Pedagogik Journal of Islamic Elementary School

Principals' Digital Leadership in Developing a Generative Artificial Intelligence (Gen-AI)-Based Learning Ecosystem in E...

Article

Document Details

Submission ID
trn:oid:::3618:144518749

Submission Date
Jun 29, 2026, 9:36 PM GMT+8

Download Date
Jun 29, 2026, 9:40 PM GMT+8

File Name
511-527 11071.docx

File Size
473.1 KB

15 Pages

4,738 Words

30,251 Characters

3% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

Match Groups

13 Not Cited or Quoted 3%
Matches with neither in-text citation nor quotation marks

0 Missing Quotations 0%
Matches that are still very similar to source material

0 Missing Citation 0%
Matches that have quotation marks, but no in-text citation

0 Cited and Quoted 0%
Matches with in-text citation present, but no quotation marks

Top Sources

2% Internet sources
0% Publications
1% Submitted works (Student Papers)

Integrity Flags

0 Integrity Flags for Review

Our system's algorithms look deeply at a document for any inconsistencies that would set it apart from a normal submission. If we notice something strange, we flag it for you to review.

A Flag is not necessarily an indicator of a problem. However, we'd recommend you focus your attention there for further review.

Match Groups

- **13** Not Cited or Quoted 3%
  Matches with neither in-text citation nor quotation marks
- **0** Missing Quotations 0%
  Matches that are still very similar to source material
- **0** Missing Citation 0%
  Matches that have quotation marks, but no in-text citation
- **0** Cited and Quoted 0%
  Matches with in-text citation present, but no quotation marks

Top Sources

2% Internet sources
0% Publications
1% Submitted works (Student Papers)

Top Sources

The sources with the highest number of matches within the submission. Overlapping sources will not be displayed.

1	Student papers	
University of Witwatersrand on 2023-11-13		<1%
2	Internet	
www.ejournal.unis.ac.id		<1%
3	Internet	
ejournal.iainpalopo.ac.id		<1%
4	Internet	
journalapes.com		<1%
5	Internet	
newjournal.lppmunindra.ac.id		<1%
6	Internet	
jme.bmj.com		<1%
7	Internet	
www.coursehero.com		<1%
8	Internet	
www.dora-metal.pl		<1%
9	Publication	
Ninik Setiyowati, Ahmad Zabidi Bin Abdul Razak, Kukuh Setyo Pambudi, Jati Fatm...		<1%

Principals' Digital Leadership in Developing a Generative Artificial Intelligence (Gen-AI)-Based Learning Ecosystem in Elementary Schools

[1]Agustin Hanivia Cindy, [2]Nur Rina Priyani Mirsa, [3]Alpendi, [4]Achmad Sya'dulla, [5]Kaidah Yunia Wati, [6]Zhou Ruguang, [7]Hamdan Said

[1]Universitas Islam Negeri Semarang, Indonesia
[2]Universitas Negeri Yogyakarta, Indonesia
[3]Universitas Muhammadiyah Bangka Belitung, Indonesia
[4]Universitas Negeri Surabaya, Indonesia
[5]Lancaster University, United Kingdom
[6]Jiangsu Normal University, China
[7]University of Technology Malaysia, Malaysia
e-mail: [1]agustin_hanivia_cindy@walisongo.ac.id

Abstract

The integration of Generative Artificial Intelligence (Gen-AI) in the Society 5.0 era has brought significant disruption to the global education landscape. At the elementary school level, institutional leaders often face gaps in official regulations that trigger restrictive rather than enabling policies. This study aims to analyze the role and digital leadership strategies of elementary school principals, identify systemic challenges and emerging supporting factors, and develop a conceptual framework for developing a safe, ethical, and innovative Gen-AI-based learning ecosystem. Using a descriptive qualitative approach with a single case study design, data collection was conducted at BINUS SCHOOL Semarang through triangulation techniques that included in-depth interviews with eight key informants (consisting of the principal, technology coordinator, four class teachers, and two parent representatives), passive participant observation, and analysis of formal school documents. The study results indicate that the digital leadership implemented in this school displays an adaptive profile (Enabling Leadership) through synchronization of the institution's vision, provision of ICT infrastructure based on content filtering, facilitation of digital pedagogical competency training, and regular updates to academic honesty guidelines. Furthermore, interactions within this ecosystem have resulted in the "BINUS Digital-Pedagogical Framework" model, which seeks to balance strategic alignment, streamline teacher administrative workloads (professional co-piloting), and limit the use of AI during the initial ideation stage (cognitive encapsulation) to protect students' original critical thinking. These findings are contextual to the characteristics of the schools studied. As a practical recommendation, elementary school principals can gradually adapt the principles of this framework through redesigning conceptual assessment tasks (AI-Resistant Tasks) and developing local SOPs with school committees to build a relevant and ethical digital citizenship curriculum.

Keywords: Academic Honesty, Digital Leadership, Enabling Leadership, Generative Artificial Intelligence, Learning Ecosystem

Introduction

Entering the era of Society 5.0, the global education landscape is experiencing massive disruption due to the integration of artificial intelligence, particularly Generative Artificial Intelligence (Gen-AI). This technology is no longer merely a static tool, but an active agent redefining how knowledge is produced, consumed, and distributed in classrooms. According to a report from the World Economic Forum (2025), more than 60% of educational institutions in developed countries have adopted AI technology to personalize the learning process and automate various complex administrative tasks. In line with this phenomenon, UNESCO (2023) in its global guide on AI in education emphasized that the use of Gen-AI, such as Large Language Models (LLMs), has great potential to reduce inequality in access to high-quality learning at the elementary level, provided that this technology is managed wisely, inclusively, and ethically. At the institutional level, elementary schools play a crucial role as the foundation where children's early digital literacy, character, and critical thinking skills begin to be formed. Therefore, transforming traditional classrooms into Gen-AI-based learning ecosystems is no longer merely a visionary option or a future addition, but rather an urgent need that must be addressed tactically now (Holmes, 2023; Livingstone & Stoilova, 2021).

The success of this disruptive technological transformation depends heavily on the dynamic interaction between two key components: the principal's digital leadership and the development of a Gen-AI-based learning ecosystem. Senge (2015), in his theory of learning organizations, asserts that adaptive leadership is key to navigating systemic change in educational institutions. In the context of this research, the principal's digital leadership is measured through several key indicators, including the articulation of a clear digital vision, the provision of adequate information and communication technology (ICT) infrastructure, the facilitation of ongoing teacher digital pedagogical competency training, and the formulation of ethical school policies regarding the use of AI. On the other hand, the formation of a Gen-AI-based learning ecosystem is reflected through indicators such as the integration of Gen-AI tools into the curriculum, the level

of teacher adaptability to new technologies, active student engagement in digital interactions, and synergistic collaboration between schools and parents. Among these two variables, the principal's digital leadership holds the most crucial position as a critical driver. Without strong strategic direction, commitment, and policy support from the principal, the adoption of Gen-AI technology in elementary schools will remain a sporadic, directionless initiative. Furthermore, the absence of competent digital leadership carries a high risk of triggering digital ethics violations and a decline in students' basic cognitive abilities due to uncontrolled technology dependence (Mulyasa, 2023; Rusdiana, 2024).

Ideally, elementary school principals are expected to act as agents of digital change, capable of harmoniously orchestrating the school ecosystem. Under these ideal conditions, teachers can utilize Gen-AI tools such as Chat GPT, Claude, or Canva AI to develop differentiated and adaptive Lesson Plans (RPPs) tailored to individual student needs, while students can explore them as safe and stimulating interactive learning assistants under close supervision. However, the reality on the ground shows a wide gap between these ideal conditions. Many elementary school principals are currently trapped in conventional leadership patterns due to a significant digital competency gap. The use of technology in most elementary schools remains very rudimentary, limited to the use of a simple Learning Management System (LMS) or simply optimizing projectors in the classroom. On the other hand, an interesting phenomenon shows that teachers are personally beginning to clandestinely adopt Gen-AI to complete their administrative tasks without official guidance from their schools a phenomenon known as "underground AI usage". This misalignment ultimately triggers collective anxiety about the potential for academic plagiarism, the degradation of students' original thinking, and crucial issues related to data leakage and security. This profound gap between ideal and actual conditions occurs because regulations from policymakers are often late in anticipating the exponential leap in Gen-AI technology. Consequently, school principals experience a regulatory stutter, which encourages them to take a "safe" stance by limiting or even completely banning the use of AI in the school environment, rather than building an adaptive, purposeful, and safe digital ecosystem for elementary-aged children (Wahyudi, 2025; Zawacki-Richter, 2019).

To clarify the scientific contribution of this study, it is necessary to systematically contrast it with previous research trends across three main pillars: digital leadership, AI in education, and digital citizenship.

Tabel 1 Research Gap and Novelty

Research Focus	Previous Studies & Focus	The Gap (What is Missing)	This Study's Novelty
Digital Leadership	Focused heavily on higher education or secondary schools (e.g., Ahmad, 2025; Smith, 2024). Assumed AI complexity is only suitable for mature, cognitively mature students.	Neglects the unique managerial and strategic challenges faced by elementary school principals navigating Gen-AI.	Focuses specifically on the **elementary school level**, analyzing how a principal transitions from restrictive gatekeeping to an **Enabling Leadership** profile.
AI in Education	Limited to the adoption of conventional e-learning, general digital literacy, or macro-policy lags (e.g., Hidayat & Utami, 2023; Weng & Chen, 2025).	Lacks empirical models that directly integrate leadership strategy with practical Gen-AI ecosystem designs at the foundational level.	Directly integrates digital leadership with the design of a Gen-AI learning ecosystem by formulating the **"BINUS Digital-Pedagogical Framework"** (balancing strategic alignment, professional co-piloting, and cognitive encapsulation).
Digital Citizenship & Ethics	Focused on technical detection of AI-generated work or generic ethical warnings (e.g., Selwyn, 2021; Ng, 2024).	Lacks structured, school-level operational frameworks that involve parents to counter young students' algorithm dependence.	Establishes a concrete upstream mitigation system through **AI-Resistant Tasks (redesigning assessments)** and a structured **Digital Citizenship & AI Ethics curriculum** with parents.

This is where the novelty of this research lies. While most Generative Artificial Intelligence (Gen-AI) research predominantly focuses on higher education institutions, this study is unique as it shifts the focus to elementary education, which faces specific, unaddressed challenges. This study offers two significant scientific novelties: First, it focuses specifically on elementary school students, whose unique characteristics in child developmental psychology require a much more rigorous and measurable content filtering system and age-appropriate AI pedagogical approaches compared to other educational levels. Second, this research directly integrates the concept of digital leadership with the empirical design of a Gen-AI-based learning ecosystem—a theme that has so far received very little exploration at the primary school level, especially amid

severe regulatory gaps due to the absence of official regulations from the ministry and the pressing need for active parental involvement to build robust digital citizenship.

The urgency of conducting this research is crucial to avoid the risk of a future "pedagogical disaster" (Williamson, 2024). The first pressing issue relates to the wild acceleration of AI technology, given that Gen-AI is evolving exponentially over time. Delaying an in-depth study of this phenomenon is tantamount to allowing schools to operate using outdated methods, while students live in an environment already surrounded by AI technology. The second pressing issue is the threat of a digital ethics crisis. Without strategic ecosystem governance led by strong digital leadership, the risk of elementary school students being exposed to biased, inaccurate, or child-unfriendly AI content will increase dramatically, potentially leading to a decline in basic cognitive abilities due to uncontrolled dependency. Therefore, an in-depth study of how school principals navigate this digital transformation is crucial to provide a practical compass for today's elementary education world. Based on the background, systemic gaps, regulatory voids, and the urgency of the issues outlined, this study specifically aims to: 1) Analyze the strategic roles and behaviors of the principal's digital leadership in initiating and directing digital transformation in elementary schools; 2) Identify the various systemic challenges, regulatory obstacles, and supporting factors faced by schools in developing functional Generative Artificial Intelligence (Gen-AI)-based learning ecosystems; 3) Formulate an effective digital leadership model or framework for school principals to engineer a safe, ethical, and innovative Gen-AI-based learning ecosystem tailored to the elementary school level.

Research Method

This research uses a qualitative descriptive approach with a single-case study design. This design was chosen to explore in-depth and contextually how the principal's digital leadership practices are applied in building a Generative Artificial Intelligence (Gen-AI)-based learning ecosystem. The research location was purposively selected at BINUS SCHOOL Semarang. This school was chosen because it has specific uniqueness as an elementary education institution that has integrated the IT Strategic Plan blueprint into the institution's vision (Fostering and Empowering), uses Apple/Microsoft Education Ecosystem-based infrastructure, and has partnered directly with artificial intelligence experts from universities. This fieldwork research was conducted for three months, starting from October to December 2025. The selection of informants used a

purposive sampling technique, where sample determination is based on certain criteria relevant to the focus of the research problem. Informant inclusion criteria include: (1) being directly involved in the creation of school digital policies, (2) being actively involved in the implementation of Gen-AI technology in the classroom, or (3) being part of the supervision of the school's digital ecosystem. Based on these criteria, there were 8 informants who participated in this study, with profile details as follows:

Table 2 Informant

Informant Code	Position / Role	Number	Specific Criteria
KS	Elementary School Principal	1 person	The main policy maker and owner of the strategic authority for school digitalization.
KT	Technology Coordinator / IT Staff	1 person	ICT infrastructure management and technical implementation of IT blueprints.
G-1 & G-2	Classroom Teacher (Science & Math)	2 people	Integrating Gen-AI (ChatGPT-4/Copilot) in Lesson Plans and assessments.
G-3 & G-4	Other Curriculum / Grade Teacher	2 people	Involved in preparing the Engineering Prompt guide and Digital Citizenship curriculum.
OT-1 & OT-2	Parent Representative	2 people	Actively participate in Parent Sharing Sessions and AI supervision at home.

Before data collection began, strict research ethics procedures were implemented. The researcher provided a participant information sheet and requested written informed consent from all informants. The researcher guaranteed the confidentiality of informants' identities through the use of anonymous codes (such as KS, KT, G-1, etc.). Data were collected through data triangulation techniques that included in-depth interviews, direct observation, and document analysis. In-depth Interviews: Semi-structured interview guidelines were independently developed by the researcher based on a synthesis of literature on digital leadership indicators (digital vision articulation, ICT infrastructure, pedagogical training, AI ethical policies) and Gen-AI learning ecosystem indicators (curriculum integration, teacher adaptability, student interaction, parent collaboration). Interviews were conducted face-to-face, lasting between 45 and 60 minutes each and recorded using an audio recorder with the informant's permission. Direct Observation: Passive participant observation was

conducted periodically throughout the fieldwork period. The focus of the observations included the principal's academic supervision process, regular teacher training activities (Professional Development), AI-based learning interactions in science and mathematics classes, and the implementation of the Parent Sharing Session program. All activities were recorded in field notes. Document Analysis: Researchers reviewed formal school documents to verify alignment between policies and field practices. Documents analyzed included the BINA NUSANTARA IT Strategic Plan blueprint, the updated Academic Honesty Guidelines, the "Guide to Prompt Engineering for Primary School Teachers" pocketbook, and examples of teacher teaching modules/lessons learned that integrate AI-Resistant Tasks.

The data analysis process was conducted interactively and continuously, following the qualitative analysis stages outlined by Moleong (2021): 1) Data Reduction: Converting interview audio recordings into verbatim transcripts, then filtering, focusing, and abstracting raw field data to ensure relevance to the problem formulation regarding digital leadership strategies; 2) Data Display: Organizing and grouping data into a systematic categorization matrix. The data was grouped based on the identified pillars: strategic alignment, the role of AI as a professional co-pilot, and cognitive encapsulation. 3) Conclusion Drawing/Verification: Summarizing patterns of relationships, meanings, and best practices in school governance in preparing a safe and ethical digital ecosystem, which were then formulated into the "BINUS Digital-Pedagogical Framework". To ensure the validity and reliability of the results of this qualitative research, the researcher implemented four data trust strategies: 1) Triangulation of Methods and Sources: Evidence of triangulation implementation was conducted by cross-referencing data from interviews with school principals (KS) regarding the digital vision, with data from observations of teachers' teaching processes in the classroom, and authentic evidence in written documents in the form of the Academic Integrity Guidelines. If there were any discrepancies, the researcher reconfirmed with the relevant informants. 2) Member Checking: Typed interview transcripts and initial drafts of the framework findings were returned to the informants (Principal and teacher representatives) to verify their compliance with what they intended when interviewed; 3) Peer Debriefing: The researcher conducted regular discussions with two fellow academics/experts in elementary education management to review the coding categories and minimize the researcher's subjective bias; 4) Audit

Trail: The researcher documented all raw field notes, audio recordings, data coding history, and draft reports chronologically and neatly so that the entire conclusion-drawing process could be transparently tracked by external parties.

Results and Discussion

Results

Categorization Criteria and Digital Leadership Profile of School Principals

To avoid subjective bias, the determination of digital maturity levels for principal leadership at BINUS SCHOOL Semarang was synthesized from indicators of adaptive organizational governance and regulation (Sheninger, 2022; Kim & Lee, 2025). The operational boundaries for each category were established as follows: 1) **Highly Adaptive**: Policies have a formal written blueprint, are visionary and anticipatory of disruption, and are implemented systematically across all school elements without delay; 2) **Excellent**: ICT facilities or competency improvement programs are provided centrally by the institution, are sustainable, and supported by a well-established strategic budget allocation; 3) **Adaptive**: The school demonstrates openness and a positive response to technological disruption, but the resulting written regulations remain local and independent due to the lack of a macro legal umbrella at the national level.

Table 3 Criteria Matrix and Digital Leadership Profile of School Principals

Digital Leadership Indicators	Empirical Reality in the Field (Data Triangulation Results)	Category
Digital Vision	Integration of Gen-AI literacy into elementary school strategic plans.	Highly Adaptive
ICT Infrastructure	Document Analysis: Contained in BINA NUSANTARA's IT Strategic Plan, page 14, regarding curriculum recalibration in the face of disruptive technology.	Very Good
Teacher Training	1:1 device ratio (BYOD/iPad/Laptop) with network-level content filtering.	Excellent
AI Ethical Policy	Observation Notes (October 24, 2025): Examination of the bandwidth limitation system and automatic blocking of non-educational AI platforms by the IT Coordinator.	Adaptive

Empirical evidence regarding the implementation of enabling leadership rather than gatekeeping was confirmed through in-depth interviews with the Principal (KS),

> *"The principal demonstrated his support by facilitating training... This was confirmed by G-1, who stated, "We were greatly helped because the principal immediately brought in an AI expert to teach us how to create prompts..." (Interview, November 2025)."*

> *"We realized that banning the use of Gen-AI at the elementary school level was a futile, defensive policy and actually encouraged aimless, underground use by teachers and students. Our position is 'enabling' allowing platform access with the requirement that we establish a digital ethics corridor and redesign assessments early on." (Interview with KS, October 12, 2025).*

Dynamics of the Gen-AI-Based Learning Ecosystem and the BINUS Digital-Pedagogical Framework

Field observations indicate that the interaction of components within the learning ecosystem at this school is driven in a balanced manner (top-down and bottom-up). Using the Apple/Microsoft Education Ecosystem infrastructure, teachers openly utilize ChatGPT-4 and Microsoft Copilot as Professional Co-Pilot to reduce daily administrative workload. Based on a document review of the fourth-grade science lesson plan (RPP), the use of AI is focused on developing differentiated learning scenarios. This empirical efficiency was revealed by one of the classroom teachers (G-1) in an in-depth interview,

> *"Before Copilot, developing science activity sheets and case studies that are friendly to children with different learning speeds took almost 3 hours per topic. Now, by incorporating specific core competency prompts, the drafts are completed in 15 minutes. "I can use the rest of my work time for personal interactions and character building for the students in class." (Interview with G-1, October 26, 2025).*

In its implementation, this model is summarized into three main pillars of the "BINUS Digital-Pedagogical Framework" (see Figure 1): Strategic Alignment (macro-vision alignment), Professional Co-Pilot (teacher workload efficiency), and Cognitive Encapsulation (cognitive encapsulation). The third pillar cognitive encapsulation is crucial because it limits the use of AI to the brainstorming stage, not as a determinant of the final outcome of student assignments.

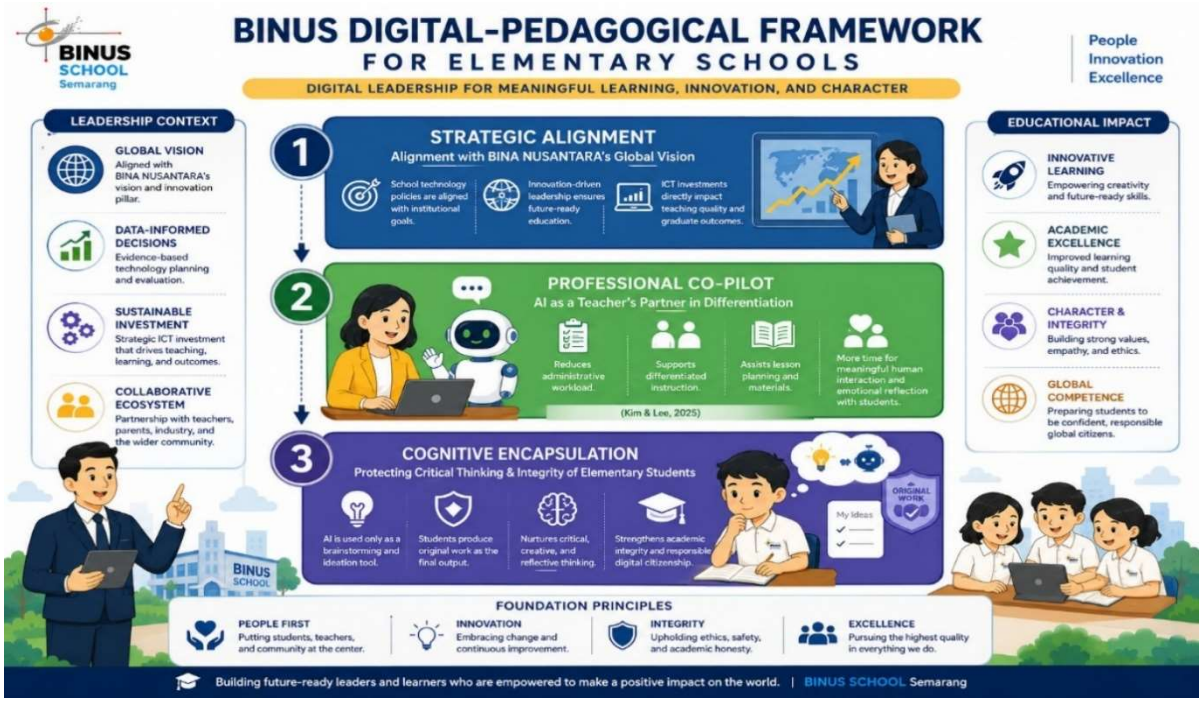

Figure 1 BINUS Digital-Pedagogical Framework

Figure 1 demonstrates that educators' professional competencies, pedagogical competencies, and learners' digital competencies are interrelated dimensions that collectively support the successful implementation of digital learning ecosystems. The empirical findings of this study reveal that the integration of Generative Artificial Intelligence (Gen-AI) in elementary schools depends not only on technological infrastructure but also on the interaction between educators' professional competencies, pedagogical practices, and students' digital competencies. Data obtained through observations, interviews, and document analysis indicate that these three dimensions operate simultaneously within the school ecosystem and are significantly influenced by the principal's digital leadership. The findings further suggest that digital leadership plays a crucial role in strengthening these dimensions through strategic policies, professional development programs, and the establishment of ethical guidelines for the use of Gen-AI in elementary schools. Therefore, the digital competence framework presented in Figure 1 serves as an analytical lens to explain how digital leadership contributes to enhancing teachers' competencies while facilitating students' digital development within a safe, ethical, and innovative learning environment.

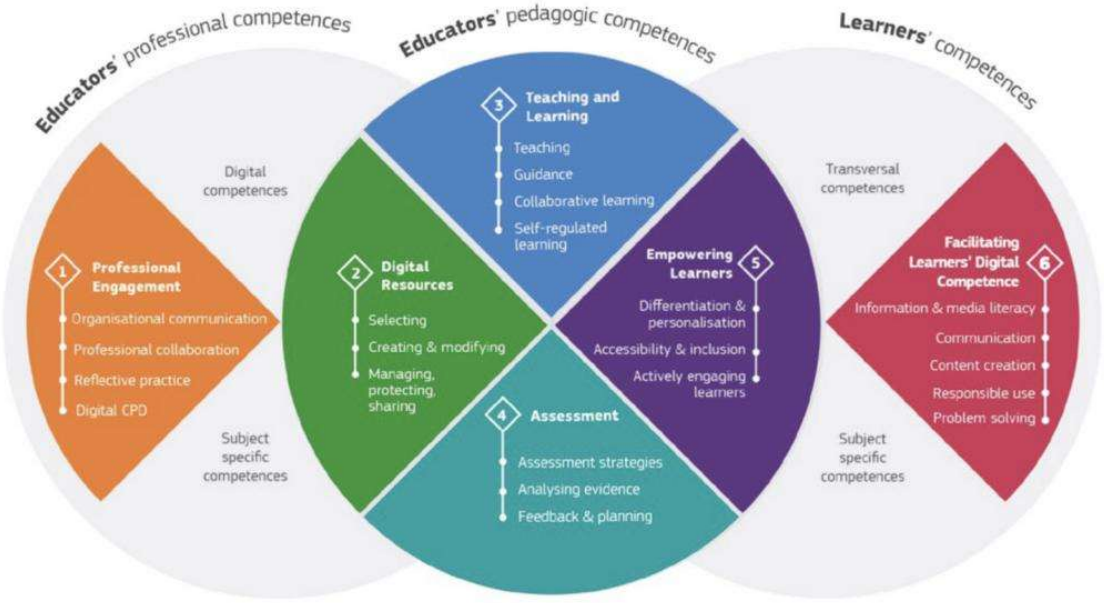

Figure 2 Digital Competence Framework for Educators and Learners

Field Dynamics: Systemic Challenges, Resistance, and Contradictions

To maintain academic credibility and avoid promotive bias, it is important to highlight that the technological transformation at BINUS SCHOOL Semarang has not proceeded smoothly and linearly. Data triangulation revealed three critical points, obstacles, and internal contradictions in the field:

The "AI Fatigue" Phenomenon and Teacher Pedagogical Anxiety

The rapid acceleration of digitalization by management has created cognitive overload among teaching staff. A psychological barrier in the form of hidden resistance was found among senior teachers (G-3):

> *"To be honest, at the beginning of the program, we experienced 'AI fatigue.' We were required to revamp the conventional assignment format into AI-Resistant Tasks within a short timeframe so that children would not simply copy the computer's answers. There was a deep anxiety among us that this automation would gradually diminish the role of empathy and the emotional bond between human teachers and elementary school students." (Interview with G-3, November 5, 2025).*

This critical situation is reinforced by the researcher's observational notes, where several teachers were found to revert to entirely manual methods when the network system experienced technical difficulties or mass login failures on students' iPads during class.

Cognitive Friction and Student Frustration with New Assessments

The implementation of AI-Resistant Tasks (such as physical mock-up projects, oral presentations, or reflective video creation) that were intentionally designed to be incapable of instant AI responses has triggered student resistance. The researcher's

observational notes in an upper-level Mathematics class (November 11, 2025) indicated cognitive friction: several students showed signs of frustration, complained, and experienced a short-term decrease in motivation because they were forced to go through laborious manual thinking processes, even though they had already become accustomed to loose and instant device use at home.

Parental Skepticism Regarding Data Privacy and Degradation of Basic Skills

External contradictions emerged explicitly during the implementation of Parent Sharing Sessions. A document review of the minutes of the November 2025 school committee meeting recorded a heated debate regarding this AI integration policy. One parent representative (OT-2) expressed her ethical concerns sharply:

> *"We are worried that our children will lose basic skills like neat handwriting, quick arithmetic without tools, and reading physical books if the school gives AI too much free rein. Furthermore, the school's IT department has not provided any explicit guarantees regarding how our children's personal data will be protected from misuse by third-party commercial algorithms." (Interview with OT-2, November 18, 2025).*

Discussion

Theoretical Interpretation: The Dialectic of the Leadership Role from Gatekeeper to Facilitator

Empirical findings regarding the Highly Adaptive (Enabling Leadership) profile of the principal at BINUS SCHOOL Semarang confirm a shift in leadership paradigms in the Society 5.0 era. While the majority of conventional elementary school leadership is trapped in a restrictive gatekeeper position (totally prohibiting the use of AI due to fears of plagiarism) (Kim & Lee, 2025; Weng & Chen, 2025; Handayani & Purwanto, 2025), this case study demonstrates that the risk of disruption can be mitigated by strengthening accommodating local policy structures. Theoretically, the principal's strategic move in launching the "Guide to Prompt Engineering" Pocket Book expands on Fullan's (2020) theory of Systemic Change Management. The researcher's interpretation suggests that an institution's adaptive capacity is not determined by the absence of risk, but rather by the flexibility of its internal regulatory structure in safely embracing disruption. However, these claims of success should be read with caution: the smooth policy transition at BINUS SCHOOL Semarang relied heavily on the strong financial support of the BINA NUSANTARA corporation, and therefore cannot be considered a universal model that can be instantly replicated in other schools.

Critical Evaluation: Cognitive Encapsulation of Psychological Barriers in Elementary Classrooms

The existence of the Professional Co-Pilot pillar has been shown to significantly free teachers from clerical/administrative routines (Luckin, 2025). The results of this study support the theoretical argument of Pratama and Wijaya (2024), who stated that technology integration should lead to an increase in the quality of personal teacher-student interaction time. However, empirical findings regarding the phenomenon of "AI Fatigue" in teachers (Interview G-3) and cognitive frustration in students provide a corrective nuance to the theory of technological optimism (Luckin, 2024). The researchers interpret that the Cognitive Encapsulation pillar does not operate in a magical vacuum. Limiting AI as a tool for ideation actually demands greater psychological energy and time on assignments from both students and teachers. This critical finding confirms warnings from Romero (2024) and Suryadi (2024) that premature digital automation without careful assessment redesign will lead to a decline in students' critical thinking skills (higher-order thinking).

Contextual Analysis: Implementing the Framework in Schools with Limited Resources (Equity and Resource Constraints Analysis)

A critical note that highlights the main limitation of the BINUS Digital-Pedagogical Framework is its heavy reliance on expensive premium ecosystems (Apple/Microsoft Education, BYOD 1:1 devices). A comparison with Fitriani's (2025) research on the phenomenon of "underground AI usage" reveals a widening digital divide: in schools with limited resources, teachers adopt AI clandestinely without secure network filtering infrastructure. As a conceptual recommendation to bridge the educational equity gap, the basic principles of this framework can still be adapted by marginalized schools with the following operational modifications: a) Premium Infrastructure Substitution: Expensive macro-level filter networks can be replaced by the use of free Gen-AI platforms (such as the standard version of ChatGPT or Google Gemini) accessed collectively using a single computer in the classroom under the teacher's visual supervision; b) Redesigning Low-Tech AI-Resistant Tasks: Teachers in schools with limited facilities can still implement the cognitive encapsulation pillar. Teachers can utilize AI privately at home to formulate contextual reasoning questions based on local wisdom, then distribute them to students in the form of written essay-reflective exams or physical group projects at school without requiring students to have personal devices in the classroom; c) Formulate Local SOPs with the Committee: The

lack of a formal, structured Digital Citizenship curriculum can be addressed by developing simple Standard Operating Procedures (SOPs) at the school level, agreed upon with the parent committee through regular meetings (Selwyn, 2021; Lestari, 2024; Chiu, 2026). This step ensures that ethical AI use is maintained at home and school, even without the support of complex cloud-based IT systems.

Conclusion

Based on field data analysis and in-depth discussions on digital ecosystem governance at BINUS SCHOOL Semarang, this study formulates three main conclusions regarding digital leadership practices amidst artificial intelligence disruption at the elementary school level: 1) The Effectiveness of Strategic Digital Leadership: The integration of Gen-AI at the elementary level is not solely determined by the sophistication of ICT devices, but is strongly driven by the proactive response of school principals. A facilitating leadership style (enabling digital leadership) has been proven to contribute to minimizing initial resistance in the field, aligning the macro vision of corporate institutions, and shifting the governance paradigm from rigid protective boundaries to directed empowerment through ethical digital corridors; 2) The Urgency of Cognitive Oversight and Ethical Structure: The development of the Gen-AI ecosystem requires a rigid balance between digital agility and protecting the psychological developmental phase of children. Through the identified conceptual model, Gen-AI is positioned as a teacher's partner (professional co-pilot) that reduces clerical routines without eroding the emotional closeness between human components in the classroom. The cognitive encapsulation approach limits the use of AI to a brainstorming tool to ensure students continue to go through essential manual thinking processes; 3) Upstream Mitigation Through Local Policies: To address the lack of formal regulations from the ministry regarding the use of artificial intelligence in elementary schools, digital leadership is implemented independently through the enforcement of academic integrity guidelines from an early age. These mitigation measures are concretely operationalized through a program to redesign homework into AI-Resistant Tasks, macro-prompt engineering training for teachers, and synchronized supervision with parents through digital citizenship education.

Practical Implications for Elementary School Principals: This study provides strategic guidance that elementary school principals need not be reactive or completely prohibit the use of AI technology. Institutional leaders are recommended to start

forming internal ICT literacy committees, updating local-level academic integrity curricula, and gradually training teaching staff to design differentiated learning scenarios with free AI support (such as standard versions of ChatGPT or Google Gemini) to streamline their teaching administrative workload. Research Limitations and Further Research Suggestions: The authors acknowledge that this study has significant methodological limitations. As a single case study conducted at a private institution with strong corporate financial support and premium technology infrastructure, the findings and the "BINUS Digital-Pedagogical Framework" model in this study are contextual and cannot be absolutely generalized to all other elementary education institutions. Barrier phenomena such as "AI Fatigue" in teachers, cognitive friction in students, and parental skepticism about data breaches are specific reflections of a technology-intensive ecosystem. Therefore, further research is recommended to expand the locus of observation by involving different school contexts, such as urban public schools (medium-resource schools) and elementary schools in remote/remote areas (low-resource schools) to test the adaptability, infrastructure substitution, and validity of the implementation of this AI governance framework in a more inclusive and comparative manner.

References