



Principal Leadership Strategies for Strengthening Digital Literacy among Teachers and Education Personnel in Rokan Hulu

Fadri Rahman^{1*}, Nurtanio Agus Purwanto²

^{1,2} Universitas Negeri Yogyakarta, Yogyakarta, Indonesia

Corresponding e-mail: fadrirahman856@gmail.com

ARTICLE INFO

Keywords:

Digital literacy;
Digital school;
Education personnel;
Principal leadership;
Transformational leadership.

Article History

Received: April 16, 2026

Revised: July 08, 2026

Accepted: August 05, 2026

ABSTRACT

Digital transformation in education requires school principals to move beyond administrative leadership and actively shape the digital capacity and work practices of teachers and education personnel. However, empirical evidence remains limited regarding how such leadership strategies are implemented in resource-constrained regional schools and whether similar strategic patterns emerge across schools with different organizational scales. This study examined principal leadership strategies for strengthening digital literacy among teachers and education personnel in two reference digital public junior secondary schools in Rokan Hulu Regency, Indonesia. A descriptive qualitative multiple-case study design was employed involving eight purposively selected informants comprising two principals, four teachers, and two education personnel. Data were collected through semi-structured interviews, non-participant observations, and document analysis and were analyzed using within-case and cross-case procedures based on the interactive model of data condensation, data display, and conclusion drawing, with source and method triangulation used to strengthen credibility. The findings identified four interrelated leadership strategies: mapping digital needs and competencies, applying gradual and adaptive capacity-building approaches, optimizing internal and district-level resources, and developing a sustainable digital work culture. These strategies were implemented through internal training, peer mentoring, supervision-based monitoring, and integration of digital-literacy initiatives into routine school management. Across both cases, principal leadership was the most consistently emphasized supporting factor, whereas disparities in digital skills and limited professional-development time represented the most prominent barriers. The findings extend transformational and distributed leadership perspectives by showing how adaptive and shared leadership practices can support school digitalization across institutions with different resource scales. Nevertheless, because digital competence was not directly measured, the findings should be interpreted as evidence of perceived and observed implementation rather than verified competence improvement.

This is an open access article under the [CC BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license



To cite this article: Rahman, F., Purwanto, N. A. (2026). Principal Leadership Strategies for Strengthening Digital Literacy among Teachers and Education Personnel in Rokan Hulu. *Indonesian Technology and Education Journal*, 4(2), 336-349. Doi: 10.61255/itej.v4i2.1725

INTRODUCTION

Education is the primary foundation for shaping a competitive generation amid intensifying global competition, and teachers occupy a strategic position as the main drivers of the learning process in schools. The role of teachers is no longer limited to the transfer of knowledge; it also encompasses mentoring and facilitating functions that build learners' character and competence holistically (Nagel & Amdam, 2025). At the same time, the disruption of information and communication technology (ICT) has massively reshaped the educational landscape: digital instruments are no longer merely communication media but have become critical elements in classroom instruction, administrative governance, data management, and teacher capacity building. Data from Statistics Indonesia show that internet-user penetration rose from 69.21% in

2023 to 72.78% in 2024 (Badan Pusat Statistik, 2025), yet this expansion of access has not been fully matched by society's readiness to use technology wisely, safely, and productively.

The gap between access and utilization is also reflected in Indonesia's Digital Society Index (IMDI) 2024, which recorded a digital-skills pillar score of 58.25 and a digital infrastructure-ecosystem pillar score of 52.70, while the digital-empowerment pillar scored only 25.66 and the digital-employment pillar only 38.09 (Kementerian Komunikasi dan Digital Republik Indonesia, 2024). These figures confirm that basic technology-access capability has developed relatively well, but its utilization to improve productivity and work quality including within the education sector still lags behind. This condition demands that school principals, as instructional leaders and education managers, take an active role in directing and developing the digital literacy of teachers and education personnel.

The obligation for educators to master information and communication technology is embedded in Indonesia's national legal framework. Law No. 14 of 2005 on Teachers and Lecturers (Republic of Indonesia, 2005) requires professional teachers to master four competency pillars pedagogical, personal, social, and professional, which, in the digital era, now also encompass ICT proficiency, as reinforced by Minister of National Education Regulation No. 16 of 2007 on Academic Qualification and Teacher Competency Standards (Minister of National Education of the Republic of Indonesia, 2007). This mandate is consistent with Article 3 of Law No. 20 of 2003 on the National Education System (Republic of Indonesia, 2003), which stipulates that the goals of national education can only be achieved if teachers and education personnel remain adaptive to the demands of the era, including digital transformation.

Conceptually, digital literacy is defined as the capacity to use digital devices, communication media, and network infrastructure to filter, manage, and produce information productively and ethically (Nagel & Amdam, 2025). Gilster, as cited in Aldosemani et al. (2025), emphasized that the essence of digital literacy goes beyond mere technical operating skills and rests on critical thinking in evaluating information in cyberspace. The European Digital Competence Framework for Citizens (DigComp), developed by Carretero, Vuorikari, and Punie (2017), maps citizens' general digital competence across five domains (information, communication, content creation, safety, and problem-solving), later adapted specifically for educators through the European Framework for the Digital Competence of Educators (DigCompEdu), developed by Redecker (2017), comprising six competence areas for teachers (Zhang et al., 2026). For the purposes of this study, digital literacy competence is operationalized following DigCompEdu's areas of professional engagement, digital resources, teaching and learning, assessment, and empowering learners for teacher informants; for education-personnel informants, whose duties center on administrative and data-management systems, competence is operationalized as proficiency in operating school digital administrative platforms (e.g., Dapodik, e-Raport, SIPLah), data accuracy and timeliness, and problem-solving when technical disruptions occur. This dual operationalization allows the same three research foci strategy, implementation, and supporting/inhibiting factors to be examined meaningfully across both professional groups. Effective technology integration in schools therefore requires a synergy of technical, cognitive, and pedagogical competencies across all school members.

Because this study interprets principal strategy through leadership theory, two frameworks are used as explicit analytical lenses. Transformational leadership, particularly the dimensions of individualized consideration and inspirational motivation (Bass & Avolio, 1994), is used to interpret how principals adapt strategies to differing readiness levels among staff and cultivate collective commitment to change. Distributed leadership (Spillane, 2006) is used to interpret how leadership functions such as mentoring and technical problem-solving are shared among actors with relevant expertise rather than concentrated solely in the principal. These dimensions informed the development of the interview guides and the coding categories described in the Method section.

In an effort to transform the education sector, the Rokan Hulu Regency Education, Youth, and Sports Office (Dinas Pendidikan, Pemuda dan Olahraga Kabupaten Rokan Hulu) officially designated a set of digitalization-target schools (Sasaran Digitalisasi Sekolah) at the primary and

junior-secondary levels across the regency for 2025, under Decree No. Kpts.400.3.1/Disdikpora-Set/043 (22 January 2025), which appointed a school-based digitalization team at each designated school tasked with planning and implementing digitalization activities, managing IT infrastructure, developing digital content, and training teachers and students (Dinas Pendidikan, Pemuda dan Olahraga Kabupaten Rokan Hulu, 2025). Both case-study schools examined in the present study, SMP Negeri 1 Rambah and SMP Negeri 1 Rambah Hilir, are named in this decree. However, the researcher's preliminary observation at one of these designated junior secondary schools revealed a different reality: some teachers were still uncomfortable operating platforms such as Rumah Pendidikan and Learning Management Systems (LMS), had not yet developed digital teaching materials, and lacked confidence teaching with digital media. Education personnel, including school operators and administrative staff, were likewise still limited in operating digital administrative systems such as Dapodik, e-Raport, and SIPLah, resulting in delayed work processes and data-entry errors. Findings from the Education Report Card (Rapor Pendidikan), a national, annually published school-quality report issued by Indonesia's Ministry of Education, Culture, Research and Technology (Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia, 2025), reinforce this condition at one of the case-study schools: although students' literacy achievement was relatively good (92.86% reaching the minimum competency threshold, on a 0–100 scale, with an average score of 73.18) and numeracy achievement was similarly favorable (96.43% reaching the threshold, average score 69.76), the indicator for the utilization of education resources was low (28.19 for quality-budget utilization and only 6.26 for teacher-quality utilization, both on a 0–100 scale) indicating that technology mastery among teachers and education personnel remains a major challenge for the sustainability of school digital transformation.

Several prior studies confirm the urgency of principal leadership in advancing digital literacy. Chang (2012) demonstrated that principals' technological leadership significantly improves teachers' technological literacy and encourages teachers to integrate technology into their teaching in Taiwanese elementary schools, while Metaferia et al. (2023) found that principals' transformational leadership practices were positively associated with teachers' job satisfaction in Addis Ababa government secondary schools suggesting that leadership style, not only technical training, shapes teachers' receptiveness to school-driven change. More recently, Xu et al. (2025) showed that principals' leadership and ICT competence jointly shape teachers' professional competence in fostering students' digital citizenship. In the Indonesian context, Pamungkas (2024) found that principals' active role through structured training and role modelling was key to the successful development of teachers' digital literacy in support of the Sekolah Penggerak (Driving School) Program, while Hulwana (2024) and Nasution (2021) showed that internal-training strategies, peer-coaching-based mentoring, and clarity of policy direction from principals contributed substantially to teachers' confidence in using technology. Nevertheless, most of these studies remain partial, focusing on a single school or on quantitative associations, and have not specifically compared strategy patterns across reference digital schools within a single regency using an in-depth qualitative lens, leaving contextual variation in principal strategy at the district level largely unexplored.

Based on this gap, the present study aims to (1) describe the forms of strategy implemented by principals in developing the digital literacy competence of teachers and education personnel; (2) analyze the implementation of these strategies in carrying out digital-literacy improvement activities within the school environment; and (3) identify the supporting and inhibiting factors influencing the success of these strategies, drawing on two reference digital public junior secondary schools in Rokan Hulu Regency. The findings are expected to contribute theoretically to the literature on educational management and leadership in the digital era, as well as practically to principals, district education offices, and policymakers in formulating more contextual and sustainable strategies for strengthening the digital capacity of educational institutions.

METHOD

Research Design

This study employed a descriptive qualitative approach with a multiple-case study design to examine in depth the phenomenon of principal leadership strategy in strengthening digital literacy. This approach was chosen for its capacity to explore informants' meanings, perceptions, and experiences contextually and naturalistically, rather than to test predetermined hypotheses (Sugiyono, 2023). The multiple-case design followed Yin's (2018) replication logic, in which the two schools were expected to display broadly similar strategic patterns given their shared reference-digital-school status, while the marked difference in institutional scale between them (Section 3.1) offered an opportunity to examine whether the pattern held under differing conditions through both within-case and cross-case analysis (Section 2.7).

Research Setting and Participants

The research locus comprised two public junior secondary schools designated as reference digital schools in Rokan Hulu Regency, Riau Province: SMP Negeri 1 Rambah (representing Rambah Sub-district) and SMP Negeri 1 Rambah Hilir (representing Rambah Hilir Sub-district), selected purposively for their track record in adopting information technology for teaching, administration, and educational services. Data collection took place from October 2025 to March 2026. Informants were determined through purposive sampling, considering their direct involvement in the policy and implementation of digital-literacy programs at each school. At each school, one principal, two teachers, and one member of education personnel were designated as key informants, yielding a total of eight informants (Table 1). The adequacy of this sample was evaluated using the concept of information power (Malterud et al., 2016): a narrowly defined study aim, high specificity of participant characteristics (informants directly responsible for digital-literacy policy and implementation), and a planned analytic strategy combining within-case and cross-case comparison were judged to justify a modest sample size for an in-depth qualitative multiple-case design. These four roles per school were included because they jointly represent the decision-making, instructional, and administrative dimensions of digital-literacy strategy at the school level.

Table 1. Profile of Research Informants

No	Informant Code	Position	School Unit	Data Technique
1	KS	Principal	SMP Negeri 1 Rambah	I, O, D
2	G1	Teacher	SMP Negeri 1 Rambah	I, O
3	G2	Teacher	SMP Negeri 1 Rambah	I, O
4	TK	Education Personnel	SMP Negeri 1 Rambah	I, O, D
5	KS	Principal	SMP Negeri 1 Rambah Hilir	I, O, D
6	G1	Teacher	SMP Negeri 1 Rambah Hilir	I, O
7	G2	Teacher	SMP Negeri 1 Rambah Hilir	I, O
8	TK	Education Personnel	SMP Negeri 1 Rambah Hilir	I, O, D

Note: I = Interview; O = Observation; D = Documentation. Source: primary research data, processed (2026).

Data Collection Techniques and Instruments

Primary data were gathered through three techniques applied synergistically: in-depth semi-structured interviews, non-participant observation of training activities and the use of digital devices, and documentary study (school work plans, training reports, decision letters, and records of digital-platform usage). Each of the eight key informants was interviewed once in a semi-structured format; interviews were conducted in Indonesian, audio-recorded with informant consent, and transcribed verbatim prior to analysis, with each interview lasting approximately 40–60 minutes (mean duration 50 minutes). Non-participant observation was conducted across multiple training, mentoring, and routine administrative sessions at each school during the data-collection period; the researcher maintained a non-participant role throughout to minimize reactivity, and field notes were written during and immediately after each session. A total of 14 observation sessions were conducted (seven per school), each lasting approximately 40–90 minutes. Documentary data were drawn from school work plans, training attendance and activity reports, principal decision letters relevant to digital-literacy programs,

and system-usage records for platforms such as Dapodik, e-Raport, and SIPLah, reviewed against a documentation checklist aligned with the three research foci; a total of 24 documents were analyzed across both schools (12 per school). Secondary data were obtained from internal school policy documents and supporting scholarly literature. Research instruments consisted of semi-structured interview guides, observation guides, and documentation guides, all developed around the three research foci and the leadership dimensions described in Section 1.

Ethical Considerations

This study was conducted in accordance with the research ethics guidelines of Universitas Negeri Yogyakarta and the ethical principles for research involving human participants set out in the Declaration of Helsinki (World Medical Association, 2013). Ethical approval was obtained from the Research Ethics Committee of Universitas Negeri Yogyakarta prior to data collection. Formal permission for on-site data collection was obtained from the principals of both schools prior to fieldwork. All eight informants gave informed consent after being briefed on the study's purpose, their right to decline participation or withdraw at any time without consequence, the voluntary nature of audio recording, and the confidentiality of their responses. Informant identities are reported only through the role-based coding system described in Section 2.6; no information that could identify individual participants beyond their institutional role is disclosed. Direct quotations used in Section 3 were shared with the relevant informants during member checking (Section 2.5) to confirm accuracy and authorize their use. Interview recordings, transcripts, and field notes were stored on password-protected devices accessible only to the research team.

Data Trustworthiness

Data trustworthiness was maintained through four criteria (Sugiyono, 2023). Credibility was strengthened through source triangulation (comparing accounts across principals, teachers, and education personnel) and method triangulation (comparing interview, observation, and documentary evidence, summarized by technique in Tables 3–5); through prolonged engagement across the multi-month data-collection period; and through member checking, in which preliminary thematic summaries were shared with key informants for confirmation or correction. Transferability was supported through thick description of the research context and informant characteristics. Dependability was maintained through an audit trail documenting coding decisions and analytic memos. Confirmability was supported by retaining interview transcripts, field notes, and coded matrices for independent inspection, so that the interpretations presented can be traced back to the original data.

Data Analysis Technique

Data were analyzed using the interactive model of Miles, Huberman, and Saldaña (2014), as applied in Rusilowati et al. (2024), consisting of three circular stages: data condensation, data display, and conclusion drawing or verification. Coding proceeded in three stages. First, initial open codes were generated inductively from interview transcripts, observation notes, and documents. Second, open codes were grouped into the four strategy categories (S1–S4) and the implementation and factor categories reported in Tables 3–5, informed deductively by the transformational- and distributed-leadership dimensions described in the Introduction; the coding process was therefore hybrid deductive-inductive. Third, coded categories were reviewed for consistency across the dataset. Coding was performed independently by the first author and then cross-checked by the second author (academic supervisor); disagreements in code assignment were resolved through discussion until consensus was reached, and unresolved cases were documented in the audit trail. A theme was classified as the most frequently emphasized supporting or inhibiting factor when it was independently reported by a majority of informants (at least five of eight) across both schools and corroborated by at least two of the three data-collection techniques; other recurring themes meeting fewer than these conditions are reported as supporting rather than the most frequently emphasized patterns. The full set of corroborating informant codes for each theme is retained in the coding matrix (audit trail); Tables 3–5 present

representative codes for illustration rather than an exhaustive list. A coding system was applied to trace data sources: KS for principal, G1/G2 for the first and second teacher informant, and TK for education personnel; SMPN1R and SMPN1RH for the school unit; and I, O, or D for interview, observation, or documentation data. For example, the code KS-SMPN1RH/I/1 denotes interview data from the principal of SMP Negeri 1 Rambah Hilir on the first interview item, and G1-SMPN1R/I/1 denotes interview data from the first teacher informant of SMP Negeri 1 Rambah. This coding, including the specific G1 or G2 designation for each teacher quotation, is applied consistently throughout Section 3 to allow every quotation to be traced to a specific informant in Table 1.

Within-Case and Cross-Case Analysis

Analysis proceeded in two stages. Within-case analysis first examined each school independently, developing a coherent account of that school's strategies, implementation practices, and contextual factors from its own interview, observation, and documentary data (Sections 3.2 and 3.3). Cross-case analysis then compared the two within-case accounts to identify convergent patterns reported as the four common strategies, S1–S4 (Section 3.4) and points of divergence attributable to differences in school scale (Section 3.1). This sequence follows Yin's (2018) replication logic for multiple-case designs, in which convergence across cases with differing conditions strengthens confidence in a pattern's robustness, while divergence highlights context-dependent boundary conditions.

RESULTS AND DISCUSSION

Characteristics of the Research Locus

SMP Negeri 1 Rambah and SMP Negeri 1 Rambah Hilir both hold the status of reference digital school, yet differ considerably in the scale of their resources. Based on Dapodik data for the even semester of the 2025/2026 academic year, SMP Negeri 1 Rambah has substantially more students, teachers, and study groups than SMP Negeri 1 Rambah Hilir (Table 2 and Figure 1). This difference in scale provides an important context for understanding the varying complexity of digitalization strategies faced by the two principals, the larger the number of school members, the broader the coordination scope the principal must manage to implement digital-literacy programs equitably.

Table 2. Resource Profile of SMP Negeri 1 Rambah and SMP Negeri 1 Rambah Hilir

Indicator	SMPN 1 Rambah	SMPN 1 Rambah Hilir	Gap
Male students	308	145	163
Female students	312	129	183
Total students	620	274	346
Number of teachers	43	18	25
Number of education personnel	8	5	3
Total teaching & education staff	51	23	28
Study groups (rombel)	21	9	12
Accreditation status	A	-	-

Note: the accreditation status of SMP Negeri 1 Rambah Hilir was not reported in the Dapodik profile data available for this study. Source: Dapodik school profile data, 2025/2026, processed by the authors (2026).

As presented in Table 2, SMP Negeri 1 Rambah serves a considerably larger school population than SMP Negeri 1 Rambah Hilir across every indicator, with a gap of 346 students, 25 teachers, 3 education personnel, and 12 study groups between the two schools. This disparity is not merely numerical; it directly conditions the operational complexity each principal must manage: a larger number of school members corresponds to a broader coordination scope that the principal must manage in order to implement digital-literacy programs equitably. A school with 51 teaching and education staff distributed across 21 study groups requires a coordination structure markedly different from one serving 23 staff across 9 study groups, particularly when the goal is to ensure that digital-literacy development reaches every individual rather than only a visible few.

This scale difference also shapes a slightly different strategic emphasis, elaborated further in Sections 3.2 and 3.3 below: informant accounts from SMP Negeri 1 Rambah point to a more gradual, persuasive approach suited to managing wider variance in digital readiness across a larger teacher population, whereas accounts from SMP Negeri 1 Rambah Hilir point to a more personalized, needs-mapping-driven style of mentoring suited to a smaller and more closely supervised staff group.

Within-Case Findings: SMP Negeri 1 Rambah

At SMP Negeri 1 Rambah, the larger of the two schools, informants described the principal's digital-literacy strategy as persuasive and staged, consistent with the greater coordination demands noted in Section 3.1. The principal explained that the main challenge was not only teachers' technical ability but their readiness and mindset toward change, so the strategy centered on "a persuasive and staged approach, beginning with outreach on the importance of digitalization, followed by training adjusted to each teacher's and staff member's ability level, so as not to create pressure" (KS-SMPN1R/I/1). A teacher corroborated this account, noting that while the principal actively encouraged teachers to adapt to technology, "he also understands that not all teachers have the same readiness, so the approach is staged and not overly forceful, especially for teachers who still need time to adjust" (G1-SMPN1R/I/1). On resource optimization (S3), the principal described combining internal and external support: "we make use of the school's internal team as mentors, and we build communication with the district education office so that teachers can join relevant training; although resources are limited, we try to optimize what is available so the capacity-building process continues" (KS-SMPN1R/I/3), a pattern a teacher confirmed by describing how "the principal usually makes use of teachers who are already more familiar with technology to mentor other teachers; we are also directed to join training from the district or other professional development activities related to technology use" (G2-SMPN1R/I/3). On implementation, the principal emphasized scheduling flexibility: "we schedule training flexibly so that it does not disrupt teachers' main duties, and we provide personal mentoring for those who are still having difficulty so they can keep up comfortably" (KS-SMPN1R/I/7), which a teacher experienced directly, reporting that "the principal gives opportunities to attend training and encourages mentoring from colleagues who understand technology better; this is quite helpful, especially for teachers not yet familiar with digital applications" (G1-SMPN1R/I/7). This pattern is corroborated by the supporting-factor data attributed to this school, including principal leadership support (KS-SMPN1R/I/11) and the learning commitment of teachers and education personnel (TK-SMPN1R/I/11), and by the inhibiting factors of high administrative workload and rapidly changing application systems (KS-SMPN1R/I/13) alongside the need for ongoing reinforcement of motivation and confidence (TK-SMPN1R/I/14).

Within-Case Findings: SMP Negeri 1 Rambah Hilir

At SMP Negeri 1 Rambah Hilir, the smaller of the two schools, informants described a more personalized style of mentoring. The principal explained that the strategy began with "examining the actual condition of teachers' and staff's abilities; from there we developed a phased training program, starting from the most basic matters such as using digital learning platforms, up to application-based administration" (KS-SMPN1RH/I/1), a needs-mapping process corroborated by an education-personnel informant who reported involvement through staff meetings to identify needs and technical constraints in application use (TK-SMPN1RH/I/4), indicating that the mapping process was participatory rather than a unilateral decision by the principal. On implementation, the principal described ensuring that training was followed by direct application: "the program is carried out through internal training, direct practice in teaching, and mentoring for teachers and staff who still need help; we try to make sure that the use of technology is not merely theoretical, but is genuinely applied in day-to-day activities at school" (KS-SMPN1RH/I/6), a pattern a teacher confirmed, reporting that implementation "has gone reasonably well because the principal makes an effort to provide training and mentoring; we are also encouraged to try using technology in teaching, although at first it still required some

adjustment" (G1-SMPN1RH/I/6). On peer mentoring, the principal described scheduling regular training and creating opportunities for teachers to share what they learned with colleagues (KS-SMPN1RH/I/7), which a teacher experienced directly: "the principal gives teachers the chance to attend training and also sets aside time for discussion and sharing experiences; mentoring from fellow teachers has also been very helpful in understanding how to use technology" (G2-SMPN1RH/I/7). Supporting evidence from this school also foregrounds principal leadership (KS-SMPN1RH/I/11) and external district support (KS-SMPN1RH/I/11), while inhibiting evidence highlights the digital-skills gap and limited development time (KS-SMPN1RH/I/13; G2-SMPN1RH/I/13) and limited facilities and unstable internet connectivity (KS-SMPN1RH/I/12; TK-SMPN1RH/I/12).

Cross-Case Synthesis: Forms of Principal Strategy

Cross-case analysis of interview, observation, and documentation data at both schools converges on four principal strategies applied consistently, albeit with the technical variation in emphasis described in Sections 3.2 and 3.3 (Table 3). These four strategies are interrelated and form a single, continuous process of school digital transformation, from needs diagnosis to the establishment of a new work culture.

Table 3. Thematic Matrix of Principal Strategies and Triangulation Evidence

Code	Strategy Theme	Brief Description	I	O	D
S1	Mapping needs and competencies	Diagnosing teachers'/staff's actual digital competence as the basis for setting program priorities	✓	✓	✓
S2	Gradual and adaptive approach	Policies implemented in stages according to individual readiness to minimize resistance to change	✓	✓	✓
S3	Resource optimization (internal & district)	Deploying more digitally proficient teachers/staff as mentors, combined with district-provided training	✓	✓	✓
S4	Building a digital culture	Embedding technology into daily communication, learning, and administration as a new work norm	✓	✓	✓

Note: I = Interview; O = Observation; D = Documentation. Checkmarks indicate that the theme was corroborated by at least one data point from that technique at both schools; they summarize, rather than replace, the narrative and documentary evidence discussed in the text.

The first strategy, mapping needs and competencies (S1), shows that principals did not roll out digital-literacy programs uniformly, but instead began by diagnosing the school community's actual competence, as illustrated in Section 3.3 by the SMP Negeri 1 Rambah Hilir principal's account of the phased-training process.

The second strategy, a gradual and adaptive approach (S2), was the strategy most frequently emphasized across informants and both cases, corroborated by interview, observation, and documentary evidence (Table 3) under the criterion defined in Section 2.6, since nearly all forms of digital-literacy development took differences in individual readiness into account. Principals did not impose change uniformly across the board; rather, they began with awareness-raising on the urgency of digitalization, followed by foundational training tailored to each teacher's and staff member's ability level, a pattern consistent across both schools that reflects a persuasive rather than instructive change-management strategy.

The third strategy, resource optimization through internal mentoring and district support (S3), shows that principals maximized internal potential—assigning teachers with stronger digital competence as peer mentors—while selectively leveraging district-provided training to strengthen the school community's capacity amid limited resources. The fourth strategy, building a digital culture through innovation in work habits and communication (S4), is evident in the growing use of online communication groups, digital teaching-material sharing, and electronic document management, which gradually became a new work norm at both schools, as affirmed by an education-personnel informant at SMP Negeri 1 Rambah Hilir: 'we have become

increasingly used to digital documents, online reporting, and communication conducted mostly through online media' (TK-SMPN1RH/I/5).

Implementation of Strategies in Digital-Literacy Improvement Activities

The four strategies above were realized through four mutually reinforcing forms of implementation, each associated with the implementation activities and informant-reported outcomes summarized in Table 4. Internal training combined with direct application ensured that technology mastery did not remain at the theoretical level, but was immediately practiced in daily teaching and administration, as stated by the principal of SMP Negeri 1 Rambah Hilir: "we make sure that technology use is not merely theoretical, but is genuinely applied in the school's day-to-day activities" (KS-SMPN1RH/I/6). Mentoring and best-practice sharing (peer coaching) emerged as the most prominent implementation form, since improving digital literacy could not rely on formal training alone but required direct assistance and peer-to-peer learning, particularly for teachers and staff still in the adjustment phase.

Table 4. Forms of Strategy Implementation and Informant-Reported Outcomes

Implementation Form	Description	Informant- Reported Outcome	Data Source (Example Code)
Internal training & direct application	Short internal workshops followed by immediate application in teaching or administration	Informants reported that technology use moved beyond theory into day-to-day teaching and administrative practice	KS-SMPN1RH/I/6; G1-SMPN1RH/I/6
Peer mentoring / best-practice sharing	More digitally proficient teachers/staff assigned as mentors for colleagues still adjusting	Informants reported mentoring and shared-experience sessions as helpful for staff still adjusting to new tools	G2-SMPN1RH/I/7; G1-SMPN1R/I/7
Supervision- based monitoring & evaluation	Periodic instructional and administrative supervision used to track adoption and identify follow-up needs	Informants reported regular supervision and evaluation discussions used to identify and follow up on obstacles	KS-SMPN1RH/I/8; KS-SMPN1R/I/8
Integration into school management	Digital- literacy activities embedded in the school work plan (RKS/RKAS) and routine agendas rather than treated as a stand- alone program	Informants reported that digital- literacy activities were treated as an ongoing part of school planning rather than a one-off initiative	KS-SMPN1RH/I/10; KS-SMPN1R/I/10

Note: outcomes listed are as reported by informants during interviews; they represent informants' and the researcher's assessment of implementation progress rather than independently verified, document- or observation-corroborated measurements. Verifying these outcomes against school work-plan documents, supervision logs, or platform-usage records would strengthen future iterations of this analysis but was beyond what the interview data alone can support. Source: primary research data, processed (2026).

Supervision-based monitoring and evaluation, in informants' accounts, helped ensure that program implementation was tracked over time, as explained by a principal: "monitoring is carried out through instructional supervision, administrative checks, and periodic evaluation discussions, so that follow-up action can be taken promptly" (KS-SMPN1RH/I/8). Integrating the program into the school management system, by embedding digital literacy into the school work plan and routine activities, is, in informants' view, key to program sustainability, helping ensure it does not remain a one-off initiative but becomes a permanent part of school governance.

Supporting and Inhibiting Factors in Strategy Implementation

The success and challenges of implementing digital-literacy strategies are shaped by the interaction of several supporting and inhibiting elements (Table 5). Consistent with the criterion defined in Section 2.6, principal leadership was classified as the most frequently emphasized supporting factor because it recurred across a majority of informants at both schools and was corroborated by interview, observation, and documentary evidence alike—manifested through

policy direction, facilitation of training, mentoring, and continuous supervision; without such support, training and technology-adoption habits are difficult to sustain in a directed manner. Using the same criterion, the digital-skills gap among teachers combined with limited development time was classified as the most frequently emphasized inhibiting factor, given that high administrative workloads further reduce teachers' opportunities to engage intensively with technology.

Table 5. Matrix of Supporting and Inhibiting Factors in Digital-Literacy Strategy

Category	Factor	Data Source (Example Code)
Supporting (most frequent)	Principal leadership support: policy direction, training facilitation, supervision	KS-SMPN1RH/I/11; KS-SMPN1R/I/11
Supporting	Learning commitment of teachers and education personnel	G1-SMPN1RH/I/11; TK-SMPN1RH/I/11
Supporting	External support from the district education office (training, policy)	KS-SMPN1RH/I/11
Inhibiting (most frequent)	Digital-skills gap among teachers & limited development time	KS-SMPN1RH/I/13; G2-SMPN1RH/I/13
Inhibiting	Limited facilities, devices, and unstable internet network	KS-SMPN1RH/I/12; TK-SMPN1RH/I/12
Inhibiting	High administrative workload & rapidly changing application systems	TK-SMPN1RH/I/13; KS-SMPN1R/I/13
Inhibiting	Need for ongoing reinforcement of motivation and self-confidence	KS-SMPN1RH/I/14; TK-SMPN1R/I/14

Note: codes listed are representative examples rather than an exhaustive citation list; the full set of corroborating informant codes for each factor is retained in the coding matrix (audit trail). "(most frequent)" indicates the factor met the frequency criterion defined in Section 2.6. Source: primary research data, processed (2026).

Integrated Discussion: Transformational and Distributed Leadership in School Digital Transformation

Overall, the findings of this study can be synthesized into a proposed conceptual framework that links principal leadership, the four strategies, their corresponding implementation forms, contextual factors, and the outcome perceived by informants (Figure 1). This framework is an empirically informed interpretation derived inductively from the two cases, not a statistically tested causal model; the arrows indicate a proposed sequence of influence rather than a confirmed moderation effect.

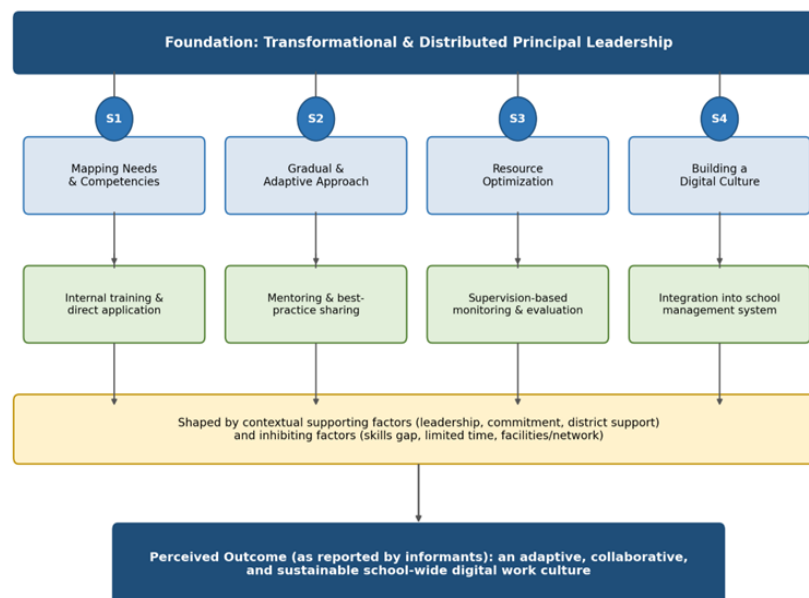


Figure 1. Proposed conceptual framework of principal strategies linked to a school digital work culture. Source: research data analysis, processed (2026).

The strategic pattern identified beginning with needs mapping, followed by a phased approach, and culminating in the reported emergence of a digital culture reflects characteristics associated with transformational leadership as conceptualized in the Full Range Leadership Theory (X. Zhang et al., 2025). The dimension of individualized consideration is evident in the gradual and adaptive strategy: principals did not demand uniform change but recognized that each teacher had a different level of readiness, designing tiered training to build confidence progressively. This pattern is consistent with X. Zhang et al. (2025), who found that principal leadership shapes teaching quality partly through the working conditions principals create for staff, and with L. Zhang et al. (2026), whose review highlights staged, individualized approaches as effective in developing educators' digital competence.

The resource-optimization strategy through internal mentoring (S3) and peer-coaching-based implementation aligns with the principle of distributed leadership (Spillane, 2006), which holds that leadership is not concentrated in a single formal figure but is distributed among actors with relevant expertise. More technologically proficient teachers were empowered as peer mentors, making the development of digital literacy a collective commitment of the school community rather than the principal's task alone. This pattern of distributed roles was similarly observed by Hulwana (2024) at SMP Negeri 7 Bukittinggi, who reported that combining formal training with peer mentoring effectively enhanced teachers' confidence in using technology.

The prominence of principal leadership as the most frequently emphasized supporting factor in this study is broadly consistent with Brunning et al. (2020), Sary et al. (2024), and Nurhalimah (2021), who similarly emphasize that clarity of policy direction and principal role-modeling are important determinants of school digitalization, alongside facility availability. Conversely, the prominence of the digital-skills gap and limited development time as inhibiting factors is consistent with Sulastris et al. (2024) and Muslikhatun et al. (2024), who point to teachers' heterogeneous technical backgrounds and high administrative workloads as structural barriers that may require sustained coaching rather than one-shot training. The similarity of challenges faced by both case-study schools despite their differing resource scales suggests that the digital-skills gap may reflect a broader, regional-level pattern rather than merely an institution-specific problem, though confirming this would require a larger, comparative sample drawing on schools beyond the two studied here.

These findings also add nuance to the literature by showing that, in this pair of cases, principal strategy at the level of district reference digital junior secondary schools tended to be similar across schools of markedly different scale, with both case-study loci displaying comparable patterns of four strategies and four implementation forms. This raises the possibility of a common strategic pattern across reference digital schools in Rokan Hulu Regency that may be worth testing in future research with a broader population of schools, rather than a confirmed generalizable framework at this stage. Practically, these findings tentatively suggest that educational management may benefit from positioning digital literacy as an integral part of school planning, human-resource development, instructional supervision, and organizational culture-building, rather than as an incidental add-on program.

Alternative Explanations and Limitations

Several alternative explanations for the reported improvements in digital work habits deserve acknowledgment. National platform mandates (e.g., required use of Dapodik, e-Raport, and Rumah Pendidikan), district-level policy directives, peer influence operating independently of formal mentoring structures, and incremental infrastructure upgrades may all have contributed to the reported changes alongside, or independently of, principal leadership. Because this study did not isolate these factors experimentally or statistically, the findings should be read as identifying principal leadership as one plausible and frequently emphasized contributor among several, rather than as the sole or dominant causal driver.

This study is limited in the following respects. First, the two-school purposive sample restricts the transferability of findings to schools with markedly different resource profiles, digital-school status, or regional policy environments. Second, the evidence relies substantially

on self-reported accounts, which may be subject to social-desirability bias, particularly given that informants were reporting on activities associated with their own school's public reference-digital-school status. Third, the study did not directly measure teachers' or education personnel's digital competence before or after strategy implementation; conclusions about competence therefore reflect informants' and the researcher's perceptions rather than objective assessment. Fourth, although this revision expands the within-case account for SMP Negeri 1 Rambah (Section 3.2) to achieve closer parity with SMP Negeri 1 Rambah Hilir, the larger school's more dispersed staff structure meant that fewer centralized documentary sources were available for direct review, and some residual asymmetry in the depth of documentary evidence between the two cases remains a limitation. Fifth, the researcher's role during observation may have introduced reactivity, whereby participants' behavior during observed sessions differed from unobserved routine practice, notwithstanding the non-participant posture maintained throughout data collection.

CONCLUSIONS

This study concludes that, based on the perceptions and observed practices reported by informants at two reference digital public junior secondary schools in Rokan Hulu Regency, principals implemented four interrelated strategies to support the digital literacy of teachers and education personnel: mapping digital needs and competencies; a gradual and adaptive approach tailored to human-resource readiness; resource optimization through internal mentoring and district education-office support; and building a digital culture through innovation in work habits and communication. These strategies were realized through four mutually reinforcing implementation forms: internal training and direct application, mentoring and best-practice sharing (peer coaching), supervision-based monitoring and evaluation, and integration of the program into the school management system. Across both cases, principal leadership was the supporting factor most frequently emphasized by informants, while the digital-skills gap among teachers together with limited development time was the inhibiting factor most frequently emphasized, compounded by facility and internet-network limitations.

These findings are broadly compatible with transformational leadership theory (Bass & Avolio, 1994) and distributed leadership theory (Spillane, 2006) as analytical lenses for interpreting educational leadership in the context of digital transformation in rural junior secondary schools; the convergence of strategic patterns across two schools of markedly different scale suggests the pattern may be potentially transferable to comparable reference digital schools, though confirmation in a larger and more varied sample is needed before broader claims of replicability can be made, and because digital-literacy competence was not measured directly, these conclusions describe the implementation of leadership strategies rather than verified competence improvement. Based on these findings, three recommendations follow. First, technological infrastructure particularly internet-network stability and device adequacy should be strengthened. Second, tiered and personalized mentoring should be sustained rather than relying on one-off training, so that the digital-skills gap can be progressively narrowed. Third, collaboration among the district education office, school committees, and external partners should be strengthened to expand access to training resources and support a more equitable distribution of digital competence. Future research employing a mixed-methods approach with a broader and more varied range of schools, and incorporating direct measures of digital competence, is recommended to more rigorously test the relationship between principal strategy and digital-literacy outcomes.

ACKNOWLEDGMENT

The author would like to thank the principals, teachers, and education personnel of SMP Negeri 1 Rambah and SMP Negeri 1 Rambah Hilir for their willingness to serve as research informants, the academic supervisor for guidance throughout this study, and the Master's Program in Educational Management, Faculty of Education, Universitas Negeri Yogyakarta, for its research support.

AUTHOR CONTRIBUTION STATEMENT

FR contributed to the conceptualization of the study, development of the methodology, investigation, data collection and curation, formal analysis, visualization, preparation of the original manuscript draft, and subsequent revision of the manuscript. NAP contributed to the conceptualization and methodological development of the study, validation of the analytical process, academic supervision, and critical review and revision of the manuscript. Both authors reviewed and approved the final version of the manuscript and agreed to be accountable for the integrity and accuracy of the work.

AI DISCLOSURE STATEMENT

During the preparation of this manuscript, the authors used generative artificial intelligence tools solely to assist with language refinement, grammatical correction, and improvement of textual clarity. The AI tools were not used to generate research data, conduct data analysis, interpret findings, develop conclusions, or make substantive scholarly decisions. All AI-assisted content was critically reviewed, verified, and revised by the authors, who take full responsibility for the accuracy, originality, integrity, and final content of the manuscript.

REFERENCES

- Aldosemani, T., Lytras, M. D., & Ordóñez de Pablos, P. (Eds.). (2025). *Innovative educational frameworks for future skills and competencies*. IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3693-7555-6>
- Badan Pusat Statistik. (2025). Statistik telekomunikasi Indonesia 2024. BPS RI.
- Bass, B. M., & Avolio, B. J. (1994). Improving organizational effectiveness through transformational leadership. Sage Publications.
- Brunning, M., Fischetti, J., & Smith, M. (2020). Renewing the Promise and Potential of School-Based Management. *NASSP Bulletin*, 104(3), 177–201. <https://doi.org/10.1177/0192636520956717>
- Burns, E., Silvennoinen, E., Kopnov, V. A., Shchipanova, D. E., Papić-Blagojević, N., & Tomašević, S. (2020). Supporting the development of digitally competent vet teachers in Serbia and Russia. *Obrazovanje i Nauka*, 22(9), 174–203. <https://doi.org/10.17853/1994-5639-2020-9-174-203>
- Carretero, S., Vuorikari, R., & Punie, Y. (2017). *DigComp 2.1: The Digital Competence Framework for Citizens with eight proficiency levels and examples of use*. Publications Office of the European Union. <https://doi.org/10.2760/38842>
- Chang, I.-H. (2012). The effect of principals' technological leadership on teachers' technological literacy and teaching effectiveness in Taiwanese elementary schools. *Journal of Educational Technology & Society*, 15(2), 328–340.
- Dinas Pendidikan, Pemuda dan Olahraga Kabupaten Rokan Hulu. (2025). *Keputusan Kepala Dinas Pendidikan, Pemuda dan Olahraga Kabupaten Rokan Hulu Nomor Kpts.400.3.1/Disdikpora-Set/043 tentang Penunjukan dan Penetapan Sasaran Digitalisasi Sekolah Jenjang SD/SMP se-Kabupaten Rokan Hulu Tahun 2025*.
- Hulwana, H. (2024). Strategi kepala sekolah dalam meningkatkan kemampuan literasi digital guru dan tenaga kependidikan SMPN 7 Bukittinggi. *Al-Marsus: Jurnal Manajemen Pendidikan Islam*, 2(1), 23-35. <https://doi.org/10.30983/al-marsus.v2i1.8257>
- Kementerian Komunikasi dan Digital Republik Indonesia. (2024). Indeks Masyarakat Digital Indonesia (IMDI) 2024.
- Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia. (2025). Rapor pendidikan Indonesia 2025.
- Malterud, K., Siersma, V. D., & Guassora, A. D. (2016). Sample size in qualitative interview studies: Guided by information power. *Qualitative Health Research*, 26(13), 1753–1760. <https://doi.org/10.1177/1049732315617444>

- Metaferia, T., Baraki, Z., & Mebratu, B. (2023). Transformational leadership practices and its influence on teachers job satisfaction in Addis Ababa government secondary schools. *Cogent Education*, 10(2). <https://doi.org/10.1080/2331186X.2023.2249658>
- Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). SAGE Publications.
- Minister of National Education of the Republic of Indonesia. (2007). *Regulation No. 16 of 2007 on Academic Qualification and Teacher Competency Standards*.
- Muslikhatun, S., Maulida, R., & Maharani, D. (2024). Coaching berbasis digital dalam peningkatan kapasitas guru. *Tadrib: Jurnal Pendidikan Guru Madrasah Ibtidaiyah*, 5(2), 101–115. <https://doi.org/10.24252/tadrib.v5i2.48293>
- Nagel, I., & Amdam, S. H. (2025). Teachers' Professional Digital Competence. *Encyclopedia*, 5(3), Article 148. <https://doi.org/10.3390/encyclopedia5030148>
- Nasution, I. (2021). Peran kepala sekolah dalam menghadapi era digitalisasi pendidikan. *Jurnal Administrasi Pendidikan*, 28(1), 44–52. <https://doi.org/10.17509/jap.v28i1.37128>
- Nurhalimah, N. (2021). Peran kepemimpinan digital dalam pengembangan sekolah abad 21. *EDUKATIF: Jurnal Ilmu Pendidikan*, 3(4), 2150–2160. <https://doi.org/10.30631/edukatif.v3i4.845>
- Pamungkas, R. B., Alauddin, Firmansyah, & Tahrir, T. (2024). Peran kepala sekolah dalam pengembangan literasi digital guru untuk mewujudkan Sekolah Penggerak di SMP Negeri 3 Palopo. *Hikamatzu Journal of Multidisciplinary*, 1(1), 238–251.
- Redecker, C. (2017). *European Framework for the Digital Competence of Educators: DigCompEdu* (Y. Punie, Ed.). Publications Office of the European Union. <https://doi.org/10.2760/159770>
- Republic of Indonesia. (2003). *Law No. 20 of 2003 on the National Education System*.
- Republic of Indonesia. (2005). *Law No. 14 of 2005 on Teachers and Lecturers*.
- Rusilowati, A., Hidayah, I., Nugrahani, R., Abidin, Z., Hutagalung, F. D., Sofchah, T., & Ariyanti, S. W. (2024). CHILD-FRIENDLY SCHOOL AND ITS RELATIONSHIP WITH THE MERDEKA CURRICULUM IN FORMING THE STUDENTS' CHARACTER THROUGH SCIENCE LEARNING. *Jurnal Pendidikan IPA Indonesia*, 13(1), 137–146. <https://doi.org/10.15294/jpii.v13i1.44482>
- Sary, F. P., Farihin, A., Tamam, B., Prasetyo, A., & Rahmatika, A. F. (2024). The influence of leadership on factors related to teachers in Islamic boarding schools. *Edelweiss Applied Science and Technology*, 8(5), 26–39. <https://doi.org/10.55214/25768484.v8i5.1628>
- Spillane, J. P. (2006). *Distributed leadership*. Jossey-Bass.
- Sugiyono. (2023). *Metode penelitian kualitatif*. Alfabeta.
- Sulastri, S., Nurkolis, N., & Kusumaningsih, W. (2024). Pengaruh gaya kepemimpinan kepala sekolah dan motivasi kerja guru terhadap digitalisasi pembelajaran di sekolah dasar negeri. *Jurnal Inovasi Pembelajaran di Sekolah*, 5(1), 329–337. <https://doi.org/10.51874/jips.v5i1.230>
- World Medical Association. (2013). World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. *JAMA*, 310(20), 2191–2194. <https://doi.org/10.1001/jama.2013.281053>
- Xu, C., Hania, A., & Waqas, M. (2025). Guiding the digital generation: Role of principals' leadership, ICT competence, and teacher professional competence in fostering digital citizenship among university students. *Education and Information Technologies*, 30(1), 1165–1189. <https://doi.org/10.1007/s10639-024-13180-2>
- Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). Sage Publications.
- Zhang, L., Yang, C., & Zheng, Y. (2026). Digital competence for sustainable education of pre-service teachers: a systematic literature review (2014–2024). *Frontiers in Psychology*, 16, Article 1710983. <https://doi.org/10.3389/fpsyg.2025.1710983>
- Zhang, X., Admiraal, W., Saab, N., & Liu, Y. (2025). Exploring teaching quality: The role of school working conditions, principal leadership, and teacher characteristics. *Educational Psychology*, 45(3), 292–313. <https://doi.org/10.1080/01443410.2025.2466663>