

Digital Competency Transformation of Elementary School Teachers in the Society 5.0 Era: A Systematic Literature Review

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ABSTRACT

Purpose - The Society 5.0 era has accelerated the integration of digital technology in education, requiring stronger digital competencies among teachers. However, the challenges faced by primary school teachers remain insufficiently synthesized in the existing literature. Therefore, this study aims to identify and analyze these challenges through a Systematic Literature Review (SLR).

Methodology - The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure a systematic and transparent selection process. A total of 43 articles (29 indexed in Scopus and 14 in SINTA) were selected from 1,256 publications published between 2020 and 2026 through the stages of identification, screening, eligibility, and inclusion. Quality assessment was done using a Critical Appraisal Skills Program (CASP) checklist adapted for educational research. NVivo 12 was used to manage and code the data for the 43 articles analyzed.

Findings - The findings reveal five major challenges: limited teachers' digital literacy, inadequate technological infrastructure, resistance to digitally based instructional change, excessive administrative workloads, and insufficient continuous professional development. These findings highlight the need for policies that strengthen teachers' digital competencies through ongoing professional training, improved infrastructure, digital-oriented curriculum development, and collaboration among governments, schools, and higher education institutions.

Contribution - This study provides evidence to support the development of inclusive, effective, and sustainable digital transformation policies in primary education.

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INTRODUCTION

Society 5.0, a concept introduced by the Japanese government, puts humans at the center of technology use. Unlike the Industry 4.0 Revolution, which focuses on automation and production efficiency, Society 5.0

integrates Artificial Intelligence (AI), the Internet of Things (IoT), big data, and robotics to solve social problems while improving people's quality of life (Abd-Rabo & Hashaikh, 2021).

Conceptually, digital transformation needs to be distinguished from just digitization (converting analog data to digital format) or digitalization (automating processes using digital technology), because digital transformation involves fundamental changes in strategy, business models, processes, organizational structure, and even work culture in an institution, including educational institutions (Mahraz et al., 2019).

This shift in paradigm requires teachers to act not just as material presenters, but as facilitators, innovators, and guides who can use digital technology effectively (Ambarwati et al., 2021). This is also emphasized by (Mayouche, 2026), who found that digital transformation changes teachers' roles into facilitators, mentors, and learning managers who integrate digital tools to boost engagement, personalize learning, and support students at risk of academic failure. This phenomenon is global, as shown by the experiences of various countries accelerating education digitalization in response to the COVID-19 pandemic crisis, including Saudi Arabia (Alghamdi, 2022) and Italy through the *Riconnessioni* project (Demartini et al., 2020), which emphasizes the global crisis as a key catalyst for accelerating the digitalization of education worldwide.

In Indonesia, this change is still propelled by the Merdeka Belajar policy, which focuses on incorporating digital technology across all education levels, including elementary school. However, the urgency of this transition is underscored by critical empirical gaps in teachers' actual digital readiness. Nationally, the digital technology proficiency of elementary school teachers remains highly uneven, with the majority stuck at a basic operational level and only a small fraction demonstrating medium-to-high competence (Bentri et al., 2022). For instance, a detailed diagnostic study of 70 elementary school teachers revealed that while 64% were highly capable of basic word processing and 73% in internet browsing, their abilities plummeted when tasked with advanced pedagogical integrations: only 30% could design audio-video media, digital assessments, or gamified learning, while 44% were completely incapable (Syahid et al., 2022). Furthermore, actual technology implementation remains low, with 16% of teachers never using digital devices in their instruction, and 31% doing so only occasionally (Syahid et al., 2022). This competence deficit has a direct cascading effect on students, given that empirical evidence shows a powerful correlation ($r = 0.804$) between a teacher's ICT skills and their students' digital literacy (T et al., 2022). This human resource gap is compounded by severe infrastructural disparities, where up to 70% of teachers in remote locations experience constant internet instability, and 50% face completely inadequate school facilities (Abroto et al., 2021). Failing to prepare elementary school teachers for the demands of Society 5.0 risks widening the gap in basic education quality between regions, particularly between Java and outside Java, as well as between public and private institutions (Bentri et al., 2022).

Several previous studies have investigated isolated dimensions of digital integration in elementary schools. For example, researchers have documented specific regional skill disparities (Syahid et al., 2022), evaluated localized one-semester training interventions (Munawaroh et al., 2022), or analyzed the lack of explicit digital standards in the national competency framework (Bentri et al., 2022). While these studies offer valuable insights, they suffer from significant limitations that reduce their theoretical and practical utility. First, they are predominantly localized, context-specific case studies centered on individual school districts or regions, making their findings difficult to generalize. Second, existing literature remains highly fragmented, treating challenges—such as infrastructural deficits, pedagogical resistance, and administrative burdens—as isolated problems rather than as interacting components of a broader socio-technical ecosystem.

Beyond these single-context primary studies, a small number of systematic reviews and bibliometric syntheses have already attempted to map teachers' digital competence, and each carries limitations that keep the present gap open. Ibda (2023) reviewed Scopus-indexed publications on elementary teachers' digital literacy using NVivo-based thematic coding. Still, the analysis remained at a descriptive, thematic-mapping level and did not engage with the Society 5.0/AI-transformation agenda, which has intensified since 2023. Wijayanti et al. (2024) reviewed post-COVID digital literacy in primary schools through Scopus, ScienceDirect, and ERIC—three predominantly Western-indexed databases that exclude nationally accredited Indonesian (SINTA) outlets, limiting the visibility of Southeast Asian evidence. Alférez-Pastor et

al. (2023) synthesized only 13 studies on primary-teacher digital-competence training from SCOPUS and Web of Science. Still, their unit of analysis was pre-service rather than in-service teachers, a population with markedly different institutional constraints. Li et al. (2023) reviewed digital competence across the entire K-12 span in China. This cross-level scope dissolves the distinctive characteristics of elementary-level teachers into a broader, more heterogeneous category. Most recently, Ma and Ismail (2025) combined a bibliometric analysis and a systematic review of digital competence in education, drawing on the Web of Science; they explicitly note that more than 60% of prior reviews on this theme mix early childhood, primary, secondary, and higher education populations, obscuring level-specific findings. Taken together, these reviews confirm that synthesis work already exists, but none of them is simultaneously (a) limited to in-service elementary school teachers, (b) grounded in SINTA-indexed literature alongside Scopus to represent the Indonesian and wider Southeast Asian context, (c) current through the 2020–2026 period in which Society 5.0 discourse and generative-AI adoption accelerated, and (d) organized around Society 5.0 as an explicit analytical lens rather than a contextual label.

The gap, therefore, is not the absence of synthesis work per se, but the absence of a synthesis that is simultaneously specific to in-service elementary school teachers, grounded in SINTA-indexed Indonesian literature alongside Scopus, current enough to capture the 2020–2026 acceleration of Society 5.0 and AI-related discourse, and organized around Society 5.0 as an explicit analytical lens rather than a contextual label. Concretely, because Society 5.0 is human-centered and built on the integration of AI, IoT, and big data, this review treats it not merely as a backdrop but as a set of three analytical criteria against which teachers' challenges are classified: (i) pedagogical readiness to work alongside AI-supported instruction, (ii) data literacy and data ethics, and (iii) the extent to which teachers have shifted from material presenters toward facilitators. To resolve the identified gap, this study conducts a Systematic Literature Review (SLR) using the rigorous PRISMA 2020 framework. By synthesizing 43 peer-reviewed articles from Scopus and SINTA databases, this study goes beyond descriptive thematic mapping to construct an integrated, multi-level taxonomy of challenges assessed against these three Society 5.0-derived criteria, which none of the reviews mapped above have applied. This synthesis provides the context-specific, evidence-based foundation that neither localized primary studies nor cross-level or cross-national reviews can offer, serving as a strategic roadmap for policy formulation and targeted professional development.

From this description, this study aims to identify, analyze, and synthesize previous research findings related to the challenges of using digital technology by elementary school teachers in the era of Society 5.0, using the three Society 5.0-derived criteria outlined above—pedagogical readiness for AI-supported instruction, data literacy and ethics, and the shift toward a facilitator role—as the analytical lens through which the identified challenges are classified and interpreted. Specifically, this study focuses on answering the following three research questions (RQs):

RQ1: What are the main challenge categories that elementary school teachers face in using digital technology in the Society 5.0 era?

RQ2: What factor most dominantly affects elementary school teachers' ability to apply digital technology in learning?

RQ3: What strategies and interventions have been proven effective in overcoming the challenges of using digital technology for elementary school teachers?

METHODOLOGY

Research Design: Systematic Literature Review

This study uses the Systematic Literature Review (SLR) method to identify, evaluate, and synthesize research on the challenges faced by elementary school teachers in using digital technology in the Society 5.0 era, as it has the potential to yield a more systematic, objective, and reproducible synthesis of evidence. Its implementation follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines to ensure transparency at every stage, from the literature search to the synthesis of results.

Literature Search Strategy

Literature identification was carried out using two scientific databases, namely SINTA (Science and Technology Index) and Scopus, chosen for their coverage of publications relevant to the field of education and their peer-reviewed status. The articles analyzed were published from January 2020 to June 2026 to capture the development of research since the emergence of the Society 5.0 concept. The search used a combination of keywords with the Boolean AND/OR operators:

("teacher challenges" OR "*tantangan guru*") AND ("digital technology" OR "*teknologi digital*") AND ("elementary school" OR "*sekolah dasar*") AND ("Society 5.0" OR "digital transformation" OR "transformasi digital")

Inclusion and Exclusion Criteria

Inclusion criteria: (1) articles published between 2020 and 2026; (2) studies on teachers' challenges in using digital technology in the context of elementary schools; (3) indexed in SINTA 1-3 or Scopus Q1-Q4; (4) using a clear research method; (5) available in full text. Exclusion criteria: (1) no empirical data; (2) editorials/opinions/short notes; (3) discussing levels other than elementary school exclusively; (4) suspected duplicate findings.

Article Selection Process (PRISMA Diagram)

Selection refers to the PRISMA 2020 flow, which consists of four stages: identification, screening, eligibility, and inclusion. The identification stage found 1,256 articles, which dropped to 1,176 after removing duplicates. Screening the titles and abstracts yielded 299 relevant articles, and the full-text review identified 43 articles that met all requirements as the main data sources for this study.

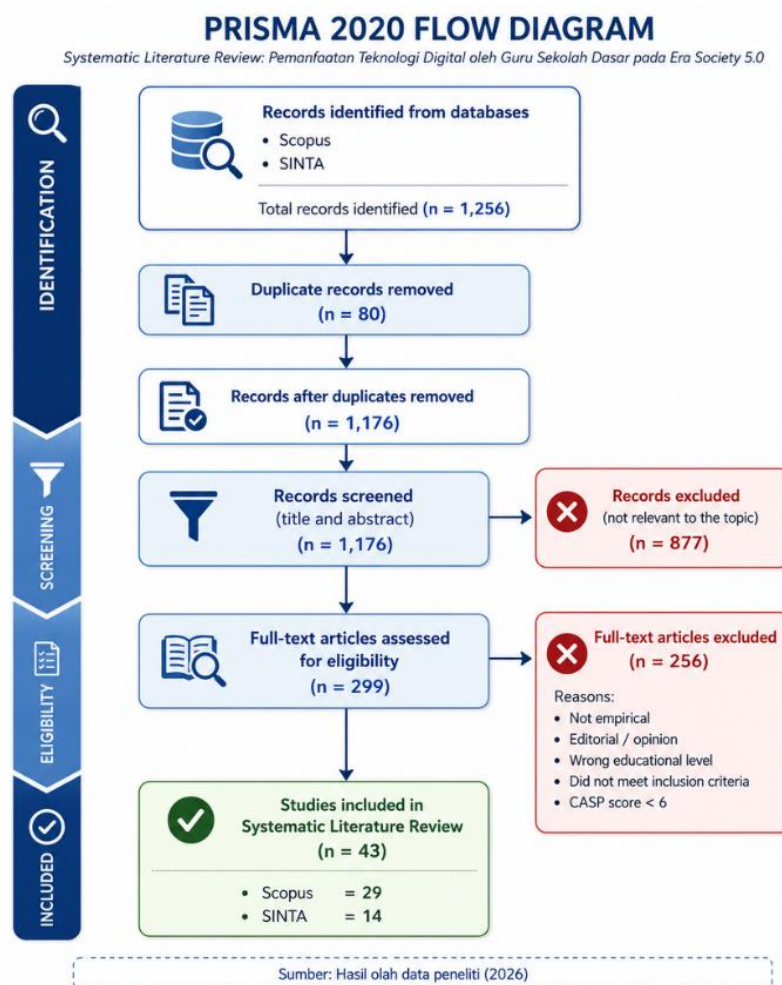


Figure 1. Research Design Flow

Table 1. Summary of Article Selection Process (PRISMA)

Stage	Information	Number of Articles
Identification (SINTA + Scopus)	Database search	1.256
After deduplication	Removing duplicate articles	80
Screening (title & abstract)	Not relevant to the research topic	877 excluded
Full text assessment	Does not meet the inclusion criteria	256 excluded
Corpus Final	Articles included in the SLR	43

Source: Researcher's data processing results (2026)

Study Quality Assessment

Quality assessment was conducted using a Critical Appraisal Skills Program (CASP) checklist adapted for educational research, covering 10 criteria, including clarity of objectives, appropriateness of methods, data validity, reliability of results, and the article's contribution to knowledge development. Articles scoring below 6/10 were eliminated. Out of 299 articles considered for eligibility, 256 were removed – some for not meeting the minimum CASP score, others for not meeting inclusion criteria – leaving 43 articles as the final corpus. The review was conducted independently by two researchers, and any differences were resolved through discussion until consensus was reached.

Data Synthesis Techniques

Data synthesis was conducted using a thematic synthesis approach developed by Thomas and Harden (2008), which comprises three stages: open coding, developing descriptive themes across studies, and developing analytical themes that yield new interpretations. NVivo 12 was used to manage and code the data for the 43 articles analyzed.

FINDINGS

Characteristics of the Included Studies

A total of 43 articles that met the inclusion criteria were analyzed in this study. Most of them came from international journals indexed in Scopus Q1-Q4 (29 articles, 67.4%), while 14 articles (32.6%) came from nationally accredited SINTA 1-3 journals. The number of studies on the use of digital technology by elementary school teachers increased significantly from 2020 to 2026, especially after the COVID-19 pandemic, which accelerated technology-based learning. In terms of approach, qualitative research dominated (47%), followed by quantitative (35%) and mixed methods (18%).

Table 2. Characteristics of Studies Included in the SLR

Characteristics	Category	Amount (n=43)/ %
Journal Indexing	SINTA 1-2	14 (32,6%)
	Scopus	29 (67,4%)
Publication Year	2020–2022	23 (53,5%)
	2023–2026	20 (46,5%)
Research Method	Qualitative	19 (44%)
	Quantitative	9 (21%)
	Mixed	10 (23%)
	SLR	5 (12%)
Geographical Context	Java	10 (23%)
	Outside of Java	3 (7%)
	International	30 (70%)
Focus Level	Public Elementary School	8 (19%)
	Private Elementary School	2 (5%)
	Not Specified	33 (76%)

Source: Results of SLR analysis (2026)

The Main Challenges for Elementary School Teachers in Using Digital Technology

The five challenges below are read through the three Society 5.0-derived criteria introduced earlier. Most of the evidence under (a) and (b) reflects unresolved operational and infrastructural readiness—still short of the pedagogical readiness for AI-supported instruction that Society 5.0 requires; (c) and (e) speak most directly to the facilitator-role shift; and, notably, almost none of the 43 studies report findings specific to data literacy or data ethics, indicating that this criterion remains empirically unaddressed in the Indonesian elementary-level literature.

Digital Literacy Skills That Are Not Evenly Spread

Digital literacy skills are the most important challenge, identified by 27 out of 43 articles (63%). Most elementary school teachers can already use basic software such as word processors and presentation tools, but they have not yet mastered more complex learning technologies. This gap was confirmed by (Syahid et al., 2022). Among 70 elementary school teachers, only 44% were very capable of operating computer applications for teaching, 29% were capable, and 27% were not capable; in terms of usage intensity, 53% of teachers used digital devices every time they taught, 31% occasionally, and 16% never used them at all (see Figure 2).

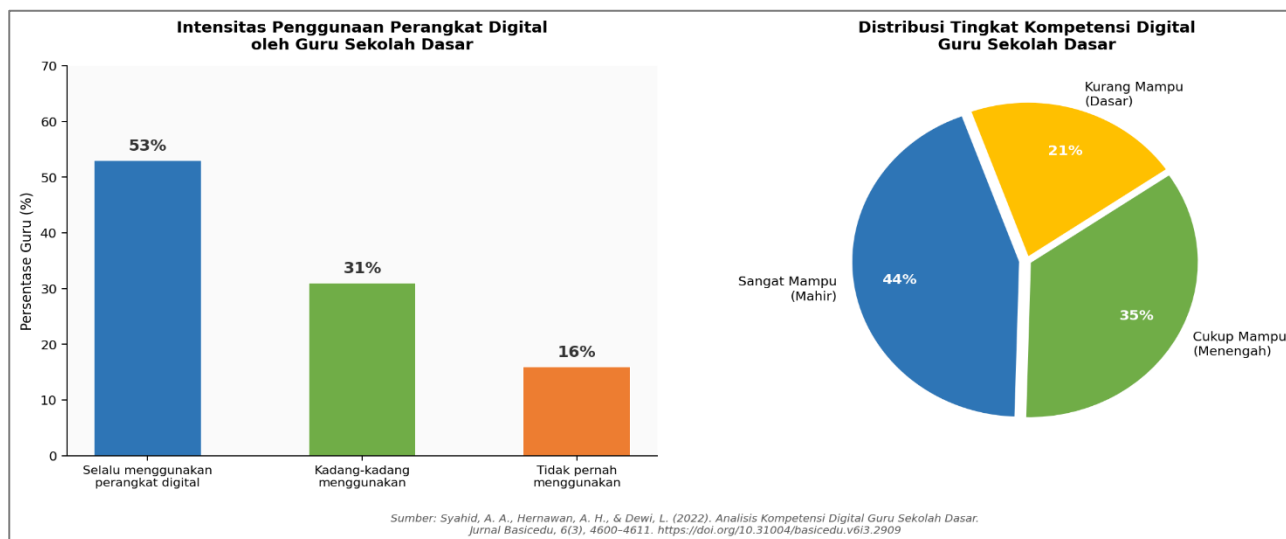


Figure 2. Distribution of Digital Competency Levels and the Intensity of Digital Device Use Among Elementary School Teachers (Syahid, A. A., Hernawan, A. H., & Dewi, L. (2022)

Out of the eight categories of digital applications studied, teachers are relatively good at basic word processing apps (64% very capable) and internet browsing (73% very capable). Still, their skills drop sharply with more complex applications: creating audio-video media, digital assessment tools, and gamification, each only mastered by 30% of teachers at a very capable level, while 44% say they are not capable (Syahid et al., 2022). This situation highlights a tiered gap: proficient with basic functions, but limited in more innovative and pedagogical uses.

In line with that, (Aini & Nuro, 2023) found that at SD Negeri 6 Tumpang, digital literacy among teachers is considered good in six indicators: variety of digital teaching materials, use of digital-themed books, technology-based learning activities, presentation of school information, use of technology in the school environment, and implementation of technology in school services, even though the intensity of using digital teaching materials is still low and the age of teachers remains a challenge for some educators. The significance of teachers' digital literacy competence on student achievement is also confirmed (T et al., 2022). In a survey of 53 upper-grade elementary school teachers, they found a strong positive relationship between teachers' ICT skills and students' digital literacy ($r = 0.804$), as well as between teachers' performance and students' digital literacy ($r = 0.634$).

A similar pattern has been identified in the public administration sector, where low digital literacy

among the workforce and the lack of structured mandatory training are the main barriers to organizational digital transformation, making tiered and continuous digital literacy the key to success (Momand & Vranić, 2025). In a crisis context, research on science and math teachers in Ukraine during the war found that only 25% of teachers rated their digital competence as high, while the majority fell into the medium category, although digitalization still positively impacted the quality of learning as long as it was accompanied by ongoing digital literacy improvement (Vorotnykova et al., 2023).

Technology Infrastructure Limitations

The limitations of technology infrastructure were identified by 25 articles (58%) as the main challenge, especially in rural areas, islands, and the 3T regions. Many schools still lack reliable internet access, and even those that do often experience unstable connections, making digital learning difficult. A similar issue has been reported in the digitization of Higher Order Thinking Skills (HOTS) assessments in Indonesian elementary schools, where limited internet access, lack of hardware, and the absence of standardized digital media have hindered the implementation of project-based and digital simulation assessments (Nugroho et al., 2025). Similar connectivity challenges also appear in distance education in other developing countries, where unstable connections, high access costs, and low confidence in using technology become major obstacles for both teachers and students during the pandemic (Noreen & Reid, 2021).

A study (Abroto et al., 2021) At SDN 79/VII Kasiro Batang Asai, Kasiro Batang Asai found that 70% of teachers experienced internet instability and 50% faced limited school facilities, while some students did not have smartphones. Similar conditions at SDN Palumbonsari III led teachers to rely entirely on WhatsApp and YouTube for online learning because they were the easiest to access (Ds et al., 2022).

Developing countries do not just experience infrastructure issues: a systematic study of inclusive digitalization in special education in Europe confirms that digital gaps, budget limitations, and resistance to change remain obstacles even though the infrastructure is relatively advanced (Damyanov & Zamfirov, 2026). On the other hand, massive government investment in Saudi Arabia, including allocating nearly 19% of the national budget for education in 2020, was able to accelerate the national online learning transition during the pandemic (Alghamdi, 2022). This shows that the success of digital infrastructure depends on policy commitment, not just economic progress.

Similar findings were reported in South Africa, where unequal access, limited funding, lack of digital skills, and the absence of an integrated national strategy are the main obstacles to digitalizing education (Mhlanga, 2020), as well as in Nigeria, where the rapid pace of technological change, regional infrastructure disparities, high digital literacy demands, and teacher resistance are major challenges that require continuous professional development, mentorship, digital tools, and adequate policy support (Ibironke & Jayeola, 2025). Comparable challenges are also found in implementing artificial intelligence for learning English as a second language in Nigeria, where limited digital infrastructure, lack of teacher training, and linguistic-cultural diversity are the main barriers to using AI optimally, so investments in digital infrastructure, teacher training programs, and ethical data practices are recommended as priority steps (Ahmed, 2024). A study on teachers' readiness in services (in-service teachers) in Nigeria also revealed that even though most already have basic digital skills, the gap in advanced competencies like creating digital content and collaborative online learning is still significant, worsened by inadequate training and the urban-rural infrastructure divide (Apata et al., 2025).

A survey of science and math teachers in Ukraine during the war found that about 20% of teachers lacked internet access at school and 25% lacked work computers. At the same time, power outages and unstable networks were the most commonly reported technical issues (Vorotnykova et al., 2023).

Resistance to Changes in Learning Paradigms

A total of 17 studies (39%) identified resistance to change as a major challenge, influenced by low confidence in using technology, fear of making mistakes, and insecurity about changes in their role as educators. Some teachers still believe that conventional face-to-face learning is more effective for elementary students, and some parents also see digital learning as less suitable for school-aged children.

At the university level, educators' skeptical attitudes toward online learning can change significantly due to institutional policy pressures. However, this change is driven more by compliance than by voluntary belief (Alhawsawi et al., 2023)—indicating that teacher resistance is dynamic and can shift in response to policy pressure or direct experience. The COVID-19 pandemic was a pivotal moment that accelerated this paradigm shift, as reflected in the study by Wijaya et al. (on elementary students' self-regulated learning in Indonesia). Research found that video-based learning using dynamic mathematics software can support independent learning at home, with female students demonstrating better self-regulated learning than male students. A review of digital learning transformation in Romania also confirmed that the COVID-19 pandemic forced educational institutions to adopt various online models suddenly, without adequate preparedness, leaving debates about the effectiveness of digital learning compared to face-to-face learning and questions about the readiness of teachers and supporting infrastructure in the post-pandemic period (Sipică & Toma, 2022).

Similar patterns of resistance are found outside the formal education sector: a study of 30 cultural experts and practitioners in Ukraine found that 50% of participants emphasized the importance of balancing digital-traditional practices due to concerns about losing direct sensory experiences, while 61% indicated the need for ongoing training to integrate technology confidently (Koshelieva et al., 2023). Similar forms of resistance have also been identified in remote foreign language teaching, where teachers are required to adapt to new digital platforms that take extra time and effort, while learners are expected to have higher self-discipline and time management compared to face-to-face learning (Visvizi et al., 2023). Studies on distance English learning also highlight that teachers need extra time and effort to master various digital tools and platforms, as well as give additional attention when supporting students remotely. On the other hand, this situation encourages teachers to develop professional skills, flexibility, and intercultural competence through experimenting with interactive platform-based teaching methods (Yuliia, 2024).

High Administrative Workload

Out of 43 articles, 5 (12%) highlighted the high administrative burden that limits teachers' opportunities to develop digital skills. Teachers' roles are not just about classroom teaching—they also involve preparing learning materials, academic reports, assessment documentation, and other school administration tasks, which reduces the time they have to learn new technology. The implementation of the Merdeka Curriculum adds to this complexity, as most administrative processes have shifted to digital systems. So even though it aims to improve efficiency, many teachers are still adapting on their own and feel increasingly burdened, which could lead to burnout and slow the school's digital transformation. This phenomenon aligns with studies on digital transformation in educational management that identify a 'hardware-heavy, software-light' trend, meaning there is too much focus on investing in hardware without accompanying reforms in data governance and administrative processes. As a result, digitalization without reworking workflows can actually end up making things harder, not easier, for educators (Mao et al., 2025).

Lack of Continuing Professional Development Programs

As many as 26 of 43 articles (60%) stated that Continuing Professional Development (CPD) programs remain incidental, typically short seminars or workshops, and thus do not provide opportunities for continuous practice, with the knowledge gained often not implemented optimally.

On the other hand, continuous professional development has been shown to deliver much better results (Munawaroh et al., 2022). The international DigiTransfEd forum emphasizes that teacher training is effective when it is designed to be ongoing, involves collaboration among educators, and is backed by consistent institutional policies (Osadchyi et al., 2023). The step-by-step training model in Ukraine includes technology introduction, skill development, mastering online pedagogy, and psychological well-being support, showing a significant difference in advanced competency achievements compared to the control group ($\chi^2 = 31.22$; $p < 0.01$), proving that tiered training has a bigger impact than short, incidental training (Andriichuk et al., 2024).

The readiness to master technology needs to be built from the teacher candidate's education period: research on 60 Elementary School Teacher Education students showed their technological knowledge was

already good, with an average score of 84 (Mustika et al., 2022), emphasizing the importance of CPD that also targets the pre-service level. An experiment with 80 education students in Kyrgyzstan showed that the group learning through digital platforms (Google Classroom, Moodle, Zoom), along with interactive methods, experienced a 25-30% increase in learning achievement compared to the conventional group, with four technology principles—hierarchical, feedback, adaptive, and integrative—as additional references for designing CPD (Sulaimanova & ..., 2025). Comparable findings were reported from a survey of 243 math teachers in Jordan, showing that the lack of training in using digital transformation tools and difficulties in integrating them into the curriculum were the most prominent challenges, making the provision of integrated infrastructure and regular training the main recommendation from math teachers to optimize the benefits of collaboration, understanding, and student engagement offered by these tools (Ghunaimat, 2026).

Table 3. Frequency Distribution of Challenges Faced by Elementary School Teachers in the Analyzed Literature

No.	Challenge Category	Freq (n=43)	Percentage	Rank
1	Digital literacy skills that are not evenly spread	27	63%	1
2	Lack of ongoing professional development programs	26	60%	2
3	Limited technology infrastructure	25	58%	3
4	Resistance to changes in the learning paradigm	17	39%	4
5	School's budget limitations for technology	13	30%	5
6	Lack of support from the school principal	11	26%	6
7	High administrative workload	5	12%	7

Source: Results of SLR analysis (2026)

Dominant Factors That Affect Digital Technology Adoption by Elementary School Teachers

Synthesis shows that a teacher's success in adopting digital technology is influenced by three groups of factors: individual, institutional, and systemic.

Individual Factors

It relates to teachers' personal characteristics, such as their level of confidence (digital self-efficacy), motivation to learn, readiness to accept change, and willingness to develop competencies independently. Teachers with high self-efficacy usually adapt more quickly to new technology, while those with negative perceptions tend to adopt it less because they feel technology adds to their workload.

Institutional Factors

This includes school support, especially the principal's leadership, organizational culture, and the availability of facilities. Schools with visionary leadership can usually create a work environment that supports learning innovation (Hasanah et al., 2022). A less supportive environment makes teachers stick to conventional methods even when technology is available.

Systemic Factors

It covers government policies, the national training system, curriculum, and even the equal distribution of infrastructure. Misalignment between policy demands and the readiness of resources on the ground is often the primary reason for low implementation of digital technologies. A similar pattern is found in education in mainland China, where large class sizes and an exam-oriented education culture are major systemic factors that hinder technology-based personalized learning (Vervoort et al., 2024)—Highlighting that systemic barriers cross countries and require interventions at the structural level, not just at the level of individual teachers or schools.

DISCUSSION

As demonstrated by the empirical breakdown of elementary school teachers' competencies, there is a clear hierarchical disparity in their digital proficiency. Teachers possess high operational capability in basic applications, such as word processing (64% very capable) and web browsing (73% very capable), yet their skills plummet to just 30% when tasked with advanced pedagogical integrations, including creating interactive audio-video media, using digital assessment tools, or employing gamified learning platforms (Syahid et al., 2022).

These findings align with Mishra and Koehler's (2006) Technological Pedagogical Content Knowledge (TPACK) framework, which emphasizes that successful technology integration occurs only when teachers master technology, pedagogy, and content knowledge holistically, not merely the technical aspects. Strengthening this pedagogical foundation is also supported by studies stating that enhancing students' critical and creative thinking, instilling values and character, and fully applying TPACK are crucial (Purwinarti et al., 2025). This perspective is in line with studies on the digital transformation of learning organizations, which emphasize that the success of digital transformation in educational institutions does not just depend on the availability of technology, but also on changes in organizational culture, leadership, and the ongoing learning capacity of all members (Ifenthaler et al., 2021).

This understanding is enriched by the perspective of service ecosystems, which views digital education as a network of interactions at three levels: micro (individual attitudes and readiness), meso (interactions between actors through technology), and macro (norms, policies, and institutional digital culture) (Visvizi et al., 2023)—strengthening the argument that the success of digital transformation in basic education depends on the alignment of changes at all three levels simultaneously, in line with findings that individual, institutional, and systemic factors influence each other. In the context of Society 5.0, technology should be positioned as a tool to support teachers' professional tasks, not as an extra burden. So, digital transformation policies need to be designed with a human-centered approach—systems that are easy to use, provide ongoing support, and provide equal access to technology. A similar point comes from a study on digital transformation in Russian elementary schools, which distinguishes external digitalization (providing internet access and digital learning resources) from internal digitalization (strengthening computational and algorithmic literacy in the curriculum). It also emphasizes that face-to-face interaction between teachers and students remains irreplaceable by computers at the elementary level (Bosova et al., 2021).

Read against the distinction drawn in the Introduction, most of the practices documented across the 43 studies still sit at the level of digitization or, at best, digitalization, not digital transformation. Converting printed materials into PDFs or videos, delivering instruction through WhatsApp and Zoom, and computerizing administrative records (Aini & Nuro, 2023; Syahid et al., 2022) are examples of digitization: analog content and processes rendered digital without changing how teaching decisions are made. A smaller subset shows digitalization, where digital tools begin to automate existing workflows—for instance, digital assessment platforms or interactive media replacing paper-based routines (Heryani et al., 2022; Nugraha, 2022)—yet pedagogical roles, curriculum structure, and institutional decision-making remain largely unchanged. Genuine digital transformation, marked by a redesigned facilitator role and AI- or data-informed pedagogical decision-making consistent with the Society 5.0 criteria applied in this review, appears only in isolated cases involving sustained, multi-tiered professional-development programs (Demartini et al., 2020; Silveira et al., 2022) and is largely absent from the Indonesian elementary-level literature reviewed here. This distinction carries a direct policy implication: interventions that only digitize—distributing devices or converting materials—will not, by themselves, produce the pedagogical and role shifts that Society 5.0 demands.

A critical limitation of previous research is the tendency to homogenize elementary school teachers' experiences, overlooking how digital challenges vary across geographic, regional, and institutional contexts. The SLR reveals a distinct divide between developing and developed nations. In developing economies such as Indonesia, South Africa, and Nigeria, teachers face a dual-layered crisis of survival: they must simultaneously battle severe infrastructural deficits—such as a complete lack of hardware, unstable

electricity, and high connectivity costs – while coping with a widespread lack of basic digital literacy (Apata et al., 2025; Noreen & Reid, 2021). Conversely, in developed European contexts, the challenges are fundamentally pedagogical and institutional rather than infrastructural (Damyanov & Zamfirov, 2026). In countries with advanced digital infrastructure, the primary struggles center on navigating teacher resistance to changing roles, addressing the digital divide within special education, and maintaining a critical balance between digital tools and traditional sensory-rich educational practices to avoid losing direct experiential learning (Koshelieva et al., 2023; Sipică & Toma, 2022). A unique macro-level context is observed in war-torn environments like Ukraine, where the physical destruction of schools, power outages, and a lack of basic teaching computers pose extreme barriers (Vorotnykova et al., 2023). Yet, evidence shows that structured, multi-tiered digital professional development that addresses both technical pedagogy and teachers' psychological well-being can build remarkable resilience, showing that human-centered support can sustain digital transformation even amidst physical collapse (Andriichuk et al., 2024).

Within the national borders of Indonesia, the digital transformation is characterized by a stark "digital apartheid" between urban centers in Java and rural or remote regions, particularly the Underdeveloped, Frontier, and Remote (3T) areas (Abroto et al., 2021). Urban and Javanese schools benefit from relatively stable internet connectivity and proximity to academic and training centers, where their primary struggles relate to administrative overload and pedagogical adaptation (Aini & Nuro, 2023). In sharp contrast, teachers in remote regions like SDN 79/VII Kasiro Batang Asai face a harsh reality where 70% experience constant internet instability and 50% work in schools with completely inadequate physical facilities (Abroto et al., 2021). Consequently, while urban teachers can leverage advanced learning management systems (Moodle, Zoom), remote teachers are forced to rely on rudimentary communication tools like WhatsApp and YouTube, which restrict their pedagogical options and severely limit the depth of digital learning (Ds et al., 2022).

The challenges also diverge significantly between public and private elementary school typologies. Public schools (SD Negeri) are subject to rigid bureaucratic control, massive administrative reporting burdens, and a wider age gap among tenured teachers, which collectively breed inertia and pedagogical resistance (Aini & Nuro, 2023). Public schools are also heavily dependent on slow-moving government procurement cycles for infrastructure upgrades. In contrast, private elementary schools (SD Swasta) often possess greater administrative flexibility and parental financial backing, enabling faster adoption of specialized digital platforms and interactive curricula. However, private schools face a stark internal divide: elite private schools operate with cutting-edge technology, while lower-income, community-funded private schools suffer from extreme budget limitations, making them even more vulnerable to technology-induced disruptions than public schools (Bentri et al., 2022).

The findings of this SLR demonstrate that the five identified challenges (digital literacy, infrastructure, resistance, workload, and CPD) are not isolated, standalone obstacles. Instead, they operate as a highly interconnected, self-reinforcing causal network that traps elementary school teachers in a vicious cycle of digital disenfranchisement.

The relationship between technological infrastructure and teacher resistance is directly mediated by digital self-efficacy. When a teacher with low or uneven digital skills attempts to conduct a digital lesson but is repeatedly thwarted by unstable internet or malfunctioning school hardware (Abroto et al., 2021; Nugroho et al., 2025), the lesson inevitably fails in real time. This public classroom failure severely damages the teacher's professional confidence and digital self-efficacy (Vorotnykova et al., 2023). To protect their professional identity and avoid future embarrassment, the teacher develops a psychological defense mechanism: active pedagogical resistance. They internalize the belief that conventional, face-to-face, text-centered learning is inherently superior and safer for young children (Alhawsawi et al., 2023). Thus, infrastructural deficits are a direct root cause of teacher resistance, transforming technical failures into permanent psychological barriers.

The lack of ongoing, structured professional development (CPD) programs directly contributes to the failure of classroom technology integration. When CPD is delivered as short, incidental, one-off seminars or workshops, it only teaches basic technical operations (how to turn on a device or navigate a software

interface) but completely omits pedagogical training (how to design a collaborative, technology-supported lesson (Munawaroh et al., 2022; Osadchyi et al., 2023). This leaves teachers with a highly fragmented understanding of digital tools, one that is completely devoid of the TPACK framework. Once they return to their classrooms and encounter minor technical or pedagogical hiccups, they lack the troubleshooting capability or pedagogical framework to adapt. Consequently, they immediately revert to traditional, text-centered, teacher-directed teaching methods (Heryani et al., 2022).

One of the most critical and non-obvious causal relationships uncovered in this study is how the digitization of school administration actively sabotages pedagogical digital transformation. The implementation of new national curricula, such as the Merdeka Curriculum in Indonesia, has shifted most teacher reporting, student grading, and lesson planning into digital databases (Mao et al., 2025). Rather than reducing workloads, this transition has created a severe administrative burden because teachers are forced to learn and navigate complex, often unoptimized administrative platforms without adequate training or technical support. This administrative overload consumes virtually all of the teachers' limited cognitive bandwidth and preparation time. As a result, teachers are left with zero time or energy to engage in professional development, practice new digital applications, or design innovative digital learning media (such as gamified assessments or motion graphics) (Syahid et al., 2022). In essence, teachers are "digitally active" when filling out administrative forms but "digitally stagnant" in their classroom teaching, demonstrating how administrative digitization directly stifles pedagogical innovation.

Some strategies are considered effective in boosting primary school teachers' use of digital technology. First, community-based training through Teacher Working Groups (KKG) allows teachers to share experiences and practice technology according to their school's needs. Second, digital mentoring programs, where more skilled teachers continuously guide their peers, are more effective than one-off training sessions.

The Riconnessioni project in Italy demonstrated the effectiveness of tiered mentoring through a cascade training strategy: each trained teacher could reach up to 16 colleagues, far exceeding the target of 10 teachers per mentor, showing that this model can efficiently expand the impact of digital skills improvement (Demartini et al., 2020). The presence of institutional digital platforms that were built before the crisis also sped up adaptation: the Universidade São Paulo learning video platform, available since 2012, supported the surge in online learning needs during the pandemic, while also promoting the adoption of new methodologies like flipped classrooms and blended learning that remain relevant post-crisis (Silveira et al., 2022).

The development of innovative digital learning media has also proven effective: motion graphic-based video media for Deepening Elementary Social Studies Material was deemed feasible and effective through expert validation (Nugraha, 2022), while digital literacy-based Pop Up Book media has been shown to significantly improve second-grade students' storytelling and reading skills with a high effect size (1.355) compared to conventional learning (Yahzunka & Astuti, 2022). Along the same lines, using technology-based media in upper elementary social studies, such as interactive animations, multimedia, audio-visuals, and infographics, has been shown to shift the learning paradigm from text-centered to more student-centered, as well as boost motivation, learning outcomes, and students' digital literacy, as long as adequate technological devices are available (Heryani et al., 2022).

Other strategies include providing Indonesian-language digital learning content that suits the characteristics of elementary school students, digitizing school administration so teachers can focus on learning quality, and accelerating the government's equal distribution of digital infrastructure, especially for schools in the 3T areas (Underdeveloped, Frontier, Remote).

CONCLUSION

Based on the results of a Systematic Literature Review (SLR) of 43 articles from the SINTA and Scopus databases, elementary school teachers still face various obstacles in maximizing the use of digital technology in the Society 5.0 era. The literature analysis identified five main challenges that consistently appear: (1) uneven digital literacy skills among teachers, (2) limited school technology infrastructure, (3) resistance to

changing the digital learning paradigm, (4) high administrative workload, and (5) suboptimal continuous professional development programs. Departing from prior studies that localized these challenges as isolated, technical, or school-specific deficits, this study offers a novel, human-centered synthesis by framing elementary digital transformation as a multi-level socio-technical ecosystem. We demonstrate that technology integration is not merely a binary choice between software and hardware acquisition but a complex service ecosystem in which teachers' pedagogical capabilities (TPACK), administrative cognitive bandwidth, and institutional support are intrinsically coupled. This model expands the academic understanding of Society 5.0 in basic education by shifting the debate from a 'hardware-heavy' focus to a holistic, human-centered policy design.

The success of digital technology integration is influenced by three interrelated groups of factors: individual (motivation, learning readiness, digital self-efficacy), institutional (school principal leadership, organizational culture, facility support), and systemic (government policies, infrastructure equality, ongoing training programs). Improving teachers' digital competence requires a more comprehensive approach than short-term training alone, namely community-based professional development models, digital mentoring, optimizing Teacher Working Groups (KKG), simplifying administrative burdens through school service digitalization, and equal access to infrastructure, which are the most recommended strategies.

Theoretically, this study provides a comprehensive synthesis of the challenges elementary school teachers face in using digital technology from a Society 5.0 perspective. In practice, the results are expected to serve as input for the government, education offices, school principals, and educational institutions in designing policies that are more responsive to the ongoing development of teachers' digital competencies.

This research has limitations because it used only articles from the SINTA and Scopus databases, so relevant studies from other databases may have been missed, and it relied solely on a literature synthesis approach without field verification. Future researchers are advised to expand their literature sources, adopt a meta-analytic approach for quantitative studies, and conduct empirical studies across various regions of Indonesia to obtain a more comprehensive picture of the implementation of digital technology in elementary schools.

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