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The Digital Leadership Model of School Principals in Enhancing a Culture of Learning Innovation in the Era of Disruption

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Abstract – *This study examines the critical role of principals' digital leadership in fostering a culture of learning innovation in the era of technological disruption through a Systematic Literature Review (SLR) based on PRISMA 2020. A total of 28 selected sources were analyzed from an initial pool of 120 publications indexed in Google Scholar, Scopus, DOAJ, and SINTA levels 2–6, published between 2015 and 2025. The main findings identify four core pillars of digital leadership: Digital Competency Leadership (LMS mastery and data-driven decision-making), Innovation Leadership (vision for PjBL and STEAM), Collaborative Networking Leadership (Professional Learning Communities supported by Google Workspace), and Ethical and Inclusive Digital Culture (data privacy and accessibility). These pillars show a strong positive correlation (r = 0.72) with indicators of learning innovation culture, including blended learning implementation, teacher collaboration, student-centered environments, data-based evaluation, and creative learning models, resulting in improvements in student learning outcomes of up to 40–50%. Key challenges include low digital literacy (only 35% of teachers are digitally proficient), limited network infrastructure, administrative workload reaching 60%, and resistance to change (45%). These challenges can be mitigated through targeted training, Kotter's change management framework, and the integration of AI and VR platforms. The resulting conceptual model offers practical recommendations, including strengthening measurable digital vision, collaborative PLCs, digital pedagogy training, and industry partnerships to build an innovative educational ecosystem aligned with the Merdeka Curriculum and Society 5.0, supporting Indonesia's Golden Generation 2045.*

Keywords – *Digital Leadership, School Principals, Learning Innovation Culture, Technological Disruption Era.*

INTRODUCTION

The era of disruption, characterized by rapid advances in digital technology, automation, big data, and artificial intelligence, demands a comprehensive transformation of the education system. Schools must not only be adaptive but also proactive in developing a culture of learning innovation. In this context, school principals play a strategic role as digital leaders who are required to integrate technology, manage change, promote collaboration, and create a sustainable innovative learning ecosystem(Yang et al., 2025).

The role of principals as digital leaders includes the ability to integrate technology into learning and management processes, manage human resources through innovation, and apply transformational leadership focused on developing teachers' and students' capacities to face digital challenges, such as digital literacy and digital pedagogy (Avolio, B. J., & Kahai, 2003). Principals are also responsible for fostering a school culture that is responsive to change, facilitating collaboration among stakeholders, and utilizing big data to support more effective decision-making.

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Digital leadership transformation requires a new paradigm in which principals function not merely as administrators, but as innovative change agents and educators who inspire and motivate the entire school community toward high-quality, adaptive learning. Strategies for managing change and strengthening digital ecosystems include enhancing teachers' digital capacity, promoting active collaboration, and digitalizing school administrative systems (Wulan & Hanif, 2025)

Despite its importance, empirical evidence indicates that many schools still face challenges in digital transformation, such as low digital literacy among educators, limited facilities, resistance to change, and weak innovation management systems. Therefore, a relevant digital leadership model is needed to strengthen the culture of learning innovation.

OBJECTIVES OF THE STUDY

This study aims to examine how principals' digital leadership models can enhance a culture of learning innovation and to formulate a conceptual framework and practical recommendations for school implementation.

MATERIALS AND METHODS

Research Design and Approach

This study adopts a qualitative descriptive approach using a Systematic Literature Review (SLR) design, enabling an in-depth synthesis of relevant literature to identify patterns, themes, and knowledge gaps. The SLR approach is effective in exploring digital leadership phenomena in education through peer-reviewed journal articles indexed in Scopus, SINTA, and Google Scholar, following the PRISMA protocol to ensure transparency, reproducibility, and rigor in source selection (Fauzi, 2025; Harahap AS et al., 2025; Khurliyah et al., 2025).

Data Sources

Data were collected from credible and up-to-date sources, including national journals indexed in SINTA (levels 2–6) and international journals indexed in Scopus. Additional references were obtained from academic books and reports from national and international educational organizations. Studies published between 2015 and 2024 were selected to ensure relevance to contemporary digital disruption contexts.

PRISMA-Based Analysis Stages

This study applies a modified PRISMA 2020 framework for qualitative SLR, consisting of four stages: identification, screening, eligibility, and inclusion (Page, McKenzie, et al., 2021; Page, Moher, et al., 2021).

1. Identification:
   A total of 120 sources were identified through Google Scholar, DOAJ, and Scopus using keywords such as "school digital leadership," "educational management in the disruption era," and "technology-based learning innovation."
2. Screening:
   Seventy-five duplicated and irrelevant sources were excluded, resulting in 45 potential articles. Two independent reviewers conducted screening with inter-rater reliability (Cohen's Kappa > 0.8).
3. Eligibility:
   Full-text evaluation based on relevance, publication year (2015–2025), and methodological clarity resulted in 28 eligible studies. Quality appraisal was conducted using MMAT and CASP checklists.
4. Synthesis:
   The 28 selected studies were analyzed thematically using NVivo software to formulate an adaptive digital leadership conceptual model.

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Analysis Instruments

1. **Thematic Analysis**

This study employs thematic analysis based on the model proposed by Braun and Clarke (2006, revised 2021), which is applied flexibly to qualitative data drawn from 28 selected literature sources to identify patterns, themes, and conceptual relationships in school digital leadership. This approach involves six recursive stages: data familiarization, initial code generation, theme searching, theme review, theme definition, and report production. NVivo software is utilized to support automated coding and manual triangulation in order to enhance the reliability of the analysis within the Indonesian educational context (Aprilita et al., 2025; Hadi & Egar, 2025; Isnaintri & Novaliyosi, 2024).

2. **Codification of Digital Leadership and Instructional Innovation Concepts**

The study further applies thematic analysis following Braun and Clarke's framework (2006, revised 2021) to systematically codify key concepts related to digital leadership and instructional innovation. Using qualitative data from the same 28 selected sources, this process identifies recurring concepts, thematic linkages, and conceptual structures that explain how digital leadership practices contribute to innovative learning. NVivo software supports automated coding, complemented by manual triangulation, to ensure analytical rigor and contextual validity in the Indonesian education setting (Hidayah & Sobri, 2025; Sabil et al., 2023).

3. **Development of a Conceptual Model Based on Literature Findings**

Based on the thematic findings, a conceptual model is developed through narrative meta-synthesis, linking core variables in which digital leadership functions as the independent variable influencing instructional innovation as the dependent variable, mediated by moderators such as school policy and teacher professional development. The model is visualized through a path diagram accompanied by hypothetical propositions to guide future empirical research. Validation is conducted using the CRAAP framework to ensure source credibility and practical relevance, providing actionable contributions for school principals in building innovative educational ecosystems aligned with the Society 5.0 paradigm (Hidayah & Sobri, 2025; Sabil et al., 2023).

RESULTS AND DISCUSSION

1. Core Components of Principals' Digital Leadership

Four main pillars emerged from the literature synthesis:

Pillar	Description
Digital Competency Leadership	Mastery of digital technologies, digital management systems, and data-driven decision-making
Innovation Leadership	Ability to formulate innovative visions, encourage experimentation, and manage change
Collaborative Networking Leadership	Capacity to build digital collaboration among teachers, students, parents, and communities
Ethical & Inclusive Digital Culture	Commitment to digital ethics, data security, and inclusive educational access

Each pillar contributes to an adaptive, innovative, collaborative, and ethical digital leadership model for educational transformation.

a. Digital Competency Leadership

This competency encompasses mastery of digital technologies relevant to educational contexts, including the utilization of digital-based education management systems such as Learning Management Systems (LMS), the use of data-driven decision-making platforms for analyzing and evaluating school performance, and the ability to adapt to emerging technological innovations. Leaders with high levels of digital competence are able to integrate technology effectively and

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efficiently into instructional processes, administrative management, and the monitoring of student learning outcomes. This pillar also includes adequate digital literacy to address challenges related to cybersecurity and the protection of student data.

b. Innovation Leadership

This pillar requires leadership capable of creating and articulating a progressive vision for educational innovation, while encouraging teachers and staff to engage in systematic pedagogical and technological experimentation. Innovative leaders are also able to manage cultural and procedural change within schools, overcome resistance, and implement sustainable digital transformation strategies. The primary focus is on creating a learning environment that is adaptive and responsive to technological advancements and the needs of twenty-first-century learners.

c. Collaborative Networking Leadership

This competency refers to the ability to build strong digital collaboration networks among key school stakeholders, including teachers, students, parents, and the wider community. It involves the use of digital communication platforms for coordination, sharing best practices, joint professional development, and fostering parental and community engagement in the learning process. Collaborative leadership facilitates a participatory and inclusive culture, leveraging digital potential to enhance connectivity and the effectiveness of educational communication.

d. **Ethical and Inclusive Digital Culture**

The reinforcement of digital ethical values forms a critical foundation of this pillar, encompassing compliance with personal data protection regulations and the safeguarding of school information security. In addition, this pillar emphasizes the provision of inclusive and learner-friendly educational services for all students, including those with special needs, through the use of adaptive technologies and digital accessibility. Ethical digital leaders ensure that technology is used responsibly and that equitable access is guaranteed in order to support educational equity.

Together, these four pillars constitute a fundamental framework for formulating a digital leadership model that is adaptive, innovative, collaborative, and ethical in managing technology-based educational transformation.

2. Indicators of an Instructional Innovation Culture

The analysis of the literature indicates that an instructional innovation culture is characterized by several interrelated dimensions that collectively support the development of an effective, adaptive, and learner-centered educational ecosystem.

a. **Technology-Based Learning (Blended and Personalized Learning)**

The integration of technology in instruction, particularly through blended learning models that combine face-to-face and online learning, as well as personalized learning approaches that tailor content to individual student needs, represents a core characteristic of an innovation-oriented learning culture. Technology is utilized not merely as a supporting tool but as a medium that enables interactivity, broad access to learning resources, and flexibility in terms of time and place.

b. **Collaboration and the Sharing of Innovative Practices Among Teachers**

An innovation culture is fostered through intensive and open collaboration among teachers, enabling the sharing of successful instructional strategies and innovative teaching practices. Digital platforms and professional learning community forums play a critical role as spaces for experience exchange and continuous professional development, thereby enhancing pedagogical

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quality and balance within the school environment.

c. **Flexible and Student-Centered Learning Environments**

Innovative learning models emphasize the importance of flexible learning environments, both in terms of instructional methods and learning spaces, that encourage students to be active, creative, and responsible for their own learning processes. A student-centered approach prioritizes learners' needs, interests, and learning styles in the planning and implementation of instruction.

d. **Data-Driven Evaluation of Learning**

An innovation culture leverages systematically collected data as a foundation for evaluating and improving instructional practices. Both quantitative and qualitative learning data support evidence-based decision-making that is responsive to student needs and to the effectiveness of the instructional strategies employed.

e. **Implementation of Creative Learning Models (STEAM, Project-Based Learning, and Inquiry-Based Learning)**

Innovative instructional strategies integrate creative and interdisciplinary approaches such as STEAM (Science, Technology, Engineering, Arts, and Mathematics), Project-Based Learning (PjBL), and inquiry-based learning. These models encourage exploration and the active, contextual development of critical thinking and problem-solving skills.

Together, these five dimensions contribute to the development of a robust and sustainable culture of instructional innovation in the era of digital transformation in education, supporting improved learning outcomes that are aligned with global demands.

3. Findings

a. **Principals' Digital Leadership Enhances Instructional Innovation through Improved Teacher Digital Competence**

The findings indicate that effective digital leadership, supported by adequate technological infrastructure and continuous professional development for teachers and students, plays a critical role in successful digital transformation. These factors significantly enhance teachers' digital competence, which in turn fosters instructional innovation and contributes to the development of Indonesia's *Golden Generation 2045*, prepared to compete in the digital era.

b. **Instructional Innovation Requires a Clear Digital Vision and Structured Change Management**

Instructional innovation cannot be optimally implemented without a clearly articulated digital vision from school principals, accompanied by structured change management strategies. These include the identification of barriers such as technological resistance and the strategic allocation of resources for digital infrastructure. A clear digital vision functions as a strategic compass that guides schools toward an innovative educational ecosystem, supported by change management stages such as Kotter's eight-step model, adapted to the Indonesian educational context.

c. **A Strong Innovation Culture Emerges from a Collaborative, Open, and Technology-Enabled School Climate**

An innovation culture is more likely to develop sustainably when school principals actively cultivate a collaborative, open, and technology-enabled environment through shared digital platforms such as Google Workspace or Microsoft Teams. These platforms facilitate the development of professional learning communities (PLCs) involving teachers, parents, and external partners, supporting pedagogical experimentation and the sharing of best practices. Such conditions accelerate

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the sustainable adoption of innovative learning models, including Project-Based Learning (PjBL) and STEAM approaches.

Discussion

1. Transformation of the Principal's Role in the Era of Disruption

The transformation of the principal's role in the era of disruption signifies a substantial shift from traditional administrative functions toward transformational leadership focused on digital development and sustainable innovation. Principals are increasingly expected to serve as change agents capable of formulating a comprehensive digital vision for their schools and responding effectively to both the challenges and opportunities presented by technological advancements in teaching and educational management (Zai et al., 2024).

Principals are no longer confined to administrative roles; instead, they must function as leaders of digital transformation who are able to:

a. **Formulate a School Digital Vision**

Developing a clear and coherent digital vision constitutes a primary strategic step, whereby principals define the direction and objectives of technology integration to support effective, inclusive, and relevant learning. This vision serves as the foundation for building a technology-based learning ecosystem that encompasses digital infrastructure, digitally competent teaching staff, and interactive learning platforms that promote personalization and collaboration (Aprilita et al., 2025).

b. **Build a Technology-Based Learning Ecosystem and Guide Teachers in Implementing Digital Pedagogy**

Principals are also responsible for directing and supporting teachers in adopting digital pedagogy through continuous professional training, systematic monitoring, and constructive feedback. This approach aligns with transformational digital leadership theory, which emphasizes innovation, teacher empowerment, and continuous change as key drivers of school excellence in the era of disruption. Such leadership requires visionary thinking, effective communication, and the proactive management of resistance to change (Resdayani, 2025).

Accordingly, principals play a pivotal role as leaders of digital transformation by integrating vision, technology, and educator capacity development to create adaptive and innovative schools amid the dynamic conditions of the digital and disruptive era.

2. The Influence of Digital Leadership on an Innovation Culture

Digital leadership directly influences several critical dimensions of instructional innovation:

a. **Teacher Motivation to Innovate**

Teacher motivation to innovate is a decisive factor in the success of digital learning transformation. Principals play a central role in fostering intrinsic motivation through recognition of achievement, digital competency training, and granting autonomy for experimentation with instructional approaches such as gamification and AI-assisted teaching. Empirical studies indicate that highly motivated teachers contribute up to 36% to innovative performance, resulting in improvements in student learning outcomes of up to 81% through blended learning and Project-Based Learning (PjBL). Resistance to change is also reduced when transformational leadership support is present (Purba et al., 2025).

Key motivating factors include an inspiring principal's vision, access to technological infrastructure such as VR Mozaik 3D and Wordwall, and professional learning communities (PLCs) that facilitate the sharing of best practices, thereby significantly enhancing teacher engagement and creativity. In the Indonesian

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context, *guru penggerak* (teacher change agents) with strong intrinsic motivation have successfully generated momentum for change through buddy teaching and collective reflection, overcoming constraints such as limited facilities through adaptive strategies (Wuisan et al., 2024). In contrast, without strong motivation, innovation tends to stagnate due to extrinsic barriers such as excessive administrative workloads or insufficient incentives. Therefore, principals need to apply psychological empowerment models to maximize teacher creativity in the era of Society 5.0 (Haumahu & Tupamahu, 2022).

b. **Professional Collaboration**

Professional collaboration refers to systematic cooperation among teachers, principals, and educational staff through professional learning communities (PLCs) aimed at sharing best practices, designing digital instructional innovations such as blended learning and PjBL, and conducting regular reflective evaluations using platforms such as Google Workspace or Microsoft Teams. This collaborative approach has been shown to increase teachers' digital competence by up to 40%, foster an innovation-oriented culture, and improve student learning outcomes through sustained team-based support in the context of educational disruption (Junawati et al., 2025; Kusumaningsih, 2024).

c. Exploration of Learning Technologies

The exploration of emerging learning technologies in the era of Society 5.0 emphasizes the integration of artificial intelligence, such as ChatGPT, as a teaching assistant for content personalization and automated assessment; the use of VR Mozaik 3D and augmented reality (AR) for immersive biology and physics simulations that enhance conceptual understanding by up to 40%; and gamification platforms such as Quizizz, Wordwall, and hybrid QuizPard, which increase student engagement by up to 69% through blended learning and real-time IoET-based monitoring. These technologies support the *Kurikulum Merdeka* through interactive LMS platforms and PjBL-based e-modules, while simultaneously requiring targeted teacher digital competency training to address infrastructure disparities and data privacy concerns in pursuit of inclusive transformation (Affianie & Patmawati, 2025; Arrobi et al., 2025; Sri et al., 2025; Zufar et al., 2024).

d. **Use of Digital Platforms such as LMS, Assessment Applications, and Interactive Multimedia**

The utilization of digital platforms, including Learning Management Systems (LMS) such as Google Classroom and Moodle, facilitates the distribution of learning materials, assignments, and synchronous-asynchronous discussions for blended learning. Assessment applications such as Quizizz, Kahoot, and Formative provide real-time evaluation supported by data-driven analytics, leading to improvements in learning outcomes of approximately 30–40%. Meanwhile, interactive multimedia tools such as VR Mozaik 3D, gamified Wordwall, and educational Canva enhance content personalization and student engagement through immersive simulations and gamified elements aligned with the *Kurikulum Merdeka* Ayuwulandari, Susilawaty & Nur, 2025; Sari, 2025; Zaharah et al., 2023).

Overall, the stronger the principal's digital leadership, the higher the intensity of instructional innovation, as reflected in improvements in teachers' digital competence of up to 45%, increased adoption of blended learning, and the integration of AI and VR technologies that contribute to gains in student learning outcomes ranging from 30% to 50% in transformational schools. This positive relationship is supported by SLR findings demonstrating a correlation coefficient of 0.72 between digital leadership vision and the frequency of pedagogical experimentation, such as PjBL and STEAM,

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reinforced by collaborative PLCs and data-driven decision-making through LMS platforms. In the Indonesian context, principals with high digital literacy have proven effective in overcoming teacher resistance through targeted training and incentives, thereby accelerating the development of a sustainable culture of innovation aligned with Society 5.0 (Hadi & Egar, 2025; Junawati et al., 2025; Kusumaningsih, 2024; Purba et al., 2025).

3. Implementation Challenges

Several major challenges hinder the effective implementation of digital leadership and instructional innovation:

a. **Low Levels of Digital Literacy among Educators**

Insufficient digital competence among teachers in operating Learning Management Systems (LMS), artificial intelligence tools, and virtual reality (VR) technologies constitutes a primary barrier. Survey findings indicate that only approximately 35% of Indonesian teachers demonstrate proficiency in digital pedagogy, which limits the effective personalization of learning and the successful implementation of blended learning models (Purba et al., 2025).

b. **Limited Network Infrastructure**

Unequal and low-quality internet connectivity, particularly in rural areas, constrains access to online learning platforms. Approximately 40% of schools experience network downtime exceeding 20%, disrupting hybrid learning implementation and real-time Internet of Educational Things (IoET)–based monitoring (Zaharah et al., 2023)

c. **High Administrative Workload for Teachers**

Excessive manual administrative tasks, including report writing, attendance recording, and documentation, reduce teachers' available time for instructional innovation by up to 60%. As a result, teachers face difficulties experimenting with Project-Based Learning (PjBL) or gamification approaches, despite the availability of AI-based platforms capable of automating up to 70% of routine administrative tasks (Hadi & Egar, 2025; Junawati et al., 2025)

d. **Resistance to Change**

Senior teachers, in particular, tend to exhibit resistance to new technologies due to fear of failure or a fixed mindset. Studies report resistance levels of up to 45% in the absence of structured change management. These challenges can be mitigated through the establishment of professional learning communities (PLCs) and the implementation of phased training aligned with Kotter's change management model (Hadi & Egar, 2025; Junawati et al., 2025)

CONCLUSION AND RECOMMENDATION

This study concludes that principals' digital leadership plays a critical role in fostering a culture of instructional innovation in the era of disruption, as evidenced by a positive correlation of 0.72 between the strength of digital leadership and the intensity of technology adoption, including artificial intelligence (AI), virtual reality (VR), and blended learning, which collectively enhance student learning outcomes by up to 40%. Effective digital leadership encompasses four integrated pillars: technological competence (LMS mastery and data-driven decision-making), innovation vision (experimentation with Project-Based Learning and STEAM approaches), digital collaboration (professional learning communities facilitated through platforms such as Google Workspace), and digital ethics (data privacy and inclusivity). These pillars collectively address key challenges, including low teacher digital literacy, limited infrastructure, excessive administrative workload, and resistance to change, through phased professional development and structured change management strategies.

The recommendations proposed in this study are derived from the synthesis of findings on digital leadership and instructional innovation and are

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intended to provide practical guidance for policymakers, school leaders, and educators in strengthening educational transformation in the digital era.

1. **Strengthening Digital Leadership Programs for School Principals.**

   Government agencies and education authorities are encouraged to design and implement systematic professional development programs that focus on digital leadership competencies for school principals. These programs should not only emphasize technical skills but also strategic leadership capacities, including digital vision development, data-driven decision-making, ethical technology use, and change management. Strengthening principals' digital leadership is essential because principals act as key change agents who influence school culture, teacher innovation, and the sustainability of digital transformation initiatives.

2. **Establishing Measurable Digital Transformation Visions at the School Level**

   Schools are advised to formulate clear, measurable, and context-sensitive digital transformation visions that align with national education policies such as *Kurikulum Merdeka*. A well-defined digital vision serves as a strategic roadmap that guides the integration of technology into teaching, learning, and school management. Measurable indicators—such as levels of technology adoption, teacher digital competence, and student learning outcomes—enable schools to monitor progress, evaluate impact, and ensure accountability in implementing digital innovation.

3. **Encouraging Continuous Professional Development in Digital Pedagogy**

   Teachers should be consistently encouraged and supported to participate in professional development programs focused on digital pedagogy and instructional innovation. Continuous training enables teachers to effectively integrate digital tools, such as Learning Management Systems, AI-assisted applications, and interactive multimedia, into student-centered learning models. By enhancing teachers' digital competence and pedagogical creativity, schools can reduce resistance to change, improve instructional quality, and foster sustainable innovation in classroom practices.

4. **Enhancing Collaboration with Industry and Digital Communities**

   Collaboration between schools, industry partners, and digital communities should be expanded to create a broader educational innovation ecosystem. Partnerships with technology companies, universities, and digital learning communities can provide access to advanced tools, expert knowledge, mentoring, and real-world learning experiences. Such collaboration supports the relevance of educational innovation, bridges resource gaps, and ensures that school-based digital transformation remains aligned with technological advancements and workforce demands in the era of Society 5.0.

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