

EXPLORING VOCATIONAL SCHOOL PRINCIPALS' DIGITAL LEADERSHIP IN CULTIVATING SCHOOL DIGITAL CULTURE

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Abstract: The accelerating digital transformation in education highlights the strategic role of principals in cultivating sustainable digital culture, yet empirical evidence from vocational schools in developing countries remains limited. This study employs a qualitative exploratory design in five public vocational high schools (SMKs) in Yogyakarta, Indonesia, with 15 informants comprising principals, teachers, and administrative staff. Data were collected through in-depth interviews, observations, and document analysis, and analyzed thematically. The findings reveal six interdependent dimensions of digital leadership: vision and policy, digital learning, teacher professionalism, digital management, assessment and supervision, and responsiveness to social–ethical issues. Together, these dimensions illustrate how principals strategically integrate technology and organizational culture to enable holistic school transformation. Unlike previous studies that primarily emphasize teacher innovation or PLC mediation, this research highlights the broader organizational processes of fostering digital culture within vocational education. Theoretically, it advances educational leadership literature by proposing a context-specific framework for digital leadership in developing countries. Practically, it provides concrete guidance for principals and policymakers in designing professional development, formulating digital policies, and fostering ethical digital awareness to strengthen sustainable school digitalization.

Key words: Digital leadership, Vocational education, School culture, Educational transformation, Principal leadership.

Abstrak: Percepatan transformasi digital dalam pendidikan menegaskan peran strategis kepala sekolah dalam membangun budaya digital yang berkelanjutan, namun bukti empiris dari sekolah vokasional di negara berkembang masih terbatas. Penelitian ini menggunakan desain kualitatif eksploratif di lima SMK Negeri di Kota Yogyakarta dengan melibatkan 15 informan yang terdiri atas kepala sekolah, guru, dan tenaga kependidikan. Data dikumpulkan melalui wawancara mendalam, observasi, serta analisis dokumen, kemudian dianalisis secara tematik. Hasil penelitian mengungkap enam dimensi kepemimpinan digital yang saling terkait, yaitu visi dan kebijakan, pembelajaran digital, profesionalitas guru, manajemen digital, asesmen dan supervisi, serta respons terhadap isu sosial–etika. Keenam dimensi tersebut menunjukkan bagaimana kepala sekolah mengintegrasikan teknologi dengan budaya organisasi sekolah untuk mendorong transformasi yang holistik. Berbeda dengan penelitian sebelumnya yang berfokus pada inovasi guru atau mediasi PLC, penelitian ini menekankan proses organisasi yang lebih luas dalam menumbuhkan budaya digital pada pendidikan vokasional. Secara teoretis, penelitian ini memperkaya literatur kepemimpinan pendidikan dengan menawarkan kerangka kontekstual kepemimpinan digital di negara berkembang. Secara praktis, hasil penelitian memberikan panduan konkret bagi kepala sekolah dan pembuat kebijakan dalam merancang pelatihan, merumuskan kebijakan digital, serta menumbuhkan kesadaran etika digital guna memperkuat digitalisasi sekolah yang berkelanjutan..

Kata kunci: Kepemimpinan digital, Pendidikan vokasi, Budaya sekolah, Transformasi pendidikan, Kepemimpinan kepala sekolah.

Digital transformation in education has emerged as a global phenomenon that reshapes both learning systems and school management, creating profound implications for the sustainability of education (Hashim et al., 2022; Oliveira & de Souza, 2021). Learning systems have shifted from conventional face-to-face models toward technology-driven practices, including online learning, *Learning Management Systems* (LMS), and digital learning resources (Liu & Yu, 2023; Yeoman & McMahon-Beattie, 2018). In parallel, school management increasingly relies on information systems, administrative automation, cloud-based data management, and online communication (Chukwuemeka-Nworu et al., 2024; Ibrahim et al., 2020). These transformations underline that technology is no longer a supplementary tool, but the foundation for building flexible, responsive, and sustainable education systems (Burbules et al., 2020; Salamony et al., 2022).

In Indonesia, vocational high schools (*Sekolah Menengah Kejuruan* or SMKs) occupy a strategic position in preparing graduates who are adaptive to technology-driven industries (Syarif et al., 2024). Yet, the digital transformation of SMKs continues to face challenges, such as infrastructure gaps, limited teacher training capacity, weak internal regulations, and leadership difficulties in ensuring comprehensive digital integration (Putri, 2025). The situation is evident in several public SMKs in Yogyakarta City: at SMKN 5 and SMKN 7, digital technology use in management and teaching remains unsupported by formal regulations, while at SMKN 2 it is confined to administrative purposes dictated by external agencies. These fragmented practices reveal weak institutional commitment and limited digital culture, even though digital culture should serve as the backbone of modern education (Chinedu, 2024).

Within this context, the principal plays a pivotal role in driving systemic transformation through digital leadership (Navaridas-Nalda et al., 2020; Ruloff & Petko, 2025). Digital leadership, as described by Sheninger (2019), represents a dynamic combination of mindsets, skills, and strategies for embedding technology into school culture. Sheninger

(2014) and Zhong (2017) further emphasize that effective digital leadership is not only reactive to technological change but proactive in cultivating collaborative, innovative, and data-driven learning ecosystems. Consequently, the effectiveness of digital transformation in vocational schools largely depends on the principal's strategic ability to manage change sustainably.

The Covid-19 pandemic accelerated this urgency, testing schools' readiness for rapid digital adoption. As Tsai (2020) notes, the crisis forced schools to embrace online learning, digital administration, and educational platforms as new norms, demanding quick adaptation from all stakeholders (Adedoyin & Soykan, 2023). These changes required teachers to master digital pedagogy, while principals were responsible for ensuring infrastructure readiness, establishing policies, and coordinating resources to sustain learning (Clarke & O'Doherty, 2021). Regional policies have further shaped this dynamic. Several SMKs in Yogyakarta, including SMKN 2 and SMKN 6, have been designated as *Regional Public Service Agencies (BLUD)* under DIY Governor Regulation Number 17 of 2024, reflecting both opportunities and managerial challenges in implementing digitalization.

Although digital leadership has been widely discussed, existing studies reveal fragmented emphases. Sheninger (2019) views digital leadership as an integration of skills and strategies for strengthening school culture, while Arnov et al (2024) highlight that digitalization in many vocational schools is still dominated by infrastructure readiness rather than leadership. Navaridas-Nalda et al (2020) demonstrate that successful technology integration depends heavily on principals' capacity to build digital culture, and Ruloff & Petko (2025) underline that implementation gaps often stem from weak leadership strategies. Yet, these studies tend to remain general, focusing on definitions, principles, or infrastructure, without deeply exploring how principals in public vocational schools operationalize digital leadership to cultivate digital culture particularly in the unique policy and industrial context of Yogyakarta.

Scholars such as AlAjmi (2022) argue that digital leadership must align with the demands of the digital age by leveraging technology platforms to shape innovative school cultures. Similarly, Andriani & Dafit (2024) emphasize strengthening digital learning culture, teacher capacity, and leadership vision to advance digitalization policies. However, prior research remains conceptually broad and lacks empirical grounding in vocational schools, where the integration of digital leadership and digital culture is most crucial.

Therefore, this study aims to explore how principals in Yogyakarta's public SMKs implement digital leadership to foster a school-wide digital culture. By bridging theoretical perspectives on digital leadership with empirical realities of local vocational schools, this research offers a context-specific framework that contributes theoretically to the literature on educational leadership and practically to policy and managerial strategies for sustainable digital transformation in vocational education.

METHOD

This study employs an exploratory qualitative method to gain an in-depth understanding of the principal's leadership in supporting the digitalization of education in state vocational high schools (*SMK Negeri*) in Yogyakarta City. According to J. Creswell (2014), exploratory qualitative research is an approach aimed at exploring and understanding the meaning that individuals or groups ascribe to a social or human problem. This approach was chosen because it allows the researcher to uncover the phenomenon of digital leadership in a naturalistic manner through direct interaction with research subjects in their real-life contexts.

This approach was selected because it is able to reveal phenomena naturalistically based on the direct experiences of the subjects in the field. The research was

conducted from March to May 2025 in five state vocational high schools that have implemented education digitalization programs. Data were collected through in-depth interviews using a semi-structured guide, observations, and documentation studies of policies and relevant records.

Research Subjects

The research subjects consisted of school principals and teachers who were directly involved in the planning, implementation, and evaluation of education digitalization in their respective schools. The selection of subjects was carried out *purposively* based on criteria of active involvement in the digitalization process, work experience, and strategic position in school decision-making. The sources of data included primary data obtained from interviews and observations, as well as secondary data from school policy documents, program reports, and archives of digitalization activities.

Table 1. Research Subjects

Research Location	Informants	
SMKN 2 Yogyakarta	Principal	and
	Teachers	
SMKN 3 Yogyakarta	Principal	and
	Teachers	
SMKN 5 Yogyakarta	Principal	and
	Teachers	
SMKN 6 Yogyakarta	Principal	and
	Teachers	
SMKN 7 Yogyakarta	Principal	and
	Teachers	

Data Analysis Technique

This study employed thematic analysis to explore and identify the main themes that emerged from the school principals' leadership practices in supporting the digitalization of education in public vocational high schools (*SMK Negeri*) in Yogyakarta City. Thematic analysis, as explained by (Braun & Clarke, 2006), is a method for organizing and describing a dataset in detail, while also interpreting the meanings contained within it.

Table 2. coding frame analytic

Main Theme	Sub-theme / Code Category	Example Data (Interview/Observation Quotes)
Vision and Policy	- Digital vision formulation - Operational policy - LMS/PMM integration	"We want to ensure that teachers and students share the same view on the importance of technology."
Digital Learning	- Digital learning materials - Learning communities	"PMM really helps us because materials are easier to access." "We are encouraged to immediately try new applications in class, and support is always available."
Teacher Professionalism	- Digital training - Teacher mentoring - Professional use of social media - Partnerships with digital providers - Infrastructure provision	"Every activity now has to be recorded in the application, from teacher attendance to school reports."
Digital Management and Operations	- Digitalization team - Administrative applications - E-report cards	
Assessment, Monitoring, Supervision	- Monitoring dashboard - Online supervision - Digital ethics	"Supervision is now more practical because it can be done online."
Social, Legal, and Ethical Issues	- Data security - Identifying barriers	"We always remind teachers and students to use technology wisely, without violating rules."

The analysis process followed six main stages: (1) familiarization with the data, by rereading interview transcripts and observation notes thoroughly to understand the content and initial patterns, accompanied by verbatim transcription; (2) coding, by assigning labels to important meaning units, both explicit and implicit; (3) theme identification, namely grouping codes into potential themes that represent relationships among codes; (4) theme review, to refine and ensure consistent representation of the data; (5) defining and naming themes, by constructing narratives that explain the essence of each theme and sub-theme; and (6) reporting, which presents the findings logically, supported by relevant data excerpts, and linked to the research questions. The validity of the data was strengthened through source triangulation, technique triangulation, and member checking with respondents to ensure the conformity of interpretations with field realities.

RESULT

The data presented were obtained from in-depth interviews with principals and teachers at SMKN 2 Yogyakarta, SMKN 3 Yogyakarta, SMKN 5 Yogyakarta, SMKN 6 Yogyakarta, and SMKN 7 Yogyakarta. There are six dimensions related to digital leadership developed by the Center for the Advanced Study of Technology Leadership in Education (CASTLE), a university-based research center in the United States that focuses on developing technology leadership in education, namely: digital leadership and vision; digital teaching and learning; productivity and professionalism; support, management, and operations; digital assessment and evaluation; and social, legal, and ethical issues. To facilitate understanding of the qualitative research findings, the data are presented in the form of a thematic diagram that visualizes the relationships among themes, categories, and sub-categories of the findings

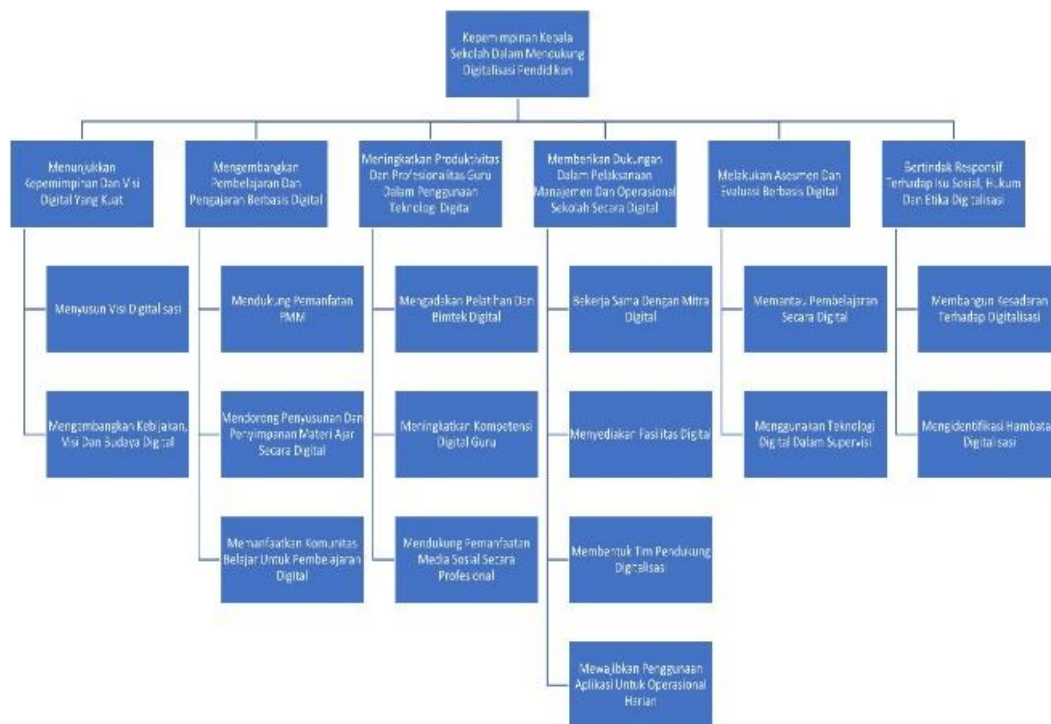


Figure 1. Results of Thematic Analysis

The findings of this study identified six dimensions of school principals' leadership in building a culture of digitalization at public vocational high schools (SMK Negeri) in Yogyakarta City.

Demonstrating Strong Digital Leadership and Vision

The study revealed that principals in SMK Negeri Yogyakarta exhibited visionary leadership in supporting educational digitalization. This leadership was reflected in their ability to guide the entire school community to understand the direction of digital transformation and adapt to technological developments. Principals consistently conveyed the message of digitalization vision in various forums, both formal and informal, and set an example in the application of technology. One principal stated, *"We want to ensure that teachers and students share the same perspective on the importance of technology in learning. All of our policies are directed toward creating a digital ecosystem in schools."*

The formulation of the digitalization vision was carried out through a participatory process, involving teachers, administrative staff, and external stakeholders to ensure the relevance and applicability of the vision in the school context. This vision contained

strategic goals, success indicators, and measurable directions for the development of educational technology. A teacher explained, *"We were involved in the discussion of formulating the vision, so the direction of digital development truly aligned with our needs in the field."* Active involvement of stakeholders strengthened the legitimacy of the vision and increased the commitment to its implementation.

Furthermore, the vision was translated into concrete policies and programs. These policies included standards for the use of technological devices, integration of technology into the curriculum, training to enhance teachers' digital competence, and mechanisms for evaluating program implementation. Principals also emphasized building a digital culture through habitual use of technology, strengthening digital literacy, and creating a work environment adaptive to innovation. An administrative staff member shared, *"The digital culture is starting to be felt here. All documents are now directed to be electronic-based, and meetings are often conducted online."*

Data triangulation was achieved through a combination of interviews, direct observations, and documentation. Observations indicated that technological

facilities in schools, such as computer laboratories, internet networks, and digital learning devices, had been optimally utilized by teachers and students. These findings suggest that the success of educational digitalization in SMK Negeri Yogyakarta does not solely depend on the provision of technological facilities, but also on leadership that is capable of building a shared vision, translating it into operational policies, and establishing a sustainable digital culture.

Developing Digital-Based Teaching and Learning

The study showed that principals in SMK Negeri Yogyakarta played an active role in developing digital-based teaching and learning. This support was realized through the provision of devices, teacher training, and encouragement to integrate technology into teaching and learning activities. One teacher explained, *"We were asked to get used to using digital learning applications. The principal also monitors how we integrate technology into our teaching."* Observations supported this statement, as teachers were seen using projectors, LMS, and online assessment applications in their classrooms. Documentation, in the form of photos of digital-based learning activities, further reinforced these findings.



Figure 2. Digital-Based Learning

In addition, principals encouraged the use of the *Merdeka Mengajar Platform (PMM)* as a means to improve the quality of learning as well as a forum for teacher collaboration. Through this platform, teachers gained access to teaching modules, instructional videos, and question banks aligned with the curriculum. One respondent noted, *"PMM really helps us in preparing lessons, because the materials are easier to access and we can also see the best practices of other teachers."*

This is consistent with the results of observations, which showed that teachers accessed PMM for lesson preparation.

Principals also encouraged the preparation and storage of teaching materials in digital form. All teachers were directed to create lesson modules, lesson plans, and teaching resources in electronic formats stored on the school's server or cloud-based storage services. An administrative staff member stated, *"Now all teaching resources have been compiled in digital files, so it is more practical and secure."* Observations supported this statement, as a shared digital folder containing teaching documents was found. Documentation in the form of digital lesson plan archives and teacher modules further reinforced this practice.



Figure 3. Teacher Teaching Modules

In addition, principals facilitated the establishment of learning communities that functioned as collaborative spaces for the development of digital learning. These communities served as forums for teachers to share experiences, ideas, and strategies for using technology. One teacher explained, *"We often exchange experiences through learning communities, both online and face-to-face, and from there we gain inspiration to apply in class."*

Triangulation of data through interviews, observations, and documentation revealed that the principal's strategies in developing digital learning were not only focused on providing facilities, but also encouraged the use of national platforms, the management of digital teaching materials, and the strengthening of collaboration through

learning communities. Thus, an educational ecosystem adaptive to digital transformation and supportive of continuous learning improvement was created.

Strengthening Productivity and Professionalism

The findings show that principals played a significant role in improving teacher productivity and professionalism in the use of digital technology. One effort was the organized and continuous implementation of training and digital technical guidance. Teachers were given opportunities to attend training facilitated by the school as well as by the education office. One teacher stated, *"The school often holds digital training, and we are even supported to join technical workshops held by the education office. This really helps us gain new knowledge."* Field observations showed training sessions for teachers focused on the use of digital learning applications, while documentation such as certificates of participation and training reports supported this practice.

Beyond training, principals encouraged the enhancement of teachers' digital competence through intensive mentoring and direct practice in classrooms. Teachers were not only asked to attend training but also directed to immediately implement newly acquired skills into teaching practices. One teacher explained, *"We are encouraged not only to attend training but also to try new applications in the classroom right away, and if we encounter difficulties, there is always mentoring."* Observations showed that teachers had become accustomed to using LMS, interactive quiz applications, and digital evaluation platforms, while documentation of principal supervision reinforced this finding.

Furthermore, principals also provided support for the professional use of social media. Social media was positioned as a tool for publicizing school activities, sharing best practices, and strengthening the school's positive image in the digital space. An administrative staff member stated, *"We are directed to use social media positively, for example by posting learning activities, teacher innovations, and student achievements."* Observations found active official school accounts presenting educational content, while screenshots of the

school's social media accounts supported the interview data.

Based on triangulation of interviews, observations, and documentation, it can be concluded that the principal's strategies in strengthening teacher productivity and professionalism have successfully enhanced digital skills, increased teacher confidence in using technology, and built awareness of ethical and professional use of social media. These efforts not only improved teachers' individual capacity but also positioned the school as a more adaptive and competitive institution in the digital era.

Providing Support for Digital School Management and Operations

The findings indicate that principals strongly supported the implementation of digital school management and operations. One form of support was through partnerships with digital partners, both educational application providers and government agencies, to expand school access to digital tools and services. One principal stated, *"We work with several parties, including educational application providers, so the school can get digital facilities that meet its needs."* This finding was supported by documentation in the form of MoUs between schools and digital partners.

In addition to partnerships, principals also ensured the provision of adequate digital facilities to support teaching and school governance. These included computers, internet networks, and projectors in classrooms. One teacher noted, *"Now the school has prepared better equipment and networks, so digital activities run more smoothly."* Observations showed teachers and students using these facilities in daily activities, while school digital inventory records supported the presence of these facilities.

Principals also formed digital support teams responsible for ensuring the smooth implementation of technology in schools, from technical assistance and device maintenance to supporting teachers in overcoming application difficulties. One team member stated, *"We were specifically appointed to help teachers use applications, including when they face technical issues in class."* Observations showed active team

assistance, while documentation in the form of appointment letters supported the finding.

Furthermore, principals mandated the use of digital applications in daily school operations. These applications were used for teacher attendance, schedule management, and administrative reporting. An administrative staff member explained, *"Now every activity must be recorded in the application, from teacher attendance to school activity reports."* Observations confirmed routine use of digital attendance applications, while screenshots and digital reports supported the data.

Based on triangulation of interviews, observations, and documentation, it can be concluded that principal support in digital school management and operations was implemented through four main steps: partnering with digital stakeholders, providing adequate facilities, establishing support teams, and mandating the use of applications for daily operations. This comprehensive strategy has made school governance more efficient, transparent, and responsive to technological developments.

Conducting Digital-Based Assessment and Evaluation

The findings reveal that principals implemented digital-based assessments and evaluations as part of strengthening managerial functions in supporting educational transformation. Digital assessment facilitated faster scoring, quicker access to results, and improved transparency for students and parents. One teacher stated, *"Assessments are now directed to use applications, so they are faster, and results can be accessed directly by students and parents."* This was supported by observations of teachers using e-report applications and documentation of digital assessment data stored in school systems.

Moreover, principals utilized technology to monitor learning digitally. Monitoring was conducted via online learning platforms, digital reports from teachers, and special dashboards containing student activity and curriculum achievement data. This made supervision more structured and real-time. One principal explained, *"We can monitor teachers' learning processes through applications, including student engagement*

and curriculum achievement." Observations confirmed digital reporting practices, while screenshots of monitoring dashboards supported the finding.

Furthermore, principals optimized the use of digital technology in supervision. Supervision, previously conducted manually, was expanded through online systems for greater practicality and efficiency. Teachers could directly receive evaluation notes and feedback digitally. One teacher shared, *"Supervision is now more practical because it can be done online, and we immediately receive evaluation notes from the principal."* Observations confirmed online supervision using digital forms, while archived online supervision reports reinforced the finding.

Based on triangulation of interviews, observations, and documentation, it can be concluded that digital-based assessment, monitoring, and supervision have significantly improved school management effectiveness. These strategies made assessments more transparent, monitoring more efficient, and teacher supervision more oriented toward continuous quality improvement.

Responding to Social, Legal, and Ethical Issues in Digitalization

The findings show that principals were responsive to social, legal, and ethical issues arising from the digitalization of education. Principals consistently reminded teachers and students to use technology according to regulations and to ensure data security. One principal emphasized, *"We always remind teachers and students to use technology wisely, not to break the rules, and to pay attention to data security."* This was aligned with observations of digital ethics campaigns in schools and documentation in the form of digital usage guidelines.

In addition, principals sought to build awareness among school communities about the importance of digitalization. Awareness was cultivated through socialization sessions, routine discussions, and the habituation of technology use in both teaching and administration. One teacher explained, *"Through the principal's guidance, we are increasingly aware that digitalization is not just a demand but a necessity to improve the quality of learning."* Observations showed teacher and student enthusiasm in digital

literacy activities, while photos of digital awareness programs supported the finding.

Furthermore, principals actively identified barriers in implementing digitalization, such as infrastructure limitations, varying teacher competencies, and resistance from some school members. One teacher noted, *"There are still obstacles, especially unstable internet connections, and some teachers need more time to adapt."* Observations confirmed this with classrooms experiencing poor internet access, while evaluation reports of digital programs supported the finding.

Based on triangulation of interviews, observations, and documentation, it can be concluded that principals were not only responsive to social, legal, and ethical issues but also successfully raised awareness of the importance of digitalization and identified implementation challenges. These strategies reflect adaptive and solution-oriented leadership in addressing digital

Table 3 Conceptual Research Finding

Main Theme	Sub-theme / Category	Description of Findings	Supporting Data (Triangulation)	Conceptual Implications
Vision and Policy	Digital vision formulation; Operational policy	Principals formulate digitalization visions aligned with national and local policies; translated into concrete operational policies.	Interview: 'We want to ensure teachers and students share the same view on the importance of technology.'; Observation: Vision-setting meetings; Documentation: Vision documents and policies.	Clear vision strengthens organizational commitment and provides direction for digital transformation.
Digital Learning	Integration of platforms (LMS, PMM); Digital learning materials; Learning communities	Teachers are directed to use PMM, prepare digital materials, and engage in learning communities.	Interview: 'PMM really helps us because materials are easier to access.'; Observation: Teachers using LMS; Documentation: Digital modules.	Supports 21st-century learning that is interactive, collaborative, and resource-based.
Teacher Professionalism	Training & mentoring; Professional use of social media	Principals provide digital training, mentoring, and encourage professional use of social media for positive school branding.	Interview: 'We are encouraged to immediately try new applications in class, and support is always available.'; Observation: Training sessions; Documentation: Certificates & reports.	Improves teacher capacity and confidence, strengthening digital professionalism.
Digital Management and Operations	Partnerships with digital providers; Digitalization team; Administrative applications	Principals establish partnerships, form digitalization teams, and mandate digital applications for administration.	Interview: 'Every activity now has to be recorded in the application, from teacher attendance to school reports.'; Observation: Digital	Enhances efficiency, transparency, and accountability in school governance.

transformation challenges, enabling schools to move toward more modern governance and teaching practices.

DISCUSSION

This study emphasizes that school principals' leadership plays a crucial role in supporting the digitalization of education in Vocational High Schools (SMK) in Yogyakarta City. The findings indicate that principals act as the driving force behind digital transformation by presenting a clear vision, integrating adaptive policies, and leading participatively to encourage the involvement of the entire school community. The digital vision developed is not limited to administrative documents but is manifested in concrete strategies that are consistently communicated to teachers, students, and education staff.

Main Theme	Sub-theme / Category	Description of Findings	Supporting Data (Triangulation)	Conceptual Implications
Assessment, Monitoring, Supervision	E-report cards; Monitoring dashboard; Online supervision	Digital assessments, real-time monitoring, and online supervision are used to enhance evaluation and teacher development.	attendance; Documentation: MoUs & inventories. Interview: 'Supervision is now more practical because it can be done online.'; Observation: Use of e-report cards; Documentation: Online supervision archives.	Makes evaluation more transparent, effective, and oriented toward continuous improvement.
Social, Legal, and Ethical Issues	Digital ethics; Data security; Identifying barriers	Principals emphasize digital ethics, data protection, and identify barriers such as infrastructure and teacher readiness.	Interview: 'We always remind teachers and students to use technology wisely, without violating rules.'; Observation: Digital ethics workshops; Documentation: Evaluation reports.	Ensures digital transformation is ethical, legal, and adaptive to real challenges in schools.

The conceptual table of research findings summarizes six key dimensions of digital leadership practiced by principals in public vocational schools in Yogyakarta City: vision and policy, digital learning, teacher professionalism, digital management and operations, assessment–monitoring–supervision, and social, legal, and ethical issues. Each dimension is detailed through specific sub-themes, such as the formulation of digital vision, integration of learning platforms, teacher training, establishment of digitalization teams, use of e-report cards, and emphasis on digital ethics. The findings are supported by triangulated data from interviews, observations, and documentation, ensuring consistency between participants' experiences, actual practices in schools, and official records.

The descriptions in the table also highlight how each dimension contributes to a holistic school digital transformation. For instance, the vision and policy dimension provides strategic direction, digital learning enhances pedagogical quality, teacher professionalism strengthens capacity and confidence, digital management ensures administrative efficiency, digital assessment fosters transparency in evaluation, and digital ethics guarantees sustainability through lawful and ethical practices. The conceptual implications drawn from these findings suggest that principals' digital leadership

extends beyond technical mastery, functioning instead as an orchestration of school culture, policies, and practices to create an adaptive, sustainable, and future-oriented educational ecosystem

In this way, principals cultivate a progressive digital culture while strengthening the school's identity as an institution that is adaptive to contemporary demands. This aligns with transformational leadership theory, which highlights the importance of leaders in providing inspiration and motivation to direct organizational change toward a shared vision (Bass & Riggio, 2006). The ability of principals to articulate a participatory digital vision also reinforces previous research emphasizing that digital leadership must mobilize the full potential of schools to adopt technological innovation (Avolio & Kahai, 2000).

Beyond vision-building, principals also play a central role in developing digital-based learning. This role is realized through facilitating the use of digital devices, providing training, and encouraging teachers to use national platforms such as the Merdeka Mengajar Platform (PMM). Through PMM, teachers gain access to teaching modules, learning videos, and best practices from peers across Indonesia. This demonstrates that principals' leadership is oriented toward improving learning quality, not merely the adoption of technology. By supporting

teachers in preparing digital teaching materials and encouraging the establishment of learning communities, principals ensure that digital transformation takes place not only at the infrastructure level but also within pedagogical practices. These findings are consistent with the literature, which states that digital instructional leadership should focus on how technology can enhance student engagement and learning outcomes (Harris & Jones, 2020). Thus, the role of principals in developing digital learning can be regarded as a catalyst for creating 21st-century learning that is interactive, collaborative, and relevant to students' needs.

Another important dimension is the role of principals in enhancing teacher productivity and professionalism. This study found that principals systematically organize training, technical workshops, and mentoring for teachers to strengthen their digital skills. Beyond that, principals encourage teachers to immediately practice newly acquired skills in teaching and ensure technical support is available when difficulties arise. Such support has had a positive impact not only on teachers' technical competence but also on their confidence and readiness to face digitalization demands. This aligns with the concept of capacity building, which emphasizes the importance of developing individual capacity as part of organizational transformation (Leithwood & Levin, 2005). In addition, the professional use of social media as directed by principals reflects visionary leadership, since social media is used not only as a communication medium but also as a platform for publicity and school branding. These findings support distributed leadership theory (Spillane, 2008), in which leaders create space for teachers to collaborate and develop professionalism both independently and collectively.

Furthermore, this study confirms that principals' leadership also impacts the management and operation of digital-based schools. Principals promote managerial transformation by building partnerships with external stakeholders, providing adequate digital facilities, establishing digitalization support teams, and mandating the use of applications in daily administrative activities. These strategies result in school governance

that is more efficient, transparent, and adaptive to technological developments. These findings are consistent with the concept of e-leadership, which emphasizes leaders' ability to leverage technology to improve management effectiveness. By integrating technology into administrative systems, principals reinforce institutional accountability and ensure the sustainability of digitalization at the structural level.

In addition to management, the evaluative dimension also receives significant attention in digital leadership. This study shows that principals have implemented digital-based assessment, monitoring, and supervision. Digital assessment accelerates grading processes and enhances transparency in students' learning outcomes; dashboard-based monitoring allows principals to oversee teaching in real time; while digital supervision enables teachers to receive feedback quickly and conveniently. This supports the literature emphasizing that technology can strengthen educational evaluation functions by providing accurate data to support decision-making (J. W. Creswell & Creswell, 2018). Moreover, digital supervision reflects the principle of formative assessment, which emphasizes the importance of continuous evaluation as a means of teacher professional development (Berisha et al., 2024). In other words, principals' leadership has successfully shifted the paradigm of evaluation from mere control to an instrument for improving the quality of learning.

The final dimension identified is principals' responsiveness to social, legal, and ethical issues in digitalization. Principals in this study actively reminded teachers and students to use technology wisely, comply with copyright regulations, safeguard personal data, and avoid misuse of social media. These efforts are crucial in fostering healthy digital literacy within the school environment. Furthermore, principals play a role in building awareness among school communities about the importance of digitalization while identifying barriers such as infrastructure limitations, variations in teacher competence, and resistance from some members of the school community. This demonstrates adaptive and solution-oriented leadership, in line with Heifetz's (1994)

concept of adaptive leadership (as cited in Eka Rachmawati et al (2023), where leaders not only address technical problems but also manage social resistance to change. These findings also align with Ribble (2015) view that ethics, law, and digital security must be fundamental pillars in educational digital transformation.

Synthesizing the six dimensions of digital leadership revealed in this study, it is clear that principals serve as change agents who are not only oriented toward providing technology but also toward cultivating digital culture, building teacher capacity, ensuring managerial efficiency, strengthening evaluation, and instilling ethical and legal awareness. Such digital leadership is comprehensive because it encompasses technical, cultural, social, and normative aspects simultaneously. This demonstrates that educational digitalization cannot run effectively without visionary, participatory, and responsive leadership. Theoretically, this study enriches the discourse on educational leadership by presenting a contextual perspective on digital leadership in Indonesia. Practically, these findings provide essential recommendations for principals to strengthen digital vision, support learning innovation, build teacher capacity, integrate technology into management, enhance digital evaluation systems, and foster digital ethics within schools. Thus, digital leadership can serve as a fundamental foundation for the success of

CONCLUSION

This study affirms that principals' digital leadership plays a crucial role in shaping school digital culture, particularly in vocational schools (SMK). The findings identified six dimensions of digital leadership: vision, learning, teacher professionalism, digital management, digital evaluation, and digital ethics, all of which complement each other in supporting technology-based educational transformation. Unlike previous studies that tended to focus on the impact of digital leadership on teacher behavior, this study broadens the scope by emphasizing the importance of establishing a comprehensive digital school culture. The novelty of this research lies in presenting an integrative conceptual framework that not only highlights

educational transformation in the era of Society 5.0.

This study's findings are in line with previous research emphasizing the importance of digital leadership in supporting teachers' practices. For example, research by A mar & Eleyan (2022) showed that principals' digital leadership fosters teachers' innovative behavior in using technology. Similarly, Rasdiana et al (2024) confirmed that principals' technological leadership significantly influences teachers' integration of technology into learning. However, both studies primarily emphasized individual teacher behavior, whether in terms of innovation or technology use in the classroom.

In contrast, this study focuses on a broader aspect: the development of a digital school culture through six dimensions of digital leadership vision, learning, teacher professionalism, digital management, digital evaluation, and digital ethics. Thus, the novelty of this research lies in combining the perspective of digital leadership with organizational digital culture-building within schools. This contribution enriches the literature by offering a conceptual framework that principals in vocational schools can use to design more comprehensive digitalization strategies, not only limited to supporting teacher practices but also encompassing regulatory reinforcement, values, and digital ethics within the school environment

principals' support for teachers but also underscores regulations, values, and digital ethics as the foundation of sustainable digital transformation. The implications of these findings are both theoretical and practical. Theoretically, this study enriches the literature on educational leadership by offering a new perspective on the relationship between digital leadership and school culture. Practically, the findings can serve as a reference for principals and policymakers in designing comprehensive digitalization strategies. Therefore, principals' digital leadership can serve as the primary foundation for the success of educational transformation in vocational schools, making them more relevant to the challenges of the Industrial 4.0 era

SUGGESTION

Practically, school principals should strengthen their digital leadership capacity by integrating continuous teacher training, establishing supportive internal policies, and embedding digital ethics within the school culture. Government bodies and policymakers are encouraged to provide regulatory support and adequate infrastructure to ensure that educational digitalization is implemented effectively and sustainably. Academically, future research may employ quantitative or mixed-method approaches to examine the correlation between digital leadership, teacher performance, and student learning outcomes. Comparative studies across different educational levels or regions are also recommended to generate broader insights into the effectiveness of digital leadership in fostering resilient school cultures during the era of educational transformation.

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