

LITERACY AS A 21ST CENTURY COMPETENCY IN CURRICULUM AND EDUCATION QUALITY IN INDONESIA

A Systematic Literature Review and Bibliometric Analysis

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Abstract: Literacy as a 21st Century Competency in Curriculum and Education Quality in Indonesia: a Systematic Literature Review and Bibliometric Analysis

This study aims to analyze literacy as a 21st century competency in relation to the curriculum and quality of education in Indonesia through the Systematic Literature Review (SLR) approach and bibliometric analysis. Data was obtained from the Scopus database with a time range of 2016–2026 following the PRISMA protocol, resulting in 32 articles for in-depth analysis. Bibliometric analysis using VOS viewer mapped publication trends, author collaborations, and thematic clusters. The results reveal three specific findings: first, publication trends show a significant increase peaking in 2024, dominated by STEM/STEAM integration and digital literacy studies, with quantitative approaches accounting for 56% of the analyzed corpus; second, network and density visualization identify digital literacy, scientific literacy, and critical thinking as the three dominant conceptual pillars binding all research themes, with artificial intelligence and vocational education emerging as the most recently growing nodes in the overlay map; third, literacy in the Merdeka Curriculum is constructed as a six-dimensional multidimensional competency reading-writing, numeracy, science, digital, financial, and cultural-civic literacy yet its implementation, particularly in Islamic educational institutions, remains constrained by teacher readiness gaps, infrastructural disparities, and fragmented institutionalization of digital literacy pedagogy. These findings provide important implications for policymakers, educators, and researchers in designing adaptive literacy strengthening strategies that support the transformation of national education.

Keywords: Educational literacy, 21st Century Literacy, Indonesian Curriculum, Quality of Education

Abstrak: Literasi sebagai Kompetensi Abad ke-21 dalam Kurikulum dan Kualitas Pendidikan di Indonesia: Tinjauan Pustaka Sistematis dan Analisis Bibliometrik

Penelitian ini bertujuan menganalisis literasi sebagai kompetensi abad ke-21 dalam kaitannya dengan kurikulum dan kualitas pendidikan di Indonesia melalui pendekatan Systematic Literature Review (SLR) dan analisis bibliometrik. Data diperoleh dari database Scopus rentang 2016–2026 mengikuti protokol PRISMA, menghasilkan 32 artikel untuk analisis

mendalam. Analisis bibliometrik menggunakan VOS viewer memetakan tren publikasi, kolaborasi penulis, dan klaster tema utama. Hasil penelitian mengungkapkan tiga temuan spesifik: pertama, tren publikasi menunjukkan peningkatan signifikan yang memuncak pada 2024, didominasi studi integrasi STEM/STEAM dan literasi digital dengan pendekatan kuantitatif sebesar 56% dari keseluruhan korpus; kedua, visualisasi jaringan dan densitas mengidentifikasi literasi digital, literasi sains, dan berpikir kritis sebagai tiga pilar konseptual dominan yang mengikat seluruh tema penelitian, dengan kecerdasan buatan dan pendidikan vokasi sebagai node yang paling berkembang pada peta overlay; ketiga, literasi dalam Kurikulum Merdeka dikonstruksi sebagai kompetensi multidimensi enam dimensi, namun implementasinya khususnya di lembaga pendidikan Islam masih terkendala kesenjangan kesiapan guru, disparitas infrastruktur, dan belum terlembaganya pedagogi literasi digital secara sistemik. Temuan ini memberikan implikasi penting bagi pembuat kebijakan, pendidik, dan peneliti dalam merancang strategi penguatan literasi yang adaptif dan mendukung transformasi pendidikan nasional.

Kata Kunci: Literasi Pendidikan, Literasi Abad ke-21, Kurikulum Indonesia, Kualitas Pendidikan

INTRODUCTION

The systematic conceptual article writing (containing the results of the review) consists of the title, author's name, institution and correspondence address, abstract, keywords, abstract, keywords, introduction, core part, summary and list of references. In the era of globalization and rapid technological advancement, the challenges of education in the 21st century require a fundamental transformation of the concept of competencies that must be possessed by students, where literacy is no longer understood narrowly as the ability to read and write, but as a set of skills for critical thinking, communicating, and adapting to such complex information flows (Ratnawati et al., 2025; Rijal et al., 2025). This change in the educational paradigm occurs simultaneously with a shift in the needs of the world of work and social life that emphasizes lifelong learning skills, so that literacy is seen as the main foundation for improving the quality of human resources and the nation's competitiveness at the global level (Simbolon, 2023; Utami et al., 2025). Responding to this urgency, the education system in Indonesia, especially through the implementation of the Independent Learning Curriculum, proactively places literacy as the main focus to form an adaptive and competent generation to face the dynamics of the 21st century (Simbolon, 2023; Utami et al., 2025). This makes literacy a strategic issue that needs to be studied in depth in the context of policy and implementation of the national curriculum, including how Indonesia responds to the challenges of 21st century competencies through an education system that is adaptive to changing (Anggraini et al., 2026; Rodiyah et al., 2025).

Furthermore, the implementation of the Independent Curriculum launched by the Indonesian government is one of the concrete efforts in integrating literacy as a basic competency that must develop at every level of education, because this curriculum not only emphasizes mastery of knowledge content but also character building, high-level thinking skills, and the ability to collaborate (Maulana & Munir, 2025; Zukmadini, Karyadi, & Rochman, 2021). In the curriculum, literacy is developed in a multidimensional manner including literacy, numeracy, science, digital, financial, and cultural literacy which is expected to form individuals who are capable of understanding information, able to make data-based decisions, and actively participating in knowledge-based societies (Fauziah, Surahman, & Mustofa, 2025; Rijal et al., 2025). The Merdeka Curriculum is explicitly designed to reform the learning system to be more adaptive to the needs of 21st century competencies, including critical thinking skills, creativity, and digital literacy, by placing learners at the center of the learning process (J & Andromeda, 2025). However, even though curriculum policies have accommodated the literacy dimension conceptually, implementation challenges still occur in the field, both in terms of teacher readiness, facilities, and student learning culture that have not fully supported the implementation of literacy as a core competency in the 21st century (Beliyawati et al., 2025). Thus, it is important to review the extent to which strengthening literacy in the curriculum contributes to improving the quality of education in Indonesia, particularly regarding the construction and systematic implementation of literacy in national education policy (Hamilaturroyya & Adibah, 2025; Unisa, Azzahra, Juanda, Rahmanda, & Abdurrahmansya, 2025).

The quality of education is essentially influenced by various factors that interact with each other, including curriculum quality, educator competence, educational resources, and evaluation systems used to assess student learning outcomes, and in this context, literacy plays a role as an indicator that describes the success of the educational process holistically (Athirah et al., 2025; Yuza & Jannah, 2026). Various international assessments such as PISA and PIRLS show that the literacy ability of Indonesian students is still relatively low compared to other countries, which indicates an inequality between the idealism of curriculum policies and the reality of learning in schools (Anggraini et al., 2026). This condition requires a scientific study that not only highlights the empirical results of literacy achievements, but also examines how literacy is constructed and implemented in education policy systematically (Hamilaturroyya & Adibah, 2025; Unisa et al., 2025). Therefore, efforts to examine literacy within the framework of 21st century competencies through *systematic literature review* and *bibliometric analysis approaches* are very relevant to describe the directions, trends, and gaps of research that have been carried out both in the national and global contexts (Izzah, Aji, & Dewi, 2026; Sogalrey, Safitri, Tijow, Sembiring, & Risamasu, 2024).

The systematic literature review approach allows researchers to map conceptual and empirical developments regarding 21st century literacy in a structured manner through tracing and synthesizing the results of previous research, while bibliometric analysis provides a more quantitative picture of the patterns of scientific publications, collaboration between researchers, and dominant themes that emerge in literacy studies in various disciplines (Pradana, Susanto, & Kumorotomo, 2022). This study will integrate the two approaches to comprehensively analyze the dynamics of literacy as a crucial competency in Indonesia, especially in the context of curriculum and education quality, highlighting the gap between policy and implementation. By combining these two approaches, this research is expected to not only contribute to strengthening the theoretical foundation of literacy as a 21st century competence, but also offer a comprehensive understanding of how literacy is implemented in educational policies and practices in Indonesia. Therefore, the results of this study are expected to be a strategic reference for policy makers, educators, and researchers in designing literacy-based education quality improvement strategies and encouraging the transformation of national education towards an adaptive, inclusive, and future-oriented system.

RESEARCH METHODS

This study employs a qualitative-contextual research framework combining Systematic Literature Review (SLR) and bibliometric analysis to map the development of concepts, themes, and academic networks related to literacy and 21st century competencies. The SLR procedure follows the PRISMA protocol to ensure transparency and replicability, while bibliometric analysis uses VOS viewer software to identify publication trends, author collaborations, key keywords, and thematic clusters (Cheng, Wang, Xie, & Yan, 2023; Page et al., 2021).

Data were sourced from the Scopus database, limited to journal articles published between 2016–2026, using keyword combinations representing three core elements: literacy, 21st century competencies, and curriculum/education quality in the Indonesian context. The research questions addressed include: (RQ1) trends and patterns of literacy research in education?; (RQ2) the construction of literacy as a 21st century competency in curriculum and policy?; and (RQ3) its implementation and contribution to improving education quality in Islamic educational institutions?.

Article selection followed the PRISMA protocol through four stages identification, screening, eligibility, and inclusion with strictly applied inclusion and exclusion criteria as presented in Table 1. The initial search yielded 6,820 records from Scopus. After removing 857 duplicates and 4,739 irrelevant records, 1,224 unique records were screened. Following title, abstract, and full-text evaluation, a

final corpus of 32 articles met all inclusion criteria and were included for SLR and bibliometric analysis.

Table 1. Article Selection Criteria

Inclusion Criteria	Exclusion Criteria
Scopus indexed journal articles	Not indexed by Scopus or documents other than journal articles (e.g. proceedings, books, reports, theses, dissertations)
Published between 2016–2026	Published before 2016
Focus on literacy (digital, technology, information, science, or other forms) as part of 21st century competencies	Does not discuss literacy as part of 21st century competence
Related to curriculum or quality of education, especially relevant to the Indonesian context	Does not explain relevance to curriculum or quality of education in the Indonesian context
Written in Indonesian or English	Not available in Indonesian or English
Available in full text format	Only available in abstract or summary form
Unique articles (not duplicates)	Duplicate articles already logged in another database

Source: Adapted from Page et al. (2021)

The entire literature selection process in this study follows the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), which is summarized in the PRISMA flowchart in Figure 1.

RESULTS AND DISCUSSION

General Overview of the Analyzed Literature

The general picture of the literature analyzed shows that research on literacy in Indonesia is developing very broadly, covering the spectrum from basic literacy to 21st century specific literacy that intersects with the demands of Society 5.0 (Rifai et al., 2021). Various studies confirm that strengthening literacy no longer just touches the conventional aspects of reading and writing, but extends to science, mathematics, digital, information, character, citizenship, disaster, religious, and workplace literacy, all of which are positioned as the foundation of 21st century competence (Ibrohim et al., 2023; Saregar et al., 2025). The literature shows systematic efforts to strengthen literacy through school literacy culture management and the development of integrated learning models such as STEM/STEAM, project-based, inquiry, and game-based which are proven to contribute to improving science, numeracy, scientific, and 21st century competency literacy (Amir, Mufarikhah, Wahyuni, Nasrun, & Rudyanto, 2019; Suryanti, Nursalim, Choirunnisa, & Yuliana, 2024; Yerizon et al., 2025).

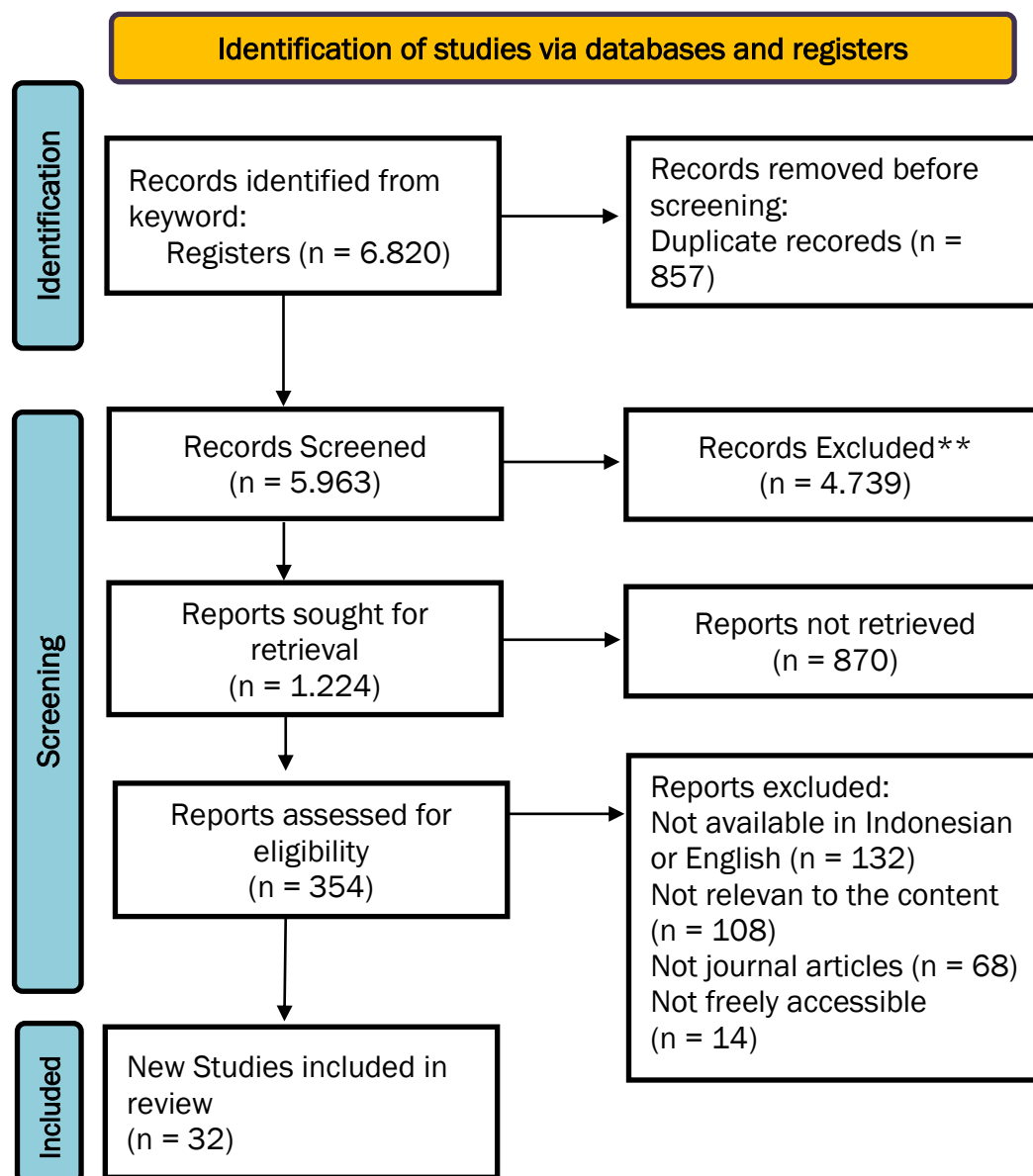


Figure 1. PRISMA Diagram

In addition, several articles affirm the importance of integrating the 4Cs (critical thinking, creativity, collaboration, communication), metacognition, and expression of opinions as the main orientation for strengthening literacy in the 21st century, although its implementation still faces variations and heterogeneities between levels of education as well as pedagogical innovations based on local contexts and digital technologies, including web-based media, adaptive modules, and project websites to encourage creativity and metacognition (Aka et al., 2025; Pantiwati et al., 2023; Semilarski & Laius, 2021). On the other hand, several articles underline the low achievement of science, mathematics, and information literacy, the learning loss of English literacy after the pandemic, and the gap in teacher and infrastructure competencies, so that literacy often develops unevenly between levels, between regions, and between disciplines (Gustine, Setyarini, &

Rodliyah, 2024; Hasanudin & Fitrianiingsih, 2020; Kadir et al., 2025). Thus, this corpus of literature generally describes Indonesia's literacy ecosystem that is dynamic, innovative, but still faces serious challenges in terms of equity, depth of critical thinking, and systemic readiness to integrate various forms of literacy into sustainable learning policies and practices.

The thematically, literature also displays a shift in focus from just knowledge transfer to the formation of a holistic student profile: religious, critical, creative, digitally adaptive, and ready to work (Abdullah, 2024; Bahri et al., 2024; Kodrat et al., 2024). Religious literacy, Qur'anic literacy, and interfaith dialogue programs are positioned as vehicles to strengthen cross cultural religious literacy while supporting an inclusive multicultural and multireligious curriculum, while studies on workplace literacy show the crucial role of computer and information literacy in employability in the digital economy era (Abdullah, 2024; Supriadi, Supriyadi, & Abdussalam, 2022). In the realm of primary and secondary education, the integration of digital literacy, critical thinking, and collaborative learning is described as important, but the relationship between components is still weak, with digital skills tending to be more advanced than students' critical and reflective abilities (Haryaka & Khadijah Razak, 2025; Herlinawati et al., 2024; Komarudin et al., 2024). Various articles affirm that school culture, perception of learning media, and teachers' professional literacy, including the ability to utilize national assessments and technology, are key mediators in the success of strengthening literacy (Marmoah, Suharno, & Suharno, 2022; Rasdiana et al., 2024; Yulianti, Suriansyah, Harsono, & Ridhaningtyas, 2025). In particular, several studies on early childhood and elementary school students emphasized the importance of pedagogical innovation, curriculum adaptation, the use of digital media and project-based websites, as well as local wisdom to strengthen digital literacy, creativity, and sustainability education contextually (Asmayawati et al., 2024; Ika Sari et al., 2024; Marini et al., 2025; Sulianta & Saudi, 2021).

Distribution by Publication Year

The trend of article publication in this study shows the dynamics of research development in recent years. The number of articles is likely to increase gradually since 2019 and peak in 2024, before declining again in 2025 and 2026. This pattern shows that research interest and productivity are at their highest point towards 2024, which can be related to the strengthening of policy agendas and academic programs in that period. The complete distribution by year is presented in Figure 2.

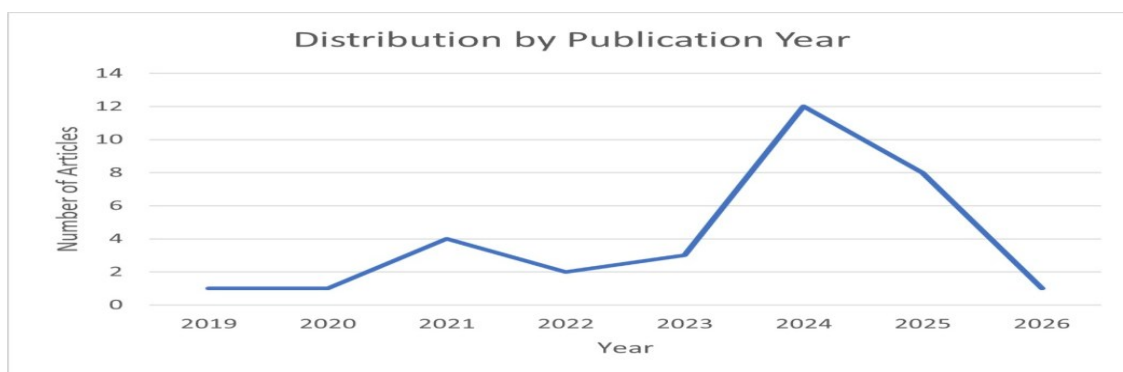


Figure 2. Distribution by Publication Year

The increase in the number of publications that peaked around 2020-2021 and then stabilized in the range of 3-4 articles per year until 2024 shows that research on literacy, STEM/STEAM, and national assessments is closely related to the dynamics of Indonesia's education policy in that period. During this period, the government began to shift the orientation of evaluation from the National Exam to the National Assessment which emphasized reading and numeracy literacy, so that issues of learning quality, school readiness, and 21st century competence became an important focus in various studies. This trend is in line with the empirical need to provide an evidence base for policy formulation, teacher capacity building, and improvement of classroom learning practices in line with the demands of industry 4.0 and knowledgeable societies.

The launch of the National Assessment/AKM since 2021 has specifically encouraged the emergence of many studies that review teachers' understanding of AKM, their strategies in integrating literacy into learning, and the readiness of ICT facilities in schools. These studies generally highlight how the results of AKM can be used to design more targeted learning interventions, for example through the development of literacy-based teaching materials, the use of digital media, or adjustments to teaching methods to be more oriented towards problem solving and reasoning. In addition, the results of the study also show that there is a gap in readiness between regions and challenges related to infrastructure and digital literacy of teachers, all of which help explain why the topics of literacy, assessment, and educational technology dominated publications in that span of the year.

On the other hand, curriculum policies that emphasize 21st century skills and 4Cs (critical thinking, creativity, collaboration, communication) and Indonesia's commitment to meet SDG 4 (quality education) contribute to the rise of research on STEM/STEAM integration at various levels of education. Many articles examine the application of learning models such as Project-Based Learning (PjBL), Problem-Based Learning (PBL), inquiry, and its variations integrated with STEM/STEAM approaches to improve science literacy, mathematical literacy, and learning outcomes. This shows that the pattern of publication distribution per year not only reflects academic trends, but is also a scientific response to the need to improve the quality of national education, efforts to improve PISA achievement, and the

global push to build a sustainable, inclusive, and relevant education system to the challenges of the future.

Distribution of Research Methods

The distribution of research methods in this study shows the tendency of researchers to choose the approach that is considered the most effective in answering the problem formulation. Experimental and research and development methods dominate the number of articles, followed by surveys, mixed methods, and descriptive methods which are also used quite intensively. Meanwhile, other approaches such as qualitative literature review, phenomenology, comparative studies, and classroom action research only appear in a relatively small portion but still make an important contribution to the methodological diversity of research. The distribution of research methods is presented in Figure 3.

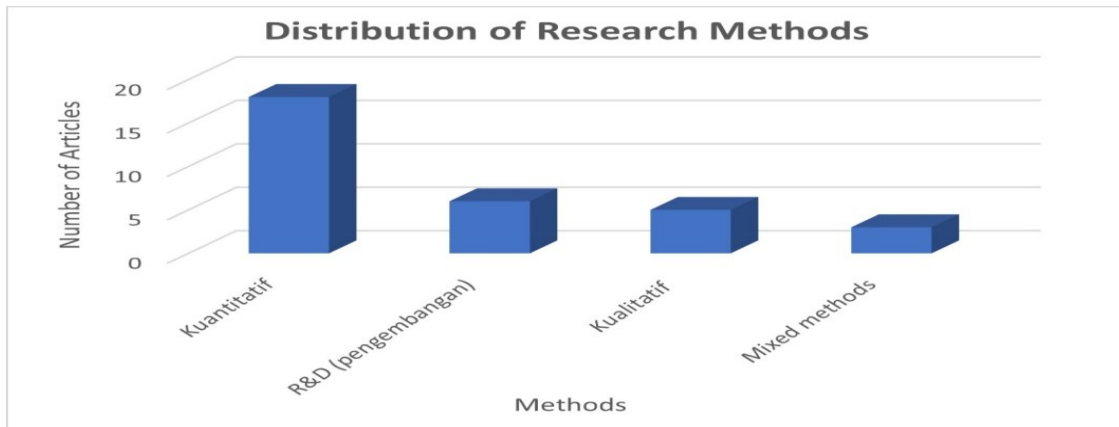


Figure 3. Distribution of Research Methods

Bibliometric analysis of the set of articles studied showed that more than half of the articles in the corpus (56%) with a total of 18 articles used a quantitative approach, thus confirming the researchers' strong preference for designs that allow for causal relationship testing and measurable measurement of intervention effects. This quantitative method is generally in the form of experiments or quasi-experiments that test the effectiveness of learning models, STEM/STEAM approaches, or literacy strengthening programs on 21st century learning outcomes and skills, as well as surveys that map the attitudes, perceptions, or literacy levels of students and teachers. The quantitative dominant portion can be understood as an effort to provide strong empirical evidence to support data-driven decision-making in educational policy and practice.

Beyond that, around 19% of articles used R&D (development) methods with a total of 6 articles, 16% used a qualitative approach with a total of 5 articles, and 9% adopted mixed methods with a total of 3 articles, which together show a diversity of methodological strategies in examining literacy, STEM/STEAM, and assessment policy issues. R&D studies focus heavily on the development and testing of devices such as modules, ICT-based media, assessment instruments, or learning models

designed to improve 21st century literacy and competence. Qualitative research such as phenomenology, case studies, or descriptive is used to explore in depth the experiences of teachers and students, especially in the implementation of the National Assessment, technology integration, and learning dynamics in local contexts including Islamic educational institutions. Meanwhile, mixed methods were chosen when researchers wanted to combine the power of numerical and narrative data, so as to not only describe the magnitude of the influence of an intervention but also explain the mechanisms, constraints, and contextual factors that affect its success in the field. This distribution pattern shows that despite the dominant quantitative approach, the research ecosystem is still underpinned by developmental and exploratory studies that are important to enrich a comprehensive understanding of improving the quality of education.

Distribution of Research Focus Topics

The distribution of research focus in this study reflects the researchers' response to the demands of 21st century competencies and the agenda of improving the quality of education. Most of the articles focus on the theme of STEM/STEAM and 4C skills, followed by science/mathematics literacy as well as digital literacy and ICT utilization, which also receive a large portion. On the other hand, the topics of national assessment and literacy, innovative learning models, as well as policies, curricula, and SDG 4 remain present albeit in smaller proportions, indicating the diversity of issues studied in these studies. The articles analyzed were grouped into six main focus areas, as shown in Figure 4.

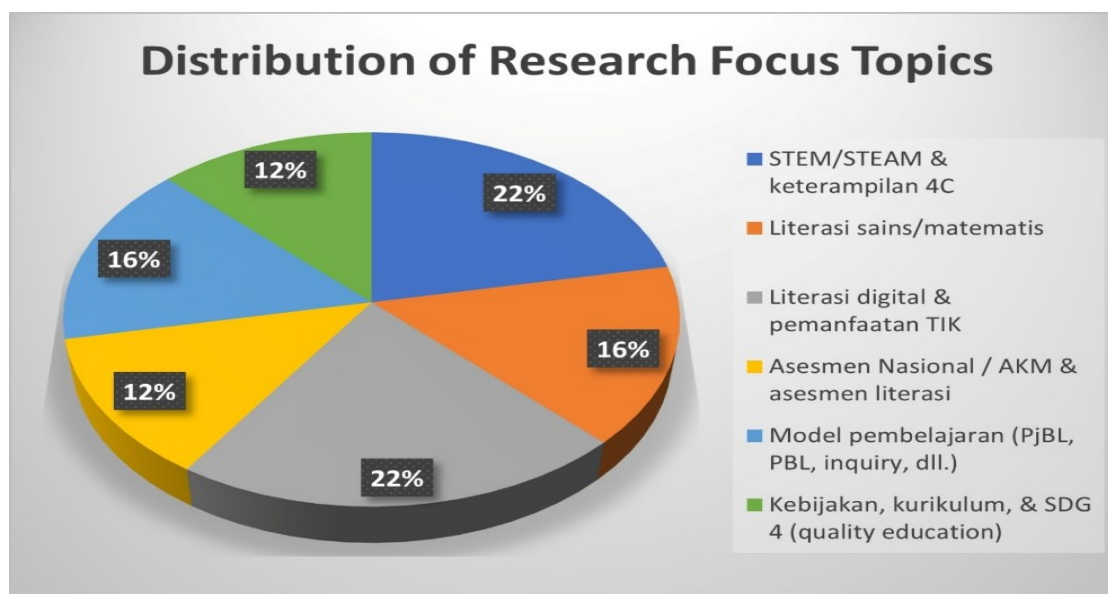


Figure 4. Distribution of Research Methods

The distribution of research focus topics from 32 articles shows that the study corpus is strongly centered on three main axes, namely the development of 21st century skills through STEM/STEAM integration, the strengthening of various forms

of literacy, and responses to assessment policies and curricula. The dominance of STEM/STEAM topics and 4C skills (7 articles) illustrates the researchers' great concern for the development of critical thinking, creativity, collaboration, and communication through integrated science and mathematics learning, often with Project-Based Learning, Problem-Based Learning, or inquiry models to train high-level thinking skills and readiness to face the challenges of the industrial era 4.0 (Amir et al., 2019; Hasanudin & Fitriainingsih, 2020; Ilma, Wilujeng, Widowati, Nurtanto, & Kholifah, 2023; Komarudin et al., 2024; Mutohhari, Sutiman, Nurtanto, Kholifah, & Samsudin, 2021; Suryanti et al., 2024; Yulianti et al., 2025). The science/mathematics literacy group (5 articles) emphasized the importance of being able to use science and mathematics concepts in real-life contexts, generally by referring to the PISA or AKM framework to measure and improve literacy through the development of learning instruments and interventions that are more contextual and problem-solving-oriented (Ibrohim et al., 2023; Kadir et al., 2025; Saregar et al., 2025; Semilarski & Laius, 2021; Sulianta & Saudi, 2021).

On the other hand, the topics of digital literacy and ICT utilization (7 articles) and learning models (5 articles) complement each other in shifting the learning paradigm from teacher-centered to student-centered and competency-based (Cintamulya, Mawartiningsih, & Warli, 2023; Gustine et al., 2024; Pantiwati et al., 2023; Sholeh et al., 2025; Supriadi et al., 2022). The digital literacy study highlights the ability of students and teachers to access, evaluate, and utilize digital information, as well as the relationship between digital literacy and the success of learning and other literacy; while the learning model study focuses on the design and implementation of PjBL, PBL, inquiry, and its variations both integrated with STEM and not to improve learning outcomes, activeness, and high-level thinking skills (Bahri et al., 2024; Haryaka & Khadijah Razak, 2025; Ika Sari et al., 2024; Kodrat et al., 2024; Marini et al., 2025; Rasdiana et al., 2024; Yasa et al., 2024). The National Assessment Group/AKM (4 articles) shows the existence of a special cluster that examines teacher perception, school readiness, AKM outcome-based learning strategies, and the implications of minimum assessment policies on teaching practices, including infrastructure challenges and teacher ICT literacy (Aka et al., 2025; Rifai et al., 2021; Wahyudi, Istiyono, Retnawati, Rusmaningtias, & Suriyanto, 2026; Yerizon et al., 2025). The topics of policy, curriculum, and SDG 4 (4 articles) act as a conceptual framework that links empirical findings with a broader agenda, such as curriculum implementation, strengthening literacy culture, and commitment to quality education, thus providing an interpretive basis for the overall findings (Abdullah, 2024; Asmayawati et al., 2024; Herlinawati et al., 2024; Marmoah et al., 2022). Overall, this distribution pattern shows that the analyzed studies do not only pursue methodological innovations, but also serve as a scientific response to the need to improve the quality of national education, improve the

achievement of international assessments, and the demands of education development that is sustainable, inclusive, and relevant to future challenges.

Network Visualization

The network map shows that the research landscape is composed of several large clusters that intersect with each other, with three dominant nodes digital literacy, scientific literacy, and critical thinking as the center of gravity of the network. These three nodes have a larger number of nodes and a larger number of connections than other terms, indicating a high frequency of occurrence and a strong connection with supporting concepts such as vocational education, teachers, creativity, artificial intelligence, and data visualization. This pattern describes 21st century literacy as a competency ecosystem that combines mastery of digital technology, understanding of science, and critical thinking skills that support decision-making and job readiness in the industrial era 4.0. Digital literacy occupies a central position and is closely related to teachers, vocational education, artificial intelligence, and data visualization, reflecting the integration of digital technology in vocational learning and education. This linkage indicates that research no longer discusses digital literacy as just a technical ability, but as a professional competency that supports teachers and students in managing information, designing learning, and preparing graduates who are adaptive to industry needs.

Meanwhile, scientific literacy forms a strong cluster associated with science learning, ethnoscience, stem education, and problem-based learning (PBL), showing that its development is largely carried out through contextual and problem-based learning approaches. The integration of local wisdom through ethnoscience expands the meaning of scientific literacy to be relevant to the social reality of students, while the presence of STEM and PBL emphasizes the importance of collaboration and cross-disciplinary problem-solving. The critical thinking nodes are stacked with the other two nodes and are related to mathematical thinking skills, reflective, and assumption of modern theory, showing that critical thinking is a learning outcome that requires reasoning, reflection, and dialogue with modern theory. The relationship between junior high school and 21st century skills shows that the research focuses on strengthening critical thinking skills at the secondary level within the framework of 21st century competencies. Critical thinking nodes form other clusters that overlap with digital literacy and scientific literacy, and are closely related to mathematical thinking skills, reflective, and assumption of modern theory. This pattern confirms that critical thinking skills are positioned as an important outcome of a learning process that demands mathematical reasoning, self-reflection, and dialogue with modern theory. The connection between critical thinking and junior high school and 21st century skills on the left side of the network indicates that a lot of research focuses on developing critical thinking skills at the junior secondary education level within the framework of 21st century skills

strengthening policies. Thus, the network map as a whole confirms that the three main domains of digital literacy, scientific literacy, and critical thinking are the main conceptual pillars that bind all research themes in the corpus studied. The network visualization is presented in Figure 5.

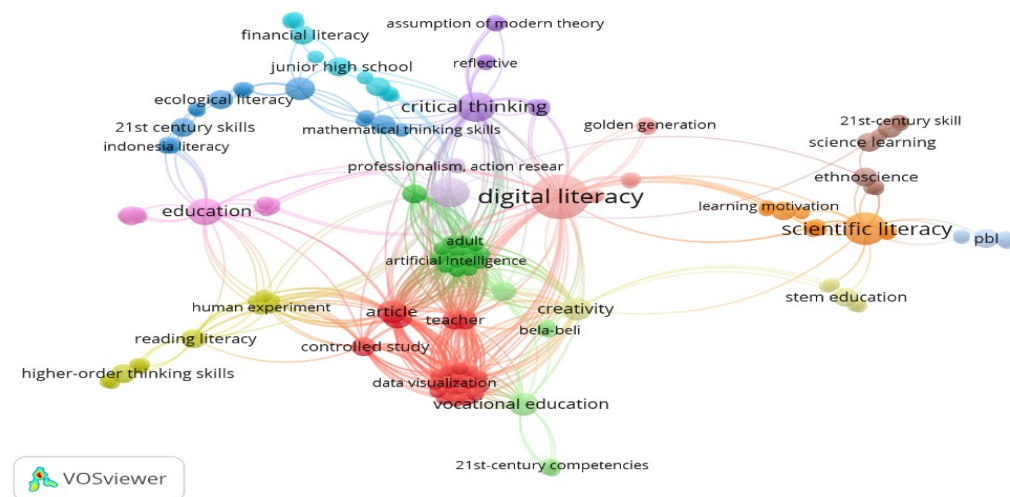


Figure 5. Network Visualization

Overlay Visualization

The overlay map gives a time dimension to the bibliometric analysis by grading the color from purple (initial period) to bright yellow (most recent period). From this visualization, it can be seen that terms such as PBL, human experiment, and assumption of modern theory appeared more dominant at the beginning of the study around 2020-2021, while the themes of digital literacy, vocational education, creativity, artificial intelligence, 21st century competencies, and several nodes related to scientific literacy strengthened in 2023-2025. This color shift marks the transition of research focus from learning model experiments to issues of technology integration, 21st century competence, and job readiness. This phenomenon is in line with changes in the global context marked by the acceleration of post-pandemic digital transformation and adjustments to national curriculum policies that emphasize literacy and competency development. The yellowing color patterns around digital literacy and artificial intelligence show the alignment between the analyzed research corpus and global trends that prioritize educational adaptation to digital disruption.

In addition to showing the dominant topics, the overlay also reveals when and in what context various research themes strengthen. The younger node colors in science learning, ethnoscience, STEM education, and learning motivation illustrate the trend of context-based science literacy and learning motivation that developed after 2022. On the other hand, topics such as education, 21st century skills, ecological literacy, and financial literacy seem to be present from the beginning but

continue to be strengthened through the Merdeka Learning policy and national literacy programs. Methodologically, the color shift from dark to light also shows a shift in research orientation from experiment-based studies to an approach that focuses on competence, contextual relevance, and the impact of technology integration. Thus, the overlay map not only records the evolution of the theme, but also confirms the repositioning of the educational research agenda in responding to

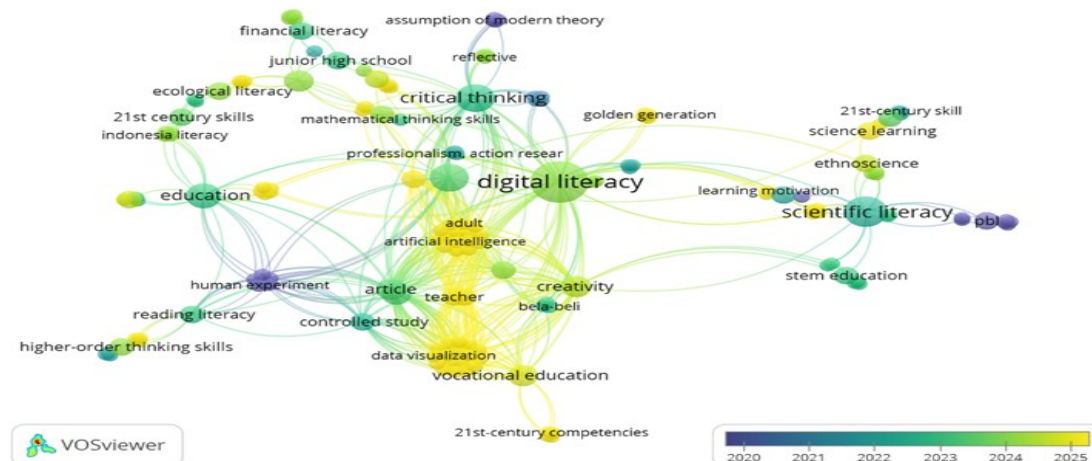


Figure 6. Overlay Visualization

Density Visualization

The density map shows that the focus of the most intensive research is in the bright yellow areas that mark high concentrations of keyword co-occurrence. The most dominant node is digital literacy, followed by scientific literacy and education, which affirm all three as core themes in the research corpus. These findings are in line with other bibliometric studies that show the dominance of digital and scientific literacy in 21st century educational discourse. High density is also seen in the clusters of vocational education, teachers, creativity, artificial intelligence, and data visualization, which indicates that literature is starting to move from normative discourse to an applicative approach related to the application of literacy in the context of vocational learning, creativity development, and digital technology integration. The presence of data visualization nodes confirms the increasing awareness of the importance of data analysis and visual representation in evaluating literacy achievements.

In contrast, terms such as higher order thinking skills, 21st century competencies, and golden generation occupy areas of moderate to low density, indicating that these themes are still less explored than digital and scientific literacy. This condition opens up new research opportunities to strengthen the study of high-level thinking skills, 21st century competencies, and character in relation to literacy. In practical terms, these results provide a direction for policy and

curriculum developers to place digital and scientific literacy as basic competencies across lessons while expanding space for the development of HOTS and 21st century skills. For teachers and education practitioners, these findings underscore the need for continuous training in project-based, STEM, and problem-based learning that leverages technology and AI to foster students' creativity, learning autonomy, and job readiness in the digital age. Density visualization can be seen in Figure 7.

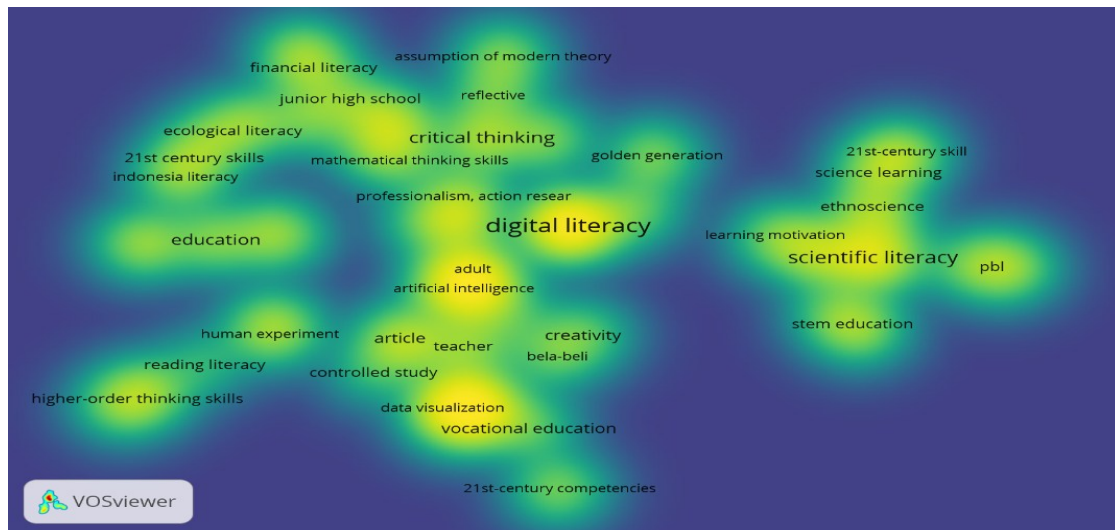


Figure 7. Density Visualization

Based on these three maps, it can be concluded that literature places digital literacy, scientific literacy, and critical thinking as the main foundation for 21st century skill development in the field of education, especially in vocational and secondary education. The close connection between this theme and creativity, learning motivation, and local context (ethnoscience) shows a shift from a learning approach that focuses only on knowledge transfer to learning that is oriented towards real problem-solving, technology use, and job readiness. In terms of education policy, this pattern indicates the need to strengthen a curriculum that explicitly integrates digital literacy and science with STEM projects, problem-based learning, and teacher training in the use of data visualization and artificial intelligence to support a more adaptive evaluation and learning process. In addition, the limited density on the theme of higher-order thinking skills and 21st century competencies opens up opportunities for further research and program development that directly measures and intervenes in students' high-level thinking competencies.

Literacy Construction in Curriculum and Policy

The construction of literacy as a 21st century competency in Indonesia reflects a fundamental paradigm shift that repositions literacy from a narrow basic skill into a multidimensional, strategic competency embedded across all levels of

the curriculum. The Merdeka Curriculum formally integrates six dimensions of literacy—reading-writing, numeracy, science, digital, financial, and cultural-civic literacy—as core competencies that must be developed holistically at every educational level, grounded in the recognition that Industry 4.0 and Society 5.0 demand individuals capable of critically processing complex information and adapting to rapidly evolving knowledge environments (Anggraini et al., 2026; Fauziah et al., 2025; Ibrohim et al., 2023; Rijal et al., 2025). At the policy level, the National Assessment (AKM) further reinforces this construction by replacing the National Exam with minimum competency assessments centered on reading literacy and numeracy, serving as a catalyst for schools to redesign learning strategies toward more contextual, reasoning-oriented, and problem-solving-based practices (Aka et al., 2025; Marmoah et al., 2022; Wahyudi et al., 2026). However, despite this conceptually robust policy construction, the analyzed literature consistently reveals a persistent gap between policy ideals and implementation realities, driven by limited teacher readiness, infrastructural disparities between urban and rural schools, and a student learning culture still largely oriented toward examination performance rather than deep literacy development (Beliyawati, Pahrudin, & Rahmi, 2025; Gustine et al., 2024; Hasanudin & Fitriyaningsih, 2020; Herlinawati et al., 2024).

Literacy Implementation in Islamic Educational Institutions

The implementation of literacy within Islamic educational institutions occupies a distinctive position in Indonesia's national literacy landscape, as literacy is not implemented as a standalone academic competency but is deeply integrated with the religious, moral, and civilizational mission of Islamic education, creating a unique intersection between 21st century competency development and the formation of students who are simultaneously religiously grounded, critically thinking, and digitally adaptive (Abdullah, 2024; Bahri et al., 2024; Kodrat et al., 2024). Religious literacy, Qur'anic literacy, and interfaith dialogue programs in Islamic schools serve as vehicles for strengthening cross-cultural understanding and civic engagement, while innovative learning models such as PjBL, inquiry-based learning, and STEM/STEAM integration are increasingly adopted to bridge the convergence between faith-based education and contemporary literacy demands, demonstrating that Islamic educational institutions are active agents in pedagogical innovation rather than passive recipients of curriculum mandates (Amir et al., 2019; Ibrohim et al., 2023; Supriadi et al., 2022). Nevertheless, persistent challenges including limited ICT infrastructure, uneven teacher professional competencies, and fragmented digital literacy integration—largely dependent on individual teacher initiative rather than institutionalized policy—indicate that realizing the full potential of literacy development in Islamic educational institutions requires a comprehensive strategy integrating policy support, targeted teacher professional development, and

pedagogical frameworks authentically aligned with the values and contextual realities of Islamic education in Indonesia (Aka et al., 2025; Herlinawati et al., 2024; Kadir et al., 2025; Rasdiana et al., 2024).

CONCLUSION

This study concludes that literacy as a 21st century competency has become a strategic issue in Indonesian education policy, especially through the implementation of the Independent Curriculum which places multidimensional literacy as the foundation for improving the quality of education. The findings of SLR and bibliometrics show the dominance of digital literacy and science literacy studies, a shift in focus from learning model experiments to technology integration, and the strengthening of vocational education themes, creativity, and artificial intelligence. However, there is still a gap between the construction of literacy in policy documents and learning practices in the field, especially related to teacher readiness, school ecosystem support, and meaningful use of technology. Therefore, it is necessary to strengthen implementation-oriented policies, continuous training for teachers, and the development of project-based, STEM, and problem-based learning models that integrate digital literacy, science, and other 21st century competencies. The results of this research are expected to be a strategic reference to formulate a further research agenda and design policy interventions that are able to encourage the Indonesian education system to become more adaptive, inclusive, and globally competitive.

Based on the findings of this study, future researchers are encouraged to expand the scope of bibliometric and systematic literature review studies on literacy by incorporating data from multiple databases such as Web of Science, ERIC, or Google Scholar to produce a more comprehensive mapping of the research landscape, and further research is recommended to examine literacy implementation at the level of specific educational units particularly in Islamic educational institutions using qualitative or mixed-methods approaches to capture contextual dynamics that quantitative studies may not fully reveal, as well as longitudinal studies to evaluate the long-term impact of the Merdeka Curriculum on students' multidimensional literacy development across different regions of Indonesia. For policymakers, curriculum developers, and educators, the findings of this study can serve as an evidence base in designing more targeted and adaptive literacy strengthening strategies, particularly in bridging the gap between curriculum policy ideals and classroom implementation realities, by integrating multidimensional literacy including digital, science, and critical thinking literacy into daily learning practices through innovative, student-centered models such as Project-Based Learning and STEM/STEAM approaches, while educational institutions at the regional level are also urged to invest in teacher professional

development and digital infrastructure to ensure that literacy-based learning can be implemented equitably and sustainably across all educational levels.

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