematic orientations.

The prominence of Aberšek, M. K. reflects a central role in advancing functional literacy research in school education, particularly within digital and STEM contexts. His work consistently addresses misconceptions about literacy acquisition in digital environments and emphasizes the need for intentional literacy development through pedagogical and metacognitive models (Aberšek, 2020; Cencelj et al., 2019; Dolenc et al., 2015). Frequent collaborations with Aberšek, B., and Cencelj point to the presence of a strong research cluster focused on science, technology, and engineering literacy. This pattern underscores the view of functional literacy as a core 21st-century competency that must be systematically cultivated through cross-disciplinary educational practices.

Contributions by Wedin and Shaswar foreground adult literacy, second-language education, and critical translanguaging approaches in migration contexts. Their studies conceptualize literacy as a social practice closely linked to social justice, ethics, and citizenship rather than as a purely technical skill (Shaswar et al., 2024; Wedin, 2024). In parallel, Baker, Brucki, and Nurss represent a foundational tradition in health literacy research, focusing on

functional literacy measurement, age-related and cognitive factors, and implications for individual decision-making and well-being (Baker et al., 2000; Brucki et al., 2011; de Oliveira et al., 2009; Nurss, 2000; Parikh et al., 1996). Other authors also contribute meaningfully, albeit with fewer publications. These collaborative networks together illustrate the evolution of functional literacy research through ongoing interaction across education, health, and linguistics.

Ultimately, the dominance of Norman and Skinner's (2006) work emphasizes the central role of digital health literacy as a conceptual foundation for cross-disciplinary functional literacy research. The eHealth Literacy Scale provides a stable, replicable framework that continues to inform studies beyond the health domain. The high citation impact of Banerjee et al. (2007) further illustrates that interventions targeting basic literacy and numeracy have profound implications for human capability development and education policy, particularly in developing contexts. Early influential works by Parikh et al. (1996), Friedman and Hoffman-Goetz (2006), and Baker et al. (2000) laid the foundation for theoretical linkages between functional literacy, psychosocial factors, age, and cognition, which have been widely adopted and extended within school education and health literacy research. Studies by Baydar et al. (1993) and Amin et al. (1998) further draw attention to the long-standing recognition that functional literacy is shaped by early education, family environment, and socioeconomic conditions. More recent research, such as Yadete et al. (2021), advances this perspective by linking literacy to public decision-making and trust in scientific information. Meanwhile, Shwartz et al. (2006) and Thompson (2013) exemplify how functional literacy concepts are operationalized within school curricula and accountability frameworks. Together, these highly cited documents provide a robust theoretical and methodological foundation that supports the continued development of functional literacy research as a multidisciplinary, socially responsive field.

Current research themes in functional literacy research in school education

The cluster structure shows that functional literacy research in school education is primarily grounded in pedagogical themes connected to several disciplinary domains. The education and literacy cluster functions as the central anchor, reflecting a shift in literacy from technical skills toward competencies that must be systematically developed through curriculum design, instructional practices, and technology integration. This orientation is consistent with research showing that functional literacy requires deliberate pedagogical planning across language education and STEM contexts (Aberšek, 2020; Cencelj et al., 2019; Mizusawa, 2021). Evidence from virtual literacy teaching further indicates that technology integration must be supported by learner-responsive pedagogy, relational support, and attention to unequal access (Isidro & Teichert, 2021). Against this background, the growing prominence of digital literacy and engineering education reflects the increasing influence of technology-mediated learning and the demands of 21st-century competencies. These developments position functional literacy as an intentionally cultivated, context-sensitive competency that connects foundational learning with emerging educational and technological demands.

The strong linkage between the education cluster and the health literacy and public health clusters illustrates the extension of functional literacy into the domains of decision-making and human behavior. Research on health literacy shows that the ability to understand, evaluate, and apply information underpins individuals' active participation in school, family, and community contexts (Dunn & Conard, 2018; Norman & Skinner, 2006). This interconnection explains why functional literacy frequently co-occurs with psychological constructs, attitudes, and health behaviors. It also highlights its increasing relevance for adolescents and young adults who navigate complex digital information ecosystems (Yadete et al., 2021).

Meanwhile, the socioeconomic and child development clusters underline that functional literacy is inseparable from structural conditions and developmental stages. Previous studies have shown that poverty, family educational background, and social environment exert long-term influences on literacy attainment (Amin et al., 1998; Baydar et al., 1993). At the same time, the focus on early reading, language acquisition, and learning difficulties positions functional literacy as a foundational element for later academic success. This cluster configuration therefore confirms that functional literacy is a cross-thematic construct that bridges education, health, and social development, while reinforcing its role as a key competency within contemporary education systems.

Potential research themes for future development in functional literacy research in school education

The observed temporal shifts in research themes suggest that functional literacy has evolved from a predominantly structural perspective to a more complex, contextualized approach. Early research, which emphasized socioeconomic conditions, basic education, and health services, represents efforts to conceptualize literacy as a development issue closely linked to social inequality, particularly in developing countries (Amin et al., 1998; Baydar et al., 1993). During the intermediate phase, functional literacy was increasingly framed as an individual capability connected to learning processes, health practices, and gender dynamics. This trend aligns with studies that position literacy as a prerequisite for active participation in formal education and informed health decision-making (Baker et al., 2000; Dunn & Conard, 2018; Parikh et al., 1996). Such a shift marks a transition from macro-level explanations toward a more learner-centered perspective on literacy development.

The dominance of technology-oriented themes in the 2020–2025 period signals a new trajectory in functional literacy research that foregrounds 21st-century competencies. The emergence of keywords, e.g., artificial intelligence, media literacy, and computational thinking, indicates that functional literacy is increasingly understood as an adaptive capacity within complex digital environments. This trend corresponds with research emphasizing that basic literacy and numeracy remain essential foundations despite rapid technological advancement (Karaali, 2023). It is also supported by empirical studies that highlight both the potential and the challenges of digital technologies in enhancing basic literacy skills among students and adults (Murphy et al., 2024; Wickramasinghe & Aragon, 2023). A recent special education study also

reported improvements in word recognition and literal comprehension through structured mobile application use (Nuswantara et al., 2026). In this sense, functional literacy increasingly serves as a bridge between foundational skills and advanced digital competencies.

Based on these findings, several future research directions can be identified. First, empirical studies are needed to examine how artificial intelligence and digital applications can be integrated into functional literacy development without undermining basic reading and numeracy skills. Second, cross-level research that systematically connects basic literacy, digital literacy, and critical literacy remains limited and warrants further exploration. Third, comparative studies across countries and social contexts are essential to better understand how functional literacy interacts with social inequality and education policy frameworks. Advancing these research agendas will help ensure that functional literacy development remains relevant, inclusive, and responsive to technological change and the evolving needs of global societies.

Implications of Study Findings

The findings of this study yield several important implications for educators, policymakers, and curriculum designers in addressing the evolving concept of functional literacy in school education. For educators, the identified shift from basic literacy toward digital, media, and artificial intelligence-related literacies indicates the need to redesign classroom practices that integrate reading and numeracy skills with critical information evaluation, problem-solving, and technology use. This implication is consistent with research emphasizing that functional literacy must be intentionally developed through pedagogical design rather than assumed to emerge automatically, particularly in digital and STEM learning environments (Aberšek, 2020; Cencelj et al., 2019; Mizusawa, 2021). Instructional strategies should also move beyond isolated literacy instruction and integrate functional literacy across subjects, including science, mathematics, and social studies, through contextualized, real-world learning tasks.

For policymakers, the documented relationships among functional literacy, health literacy, and socioeconomic conditions highlight the need for coordinated policies across sectors. Literacy outcomes are shaped not only by educational experiences but also by health behaviors, access to information, and broader social conditions, particularly among vulnerable populations (Baker et al., 2000; Norman & Skinner, 2006). Accordingly, school literacy initiatives should be integrated with relevant public health and social development programs, especially in contexts marked by social inequality (Yadete et al., 2021). Implementing such cross-sector initiatives requires clear communication, well-defined responsibilities, practitioner training, and sustained professional communities (Matjokana & Bipath, 2024). Beyond national coordination, the global collaboration patterns identified in this study indicate that policymakers can strengthen literacy policies through international benchmarking and evidence-informed practices. These external insights should complement context-sensitive interventions that address local educational and social needs.

From a curriculum design perspective, the prevalence of technology-related themes in recent research suggests the need for balanced curriculum frameworks. As digital innovation,

artificial intelligence, and computational thinking gain relevance, the findings caution against marginalizing foundational reading and numeracy skills (Karaali, 2023). Curriculum designers should therefore ensure vertical coherence, in which basic literacy competencies are systematically developed in early grades and progressively integrated with higher-order and digital literacies in later grades (Dunn & Conard, 2018; Murphy et al., 2024). Positioning functional literacy in this way will strengthen its role as a strategic competency that supports academic achievement, informed decision-making, and students' readiness to participate in a knowledge-based and digitally mediated society.

CONCLUSION

This study set out to map and synthesize the evolution of functional literacy research in school education through a comprehensive bibliometric approach. By analyzing scientific publications from 1970 to 2025, the study systematically examined global publication trends, the structure of the research landscape, dominant thematic orientations, and emerging directions for future inquiry. The findings reveal that research on functional literacy developed slowly in its early stages, grew steadily from the mid-1990s, and then accelerated sharply after 2018. This surge reflects the growing recognition of functional literacy as a strategic and cross-cutting competency in school education. At the same time, the relatively moderate citation impact of recent publications suggests that much of this expanding scholarship is still consolidating and maturing intellectually.

Regarding the research landscape, the results confirm that functional literacy research is both global and multidisciplinary. The field draws on contributions from diverse journals, institutions, and countries, with strong leadership from the United States, the United Kingdom, and China, and supported by extensive international collaboration networks. Citation and authorship analyses further reveal that the field's conceptual and methodological foundations are largely anchored in influential early studies, especially in health literacy, basic education, and education policy. These foundational works continue to inform contemporary research. Thematic analysis also indicates that current research is structured around pedagogical practices, health literacy, socioeconomic contexts, and child development. In addition, more recent studies increasingly engage with digital literacy, artificial intelligence, and 21st-century competencies. Overall, these findings point to an ongoing shift toward more integrative and contextualized understandings of functional literacy that connect basic skills with technological innovation, social justice, and sustainable development.

This study acknowledges several limitations, most notably its reliance on a single database (i.e., Scopus), which may not fully represent the global literature on functional literacy, especially local or non-English-language publications. Moreover, as a descriptive bibliometric analysis, this study does not capture the qualitative dimensions of functional literacy themes and practices in schools. To address these limitations, future research should combine multiple databases such as WoS and Dimensions, integrate systematic review approaches, and expand

qualitative investigations through cross-context case studies. These approaches would contribute to a more comprehensive understanding of the dynamics, challenges, and opportunities for advancing functional literacy in school education.

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Conflict of Interest

All authors declare that they have no conflict of interest related to the study, authorship, or publication of this manuscript.

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Generative AI Statement

Artificial intelligence tools, including ChatGPT 5.1, were employed during the manuscript preparation to enhance the clarity and coherence of the text, while Grammarly was used to support grammatical accuracy. All AI-assisted outputs were critically evaluated and revised by the authors to ensure academic rigor and fidelity to the research content. The authors retain full responsibility for the final version of the manuscript and the integrity of its scholarly contributions.

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