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Trends and Predictive Factors of Teacher Digital Literacy: A Literature Review (2020–2025)

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A B S T R A C T

Digital technological developments have reshaped global education, requiring schools to adapt through learning innovation, visionary leadership, and organizational cultures that support digital transformation. School culture plays a crucial role in shaping teachers' values, behaviors, and attitudes toward effective technology use in the classroom. Teacher digital literacy is a key competency for 21st-century learning and is strongly influenced by collaborative and adaptive school cultures. This study aims to identify, review, and synthesize recent research on the relationship between school culture support and teacher digital literacy in digital school organizations. A Systematic Literature Review (SLR) was conducted using the PRISMA method, analyzing publications indexed in Scopus and Google Scholar from 2000 to 2025. The initial search identified 235 articles, and 22 studies met the inclusion criteria after screening and duplicate removal. Bibliometric analysis using VOSviewer identified four main clusters: teacher competence and basic education, school management and culture, school support and teacher innovation, and digital leadership. The findings indicate that school culture acts as a central link connecting digital leadership, teacher competence, and organizational support in fostering teacher digital literacy. A collaborative, innovative, and visionary school culture is a critical factor in successful technology integration and educational digital transformation.

1. Introduction

Digital transformation in education has brought significant paradigm shifts in school governance, leadership roles, and teachers' professional competencies. This process not only demands technological mastery but also changes in values, mindsets, and organizational culture within schools. Schools are no longer positioned merely as traditional teaching institutions, but as dynamic learning ecosystems that are digitally connected. In this context, teachers' digital literacy skills become a key element in ensuring that technology integration in learning is

effective and sustainable (Blau & Shamir-Inbal, 2017). Teacher digital literacy encompasses not only technical skills but also critical, collaborative, and reflective abilities in using technology to create meaningful learning experiences (Abdallah et al., 2024). Therefore, digital literacy cannot be separated from the school environment that shapes teachers' professional behavior in responding to technological change.

School culture plays a fundamental role in directing professional behaviors and values among school members. It reflects shared values, beliefs, norms, and practices that function as a framework for understanding change within educational organizations (Chalkiadaki & Tomás-Folch, 2020). Schools with open and innovative cultures tend to adopt new technologies more effectively, as collaboration and experimentation are embedded in teachers' routines. Conversely, rigid organizational cultures often generate resistance to change, resulting in slower development of teachers' digital literacy (Rasdiana et al., 2024). In primary and secondary education, supportive school cultures function as enabling environments for teachers to learn, collaborate, and develop digital competencies sustainably.

School leadership, particularly digital leadership, plays a strategic role in shaping adaptive school cultures. Principals with a clear digital vision are able to direct technology use in both instructional and administrative practices while encouraging teacher involvement in innovation (Banoğlu et al., 2023). Digital leadership extends beyond technical expertise to include the ability to inspire, facilitate collaboration, and build organizational climates that support pedagogical experimentation (Rasool & Naidoo, 2024). Thus, digital leadership and school culture form a mutually reinforcing relationship that supports educational transformation. In practice, positive school cultures create environments where teachers feel safe to experiment, take pedagogical risks, and share knowledge. Abdallah et al. (2024) highlight that organizational climates emphasizing collaboration and professional learning significantly support teacher competency development. Similarly, Blau and Shamir-Inbal (2017) emphasize that sustainable ICT integration depends on leadership support and collaborative values embedded in daily school practices. These findings indicate that digital transformation is a social process rooted in organizational culture rather than solely driven by policy.

School culture also acts as a catalyst for developing learning ecosystems oriented toward digital collaboration and continuous professional development. Schools that promote trust, cooperation, and collective reflection are more likely to encourage teachers to integrate technology effectively. Baroroh et al. (2025) demonstrate that inter-teacher collaboration strengthens digital teaching practices, while Romero-García et al. (2024) argue that sustainable school cultures balance innovation and stability, integrating technology into school identity rather than treating it as an auxiliary tool. Furthermore, digital leadership ensures that school cultural values remain aligned with educational innovation policies. Principals who implement technology-based supervision and management systems can strengthen digital culture and enhance teachers' professional competencies (Rasdiana et al., 2024; Abu-Tineh et al., 2025). Through open communication, teacher empowerment, and continuous mentoring, school leaders create conditions that support active

participation in digital practices. Consequently, school culture and digital leadership interact synergistically to form responsive digital learning systems.

Numerous studies in global and national contexts indicate that strong school culture support is essential for the successful implementation of educational digitalization policies. Research by Anwar et al. (2023) and Surahman and Salmon (2023) confirms that collaborative school cultures are positively associated with the quality of digital learning. Even in specific educational contexts, organizational cultures grounded in ethical values have been shown to strengthen teachers' digital literacy by guiding responsible technology use (Sogalrey et al., 2022; Suryanti & Ikawati, 2025). This suggests that teacher digital literacy reflects not only technical proficiency but also professional ethics and social identity shaped by school culture. However, despite growing interest in this topic, systematic and integrative analyses examining the relationship between school culture and teacher digital literacy remain limited. Previous studies often emphasize technological training without sufficiently considering organizational culture as a mediating or enabling factor (Baharuldin et al., 2020; Stefan et al., 2024). As a result, understanding of how school culture, leadership, and organizational support interact to foster digital literacy is still fragmented.

Based on these gaps, this study addresses four research questions:

1. What are the research trends on teacher digital literacy from 2020 to 2025?
2. What factors predict teacher digital literacy?
3. How does school culture influence the development of teacher digital literacy?
4. How are digital leadership, organizational support, and teacher digital literacy related within digital school ecosystems?

This study employs a Systematic Literature Review using the PRISMA method to ensure a transparent and structured synthesis of relevant literature (Abdallah et al., 2024; Baroroh et al., 2025). Bibliometric analysis with VOSviewer is used to map keyword relationships and conceptual patterns. The findings are expected to contribute theoretically to models of school culture–based digital literacy and to offer practical guidance for school leaders and policymakers in developing sustainable digital school ecosystems.

2. Methodology

This study employed a Systematic Literature Review (SLR) method based on the PRISMA protocol, which involves four main stages: identification, screening, eligibility, and inclusion. In the identification stage, data were obtained using the Publish or Perish (PoP) software from the Scopus and Google Scholar databases, covering the period 2000–2025. The keyword combinations used included "school culture," "digital literacy," "digital competence," "ICT literacy," and "teacher." The initial search yielded 235 articles, which were compiled in Mendeley for reference management and duplicate checking. After screening the titles and abstracts, 210 articles were excluded because they were not relevant to the focus of

the study, leaving 22 articles that met the inclusion criteria: written in Indonesian or English, published as indexed journal articles, available in full-text format, and relevant to the themes of school culture and teacher digital literacy.

Data analysis was conducted using VOSviewer to visualize bibliometric maps based on keyword co-occurrence. This analysis generated thematic clusters and conceptual relationships that supported qualitative interpretation. Each article was then examined to identify its theoretical and empirical contributions to the development of teacher digital literacy within the framework of a digital school culture. This process enabled a systematic comparison of findings across studies to identify consistent patterns and research gaps. The synthesized results provide an integrative perspective on how school culture and leadership interact to support the advancement of teacher digital literacy.

3. Results and Discussion

Results

The results section begins by outlining the systematic process used to identify, screen, and select relevant studies for inclusion in this review. To ensure transparency and methodological rigor, the literature selection followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. This process provides a clear overview of how the initial pool of studies was refined through successive stages, including identification, screening, eligibility, and final inclusion. The overall flow of article selection and the number of studies retained at each stage are visually summarized in Figure 1.

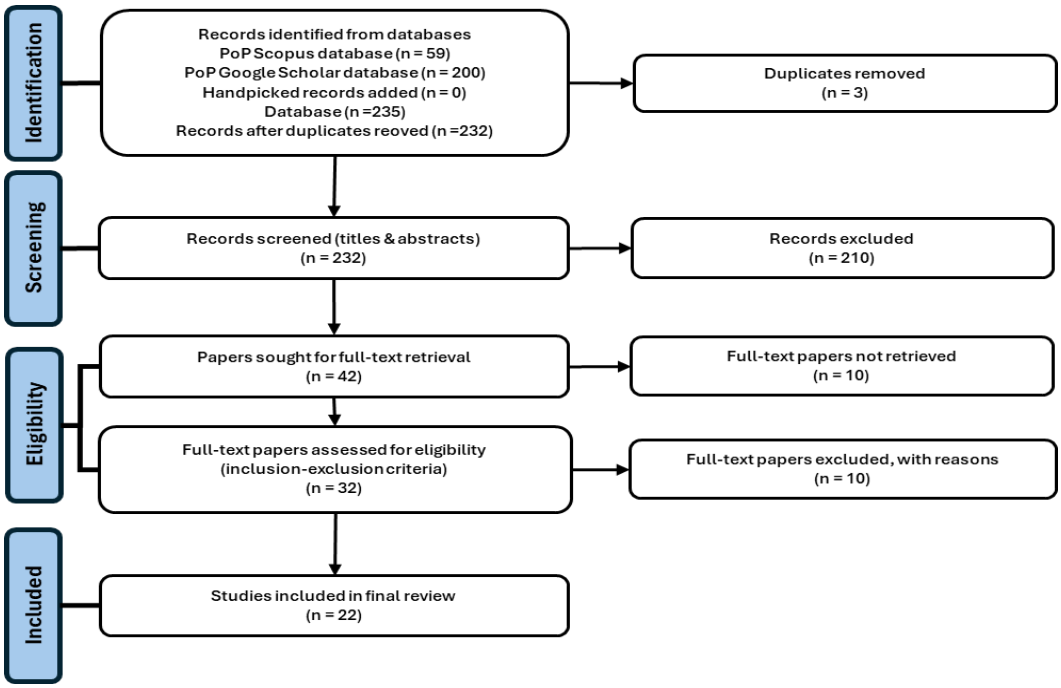

Figure 1. PRISMA Flow Diagram of the Literature Selection Process

Figure 1 illustrates the PRISMA flow diagram detailing the number of records identified through database searching, the removal of duplicate studies, and the screening of titles and abstracts. It also shows the number of full-text articles assessed for eligibility and the final set of studies included in the review. This visual representation clarifies the decision-making process at each stage and supports the transparency and reproducibility of the study selection procedure. To ensure consistency and relevance in the literature selection process, clear inclusion and exclusion criteria were established prior to the screening stage. These criteria guided the evaluation of studies based on their alignment with the research objectives, methodological quality, and contextual relevance. Table 1 presents the inclusion and exclusion criteria applied in selecting the literature for this review.

Table 1. Inclusion and Exclusion Criteria for Literature Selection

Criteria	Inclusion	Ekclusion
Language	Indonesia-English	Non Indonesia-English
Full Text	Available	Not Available
Type	Indexed Journal Articles	Proceedings and Unpublished Literature
Relevance	Literature has a strong contribution to the study	Literature does not have a strong contribution to the study

Trends in Research on Teacher Digital Literacy (2020–2025)

At the identification stage (Stage 1), data collection was conducted through various internationally indexed databases and open-access scholarly sources to obtain publications relevant to the topic of "school culture support and teacher digital literacy." The initial search using Publish or Perish (PoP) in the Scopus database yielded seven articles for the period 2020–2025, using keywords combining the concepts of school culture, supportive school environment, and digital school culture with the terms digital literacy, digital competence, and ICT literacy linked to teacher or school teacher. A second search, expanding the time span to 2000–2025 and adjusting the keyword combinations, produced an additional ten articles. To strengthen thematic coverage, a third search was conducted for the period 2017–2025 using more comprehensive keywords, including organizational culture, school climate, technology integration, and digital skills, resulting in 42 articles. In addition, a parallel search in the Google Scholar database with a publication range of 2000–2025 and a maximum of 200 results further increased the diversity of the retrieved literature.

These findings indicate that research trends on teacher digital literacy have increased significantly during the 2020–2025 period, as reflected in the growing number of publications and the expanding range of keywords. The focus has shifted from purely technical competence toward the integration of organizational culture, digital leadership, and institutional support. This publication growth pattern suggests that digital literacy is no longer understood narrowly but rather as a multidimensional phenomenon involving school organizational structures.

Identification of Predictor Factors of Teacher Digital Literacy

All retrieved results were organized and compiled using Mendeley for reference management, metadata updating, and duplication detection. Of the initial 235 records, three duplicates were identified, leaving 232 articles eligible for the next screening stage. The screening stage (Stage 2) focused on an initial review of titles and abstracts to ensure alignment with the research focus, namely the relationship between school culture and teacher digital literacy within the context of digital school organizations. Of the 232 identified articles, 210 were excluded due to a lack of relevance, inappropriate educational context, or the absence of a direct discussion on school culture and teacher digital literacy. This process resulted in 22 articles for further analysis.

The synthesis of these 22 articles indicates that the most consistent predictors of teacher digital literacy include school culture as the most dominant predictor shaping how teachers interpret and utilize technology; digital leadership, which influences the vision and direction of transformation; school support, encompassing training, supervision, and policy; an innovative school climate that encourages experimental teacher behavior; and teachers' pedagogical and technological competence as an individual capacity strengthened by the organizational environment. Thus, teacher digital literacy emerges as the result of an interaction between individual competencies and organizational factors, rather than merely a technical skill acquired through training. The resulting visualization illustrates the dominant thematic patterns and their interconnections across the reviewed studies, as shown in Figure 2

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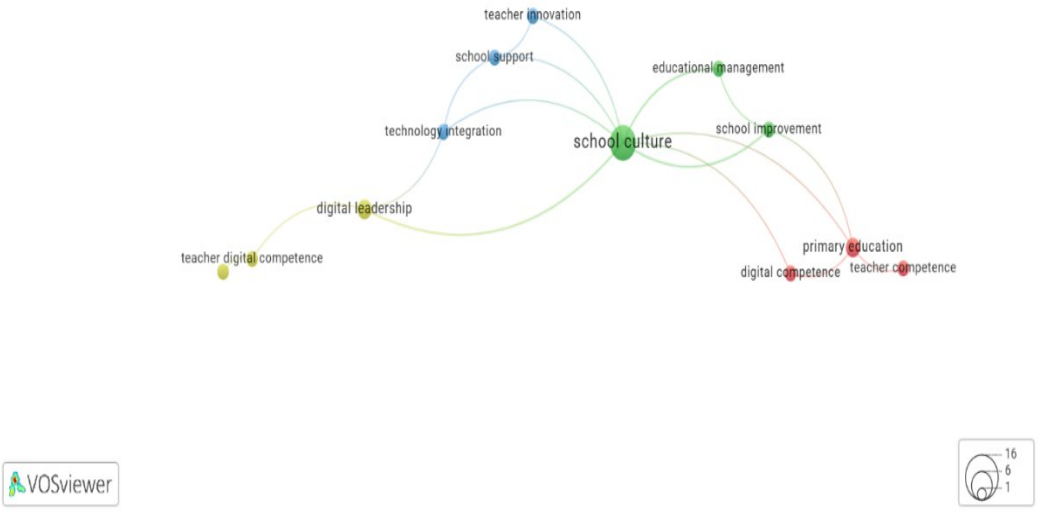

Figure 2. Keyword Co-occurrence Network of School Culture and Teacher Digital Literacy (VOSviewer Analysis)

The eligibility stage (Stage 3) subsequently ensured that the selected articles met the inclusion criteria, namely publications written in Indonesian or English, indexed journal articles, available in full-text format, and possessing conceptual or empirical relevance to the research theme. Articles that did not meet these criteria such as conference proceedings, unpublished literature, or studies without full-text availability were excluded from the analysis. Consequently, the included stage (Stage 4) confirmed that a total of 22 final articles were selected as the basis for the systematic analysis in this study, representing a synthesis of current literature on the roles of leadership, school culture support, and teacher digital literacy in the era of technology-based educational transformation. To further examine the conceptual structure of the selected literature, a bibliometric analysis was conducted to identify relationships among key terms related to school culture and teacher digital literacy.

The Role of School Culture in Teacher Digital Literacy

The analysis of the bibliometric map (keyword co-occurrence) reveals four main thematic clusters that are interconnected but have distinct focal points. The first cluster highlights teacher competence and the context of primary education, the second cluster centers on educational management and school culture, the third cluster focuses on school support, teacher innovation, and technology integration, while the fourth cluster emphasizes digital leadership and the technological capabilities of school principals. Quantitative data derived from the VOSviewer mapping including node position, cluster membership, number of occurrences, and total link strength support this pattern. The keyword school culture (id 44) appears most frequently, with 10 occurrences and the highest total link strength (11), indicating its central role within the network. The keywords digital leadership (id 11) and primary education (id 39) each show three occurrences with a total link strength of four, demonstrating their bridging positions across related clusters. All node attributes used in this analysis were obtained from the keyword index file generated by VOSviewer.

These findings directly demonstrate that school culture functions as the primary foundation and mediating factor in the development of teacher digital literacy. School culture connects three dominant domains educational management, school improvement, and the context of primary education. Thus, school culture should not be viewed merely as a contextual variable, but rather as the core of the digital school ecosystem that shapes how teachers adopt, utilize, and sustain technology integration in teaching and learning processes.

The Synergistic Relationship between Digital Leadership, Organizational Support, and Teacher Digital Literacy

More specifically, the co-occurrence matrix reveals several key relationships that illustrate the strength of connectivity between concepts. The most prominent relationship is observed between digital leadership and school culture (11–44) with a weight of two, followed by the relationship between educational management and school culture (20–44) with the same weight. Another strong linkage appears between school culture and school improvement (44–45), while the relationship

between primary education and school culture (39–44) has a weight of one, as does the relationship between teacher digital competence and technology leadership (53–60). All keyword pairs represent meaningful conceptual interactions and are derived directly from the VOSviewer edge/co-occurrence matrix. These findings provide a comprehensive explanation that teacher digital literacy develops through mutually reinforcing relationships among digital leadership as the driver of change, school culture as the social space that mediates values and practices, and organizational support as the structural foundation that sustains teachers' digital learning. In other words, digital leadership does not exert its influence directly alone, but operates through school culture and organizational support to produce sustainable teacher digital competencies.

The numerical results further indicate that the management and school culture cluster exhibits the highest density of relationships. School culture acts as a central connector linking educational management, school improvement, and primary education, highlighting its critical role as a conceptual bridge between managerial policies and educational practices at the basic education level. Meanwhile, the digital leadership and teacher competence cluster shows strong connections with the culture and management cluster through the relationship between digital leadership and school culture. This confirms that research on digital leadership does not stand in isolation, but is closely intertwined with the dynamics of school organizational culture and institutional support contexts. Supporting data, including node numbers, cluster classifications, and linkage weights, are fully documented in the analyzed index file.

Discussion

Research Trends in Teacher Digital Literacy 2020 to 2025

The findings of this bibliometric mapping confirm empirical and theoretical perspectives in the literature that school culture is a central element in the educational ecosystem and serves as the main mediator for technology integration teacher competence development and instructional innovation (Blau and Shamir Inbal 2017 Abdallah et al. 2024). The dominance of school culture in the keyword network also indicates that research trends from 2020 to 2025 have shifted from a technical focus such as ICT training and basic digital skills toward more systemic approaches including school culture digital leadership and institutional support. This indicates that recent studies conceptualize teacher digital literacy as a multi level phenomenon rather than merely an individual capability. Accordingly research trends demonstrate an escalation of topics that increasingly emphasize organizational context and the dynamics of school culture as key determinants of teacher digital literacy within the digital ecosystem.

Predictive Factors of Teacher Digital Literacy

Clusters linking school support teacher innovation and technology integration illustrate layered practical pathways. Institutional support in the form of supervision training digital infrastructure and school management policies consistently

encourages innovative teacher behavior which in turn accelerates the process of technology integration in the classroom. These findings align with multilevel mediation models that position school support and teacher perception as primary predictors of technology integration (Shen et al. 2024). Additionally research by Stefan et al. (2024) emphasizes that an innovative school climate plays a crucial role in facilitating technology based learning. Thus the bibliometric cluster findings confirm that predictive factors of teacher digital literacy include school culture organizational support innovative climate digital leadership and pedagogical competence. All of these factors are interrelated and form a complex predictive structure influencing teacher digital literacy.

The Role of School Culture as a Mediator of Teacher Digital Literacy

The dominance of school culture within the keyword network strengthens its position as the primary mediator in technology integration the formation of teachers professional values and the development of digital competence. Previous studies confirm that collaborative reflective and adaptive school environments significantly enhance teachers capacity to integrate technology in a sustainable manner (Abdallah et al. 2024 Rasdiana et al. 2024). A strong school culture also shapes innovative norms the courage to experiment and readiness to face digital change. In this context school culture not only functions as a supporting environment but also acts as a mediating factor that unifies the influence of leadership organizational support and teacher competence. Thus the findings affirm that school culture is the fundamental foundation that determines how technology is interpreted adopted and practiced by teachers.

The Synergistic Relationship of Digital Leadership Organizational Support and Teacher Digital Literacy

The strong relationship between digital leadership and school culture (edge 11 to 44) reinforces the argument that principals digital leadership functions as the driving force behind changes in a schools digital culture. Digital leadership does not merely represent technological ability but also shapes the value framework and vision that encourage technology adoption at the organizational level. Previous studies emphasize that visionary and instructional leadership can create a learning culture that facilitates sustainable technology integration (Banoğlu et al. 2023 Rasool and Naidoo 2024).

The bibliometric cluster findings also demonstrate a connection between teacher digital competence and technology leadership confirming that teachers digital abilities are not developed independently but through school policy support instructional supervision and cultural management implemented by school leaders. Accordingly teacher digital literacy emerges as the result of synergy among three components digital leadership as a catalyst school culture as a mediator and organizational support as a facilitator. This synergistic relationship illustrates that digital transformation in education can only succeed when policy structures leadership and culture operate in harmony.

The strength of this analysis lies in its ability to explain thematic structures and intertopic connections that represent contemporary research trends in educational leadership and digital literacy. However limitations remain such as the low frequency of several keywords (occurrences 2 to 3) which may affect cluster stability and result representativeness. Technical parameters in VOSviewer including occurrence thresholds and normalization methods may also influence visualization outcomes. Therefore future research is recommended to expand data coverage conduct sensitivity analyses and integrate mixed methods approaches to validate mediation pathways between school culture digital leadership and teacher digital literacy.

4. Conclusion

This systematic review affirms that school culture is the fundamental foundation for building an effective, adaptive, and sustainable teacher digital literacy ecosystem. School culture functions not only as a contextual background but also as a transformational catalyst that mediates the relationship between digital leadership, organizational support, and the enhancement of teachers' professional competence. Schools with collaborative, reflective, and innovation-oriented cultures demonstrate higher levels of digital literacy, as values such as cooperation, trust, and willingness to experiment with technology become embedded in the collective identity. Accordingly, school culture determines how teachers interpret and utilize technology in pedagogical practices.

Furthermore, principals' digital leadership is proven a key driving force in shaping a school culture that supports technology integration. Visionary principals who are able to develop a shared digital vision, implement instructional e-supervision, and provide continuous professional support contribute significantly to the improvement of teachers' digital literacy. A positive school culture serves as a bridge between leadership policies and classroom practices, where open communication, collaborative learning, and collective reflection become integral parts of school life. In addition, organizational support and a conducive school climate strengthen teachers' motivation and participation in developing digital competencies both individually and collectively, transforming schools into vibrant digital learning communities.

Based on the synthesis results, the proposed recommendation is the need for integrated teacher professional development strategies aligned with the strengthening of school digital culture. School leaders and policymakers should not focus solely on improving technical skills but also on cultivating collaborative, reflective, and adaptive cultural values. Further mixed methods and longitudinal studies are required to empirically examine the mediating role of school culture in the context of digital transformation across different educational levels. Through these efforts, schools can function as resilient and sustainable digital learning communities while simultaneously enhancing learning quality and educational competitiveness in the digital era.

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