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Enhancing students' digital literacy through digital-based classroom management in informatics learning

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Abstract. This study examines digital-based classroom management to enhance students' digital literacy in Informatics learning. The rapid expansion of educational technology requires structured classroom strategies that systematically foster multidimensional digital competencies rather than merely support content delivery. This research aims to analyze how digital-based classroom management through the 1 Cerdas Application enhances students' digital literacy competencies. A descriptive qualitative approach was employed in a public lower secondary school involving school leaders, Informatics teachers, and students selected purposively. Data were collected through classroom observations, in-depth interviews, and document analysis, and analyzed using an interactive qualitative model consisting of data condensation, data display, and conclusion drawing. The findings indicate that structured platform-based management improved students' technical proficiency, collaborative engagement, creative digital production, information evaluation skills, and ethical technology awareness, although infrastructure instability and varied digital readiness remained challenges. The study concludes that digital-based classroom management serves as a systemic pedagogical strategy for strengthening digital literacy and recommends continuous infrastructure improvements and teacher professional development to sustain the effectiveness of innovation.

Introduction

The rapid advancement of digital technology in the twenty-first century has transformed educational ecosystems, redefining how knowledge is constructed, accessed, and evaluated. Ideally, contemporary education should integrate digital technology not merely as an instructional aid but as a structured pedagogical system that fosters multidimensional digital literacy, including technical proficiency, critical evaluation of information, collaboration, creativity, and ethical awareness. Recent empirical studies emphasize that digital transformation in schools must move beyond device provision toward systemic pedagogical integration to prepare students for complex digital societies (Kiryakova & Kozhuharova, 2024; Susandi, 2022).

Within this ideal framework (das sollen), digital-based classroom management is conceptualized as a structured orchestration of digital platforms, learning interactions, assessment mechanisms, and behavioral regulation designed to optimize learning engagement and literacy development (Purnadewi & Widana, 2023). Unlike conventional classroom management focused primarily on

order and discipline, digital-based classroom management regulates technology-mediated learning flows, platform interaction patterns, and real-time monitoring systems. Simultaneously, students' digital literacy is understood as a multidimensional competence encompassing technical operation, cognitive processing, collaborative participation, creative production, and ethical use of technology.

However, empirical realities reveal persistent discrepancies between these ideal conditions and classroom practice. Preliminary observations conducted on December 22, 2025, at a public lower secondary school in South Bengkulu Regency indicate that although digital facilities such as laptops, internet access, and learning platforms are available, their utilization remains predominantly instrumental. Technology is primarily used for presentations and task submissions, while structured digital monitoring, collaborative orchestration, and interactive literacy facilitation remain limited. Student participation in digital discussions and analytical tasks is relatively low, suggesting that digital infrastructure has not yet functioned as an integrated classroom management system.

This situation aligns with broader findings indicating that digital integration in many schools remains surface-level, focusing on media usage rather than systemic pedagogical transformation (Basri et al., 2025; Ramadhan & Inayati, 2024). Several recent studies emphasize the development of digital literacy but primarily examine media exposure, ICT skill acquisition, or e-learning adoption (Made et al., 2024; Syafitri et al., 2024; Gani et al., 2025). Research explicitly positioning classroom management as the structural driver of digital literacy development remains limited, particularly in Informatics learning at the junior secondary level. Moreover, existing scholarship tends to emphasize technical competence while underexploring managerial orchestration, digital interaction regulation, and the embedding of ethical literacy within classroom systems.

These discrepancies highlight a significant research gap: while digital literacy and educational technology integration have been widely studied, the role of digital-based classroom management as a systemic pedagogical mechanism shaping literacy outcomes remains under-theorized and under-investigated. This gap is particularly critical in Informatics learning, where digital competence development should be embedded structurally rather than cultivated incidentally. Responding to this gap, the present study proposes digital-based classroom management through the 1 Cerdas Application as an integrated pedagogical managerial system that regulates instructional flow, interaction patterns, assessment practices, and literacy habituation. Theoretically, this study extends the digital pedagogy discourse by conceptualizing classroom management not as an auxiliary function but as a central driver of innovation, shaping literacy development trajectories.

The novelty of this research lies in three aspects: (1) positioning digital classroom management as the primary structural determinant of digital literacy development rather than treating technology as a supplementary instructional tool; (2) integrating managerial, pedagogical, and ethical dimensions within a unified analytical framework; and (3) examining this relationship specifically within Informatics learning at the junior secondary level, a context that remains underrepresented in recent scholarship. Based on this rationale, the study addresses the following research questions: (1) How is digital-based classroom management systematically planned in Informatics learning? (2) How is it implemented through platform-mediated instructional practices? (3) How does it enhance students' multidimensional digital literacy? (4) What constraints and sustainability strategies emerge in its implementation?

Accordingly, the objectives of this study are to (1) analyze the systemic planning of digital-based classroom management, (2) examine its implementation through the 1 Cerdas Application, (3) evaluate its contribution to students' digital literacy across technical, cognitive, collaborative, creative, and ethical domains, and (4) identify constraints and adaptive sustainability strategies. The findings are expected to contribute theoretically by strengthening the conceptual link between

classroom management and digital literacy development, and practically by providing structured recommendations for schools seeking to build sustainable, ethically grounded digital learning ecosystems.

Method

Research Design

This study employed a qualitative case study design. The case study approach was selected because the research focused on an in-depth exploration of the implementation of digital-based classroom management within a bounded institutional context, namely SMP Negeri 5 Bengkulu Selatan. The objective was not statistical generalization but an analytical understanding of how digital classroom management functioned as a systemic pedagogical mechanism shaping students' development of digital literacy. A case study design is appropriate for investigating complex educational phenomena in real-life settings, where contextual variables cannot be separated from practice. This design enabled holistic analysis of planning structures, instructional orchestration, platform utilization, interaction patterns, literacy outcomes, and sustainability dynamics within a single institutional ecosystem (Creswell & Poth, 2016; Leavy & Patricia, 2017).

Research Site and Duration

The research was conducted at SMP Negeri 5 Bengkulu Selatan, a public lower secondary school implementing Informatics learning supported by digital facilities, including computer laboratories, institutional internet access, and the 1 Cerdas Application platform. The school serves students from diverse socioeconomic backgrounds and has initiated a gradual digital transition program through infrastructure development and teacher professional training. This contextual profile made the site relevant for examining systemic digital classroom innovation. Data collection was conducted over a four-month period (December 2025–March 2026), encompassing repeated observation cycles, interview sessions, and analysis of documentation to ensure data saturation.

Research Subjects and Sampling Technique

Participants were selected using purposive sampling with criterion-based selection. Inclusion criteria included: (1) Direct involvement in digital classroom management; (2) Active engagement in Informatics learning; (4) Experiential knowledge of the 1 Cerdas Application. The participants included.

Table 1. Research Subjects

No	Research Subject	Number	Role in Research
1	Principal	1	Institutional policy and digital innovation support
2	Vice Principals	2	Curriculum, student affairs, and infrastructure management
3	Informatics Teachers	4	Planning and implementing digital classroom innovation
4	Students (Grade VIII–IX)	12	Experiencing digital literacy development processes

The sample size was guided by information richness rather than statistical representation.

Researcher Presence

In qualitative inquiry, the researcher functioned as the primary research instrument. The researcher was physically present during classroom activities, observing instructional processes, platform utilization, interaction management, and student engagement patterns. The researcher also conducted in-depth interviews and facilitated reflective dialogues with participants. Reflexive positioning was maintained to minimize interpretive bias while preserving analytical sensitivity toward contextual realities.

Data Collection Techniques

Data were collected through three integrated techniques to ensure depth and triangulation: 1) Classroom Observation, Direct observations were conducted during Informatics learning sessions to examine digital classroom orchestration. Observational focus included platform usage, instructional flow, digital interaction patterns, collaborative learning activities, and real-time classroom regulation strategies. 2) In-depth semi-structured interviews were administered to teachers, school leaders, and students to explore perceptions, experiences, managerial rationales, and literacy development impacts. The semi-structured format enabled probing of emergent insights while maintaining thematic alignment with research objectives. 3) Documentation Study, Documentary evidence included lesson plans, digital modules, LMS screenshots, student digital projects, assessment records, and institutional policy documents. Documentation functioned to corroborate observational and interview findings.

Research Instruments

Instrument development in this study was grounded in theoretical frameworks and systematically aligned with the research problem formulations to ensure conceptual coherence and empirical relevance. The construction of instruments was organized into three integrated clusters reflecting the multidimensional focus of the research. First, an observation protocol was designed to capture real-time practices of digital-based classroom management, including platform utilization, instructional orchestration, interaction patterns, and student engagement dynamics. Second, semi-structured interview guides were developed to explore participants' perspectives regarding innovation strategies, implementation experiences, and perceived impacts on students' digital literacy development. Third, documentation checklists were developed to identify and analyze digital learning artifacts, including lesson plans, learning management system records, student digital projects, and assessment outputs.

Table 2. Instrument Blueprint

Research Focus	Indicators	Data Sources	Techniques
Planning Innovation	Digital literacy integration, platform design, instructional strategy	Teachers, Leaders	Interview, Documentation
Implementation	Platform use, interaction management, and collaboration	Teachers, Students	Observation, Interview
Literacy Optimization	Information literacy, collaboration, content creation, and ethics	Students, Teachers	Observation, Documentation
Constraints & Follow-up	Technical, pedagogical, managerial barriers	All participants	Interview, Documentation

Instrument validation was conducted through expert judgment involving two educational management scholars and one digital pedagogy practitioner with experience in implementing digital classrooms. The validation process was carried out in two stages. In the first stage, experts reviewed the instrument grid to assess conceptual alignment between research objectives, theoretical constructs, indicators, and data collection techniques. Each indicator was evaluated based on relevance, clarity of wording, and its adequacy in capturing the dimensions of digital-based classroom management and digital literacy development. In the second stage, the experts examined the operational formulation of observation protocols, interview questions, and documentation checklists to ensure analytical depth and contextual appropriateness.

Feedback from the experts resulted in several refinements, including clarifying overlapping indicators, rephrasing ambiguous interview prompts to avoid leading questions, strengthening

ethical literacy components within the observation rubric, and adding probing questions to capture interaction quality and digital autonomy. The validation outcome indicated that the instruments achieved strong content validity, as all indicators were deemed relevant and theoretically grounded. Minor revisions were implemented prior to field deployment to ensure methodological rigor and data adequacy.

Data Analysis Technique

Data analysis in this study was conducted using an interactive qualitative analysis model characterized by cyclical and concurrent analytical flows. This model enabled the researchers to process, interpret, and validate data systematically from the initial stages of field engagement through to the final interpretation phase. Rather than occurring linearly, the analytical activities were undertaken iteratively, allowing continuous movement between data reduction, organization, and meaning construction (Miles et al., 2014). The stages of the analysis process are summarized in Table 3.

Table 3. Interactive Qualitative Data Analysis Procedures

No	Analytical Flow	Process Description	Analytical Output
1	Data Condensation	Raw data derived from field notes, interview transcripts, and institutional documents were coded, categorized, and reduced into thematic clusters. The condensation process focused on identifying core themes, including innovation strategies, digital orchestration practices, literacy development outcomes, and implementation barriers.	Thematic codes, categorized data clusters, preliminary pattern identification
2	Data Display	Thematized data were systematically organized into narrative matrices, conceptual diagrams, and cross-participant comparison tables to facilitate visualization of relational patterns and analytical connections across data sources.	Data matrices, conceptual maps, comparative displays
3	Conclusion Drawing and Verification	Interpretations were constructed iteratively through pattern matching, alignment with theoretical frameworks, and triangulation across sources and methods to ensure analytical validity.	Verified interpretations, substantive findings, validated conclusions

Coding was conducted through open coding, axial categorization, and thematic clustering to identify patterns across planning, implementation, literacy outcomes, and constraints.

Criteria for Drawing Conclusions

Conclusions regarding the optimization of students' digital literacy were formulated using a set of qualitative analytical criteria that reflect the multidimensional nature of literacy development in digital classroom environments. The first criterion, pedagogical integration depth, examined the extent to which digital platforms were systematically embedded in structuring instructional processes, including learning design, activity management, and assessment practices. The second criterion, interaction quality, focused on identifying evidence of collaborative, participatory, and dialogical engagement facilitated through digital learning spaces. The third criterion, literacy competence manifestation, assessed students' demonstrated ability to access, evaluate, create, and meaningfully and critically communicate digital content. The fourth criterion, ethical digital awareness, examined students' sense of responsibility, safety awareness, and adherence to ethical

norms when using technology. The fifth criterion, learning autonomy, explored the emergence of self-regulated learning behaviors within digitally mediated contexts.

Trustworthiness of Data

Data validity in this study was established by applying four trustworthiness criteria to ensure the rigor and integrity of the qualitative findings. Credibility was maintained through source and method triangulation, prolonged engagement in the research setting, and member checking, in which participants verified the accuracy of the interpreted data. Transferability was addressed by providing thick, contextualized descriptions of the school environment, digital infrastructure, and classroom innovation ecology, enabling readers to assess the applicability of findings to comparable contexts. Dependability was ensured through a systematic audit trail that documented all research procedures, including data collection protocols, coding processes, and analytical decisions, thereby enabling methodological traceability. Confirmability was reinforced through reflexive journaling and data-grounded interpretation, ensuring that conclusions were derived directly from empirical evidence rather than researcher bias or presupposition.

Results and Discussion

Innovative Classroom Management Planning

The results indicate that innovative digital classroom management planning was conducted systematically and institutionally integrated. Planning extended beyond instructional documentation to encompass curriculum alignment, embedding digital literacy, infrastructure readiness, and leadership support. Teachers formulated learning objectives by embedding multidimensional digital literacy competencies. These included technical skills, information evaluation, ethical awareness, and digital creativity. "*We design learning objectives so students not only operate technology but also understand digital ethics and responsibility*." (KP, Informatics Teacher). "*Students are directed to search, filter, and process digital information relevant to learning materials*." (AR, Informatics Teacher). This finding reflects a shift from device-centered instruction toward literacy-centered digital pedagogy, aligning with multidimensional digital literacy frameworks emphasizing cognitive, technical, and ethical integration. Digital literacy integration was also evident in lesson plans, learning modules, and assessment design. "*Digital literacy indicators are embedded in core activities and digital assignments*." (FA, Informatics Teacher). "*We design project-based digital tasks so students produce technology-based work*." (YO, Informatics Teacher). Institutional leadership reinforced this planning ecosystem. "*Digital learning innovation is part of our school development vision*." (RD, Principal). "*Digital classroom management has been integrated into curriculum planning*." (PM, Vice Principal Curriculum). Infrastructure planning also supported innovation readiness through laboratories, internet access, and digital devices.

To provide a structured analytical synthesis of the planning findings, the multidimensional components of innovative digital classroom management were mapped into several interrelated planning domains. This categorization was developed using triangulated evidence from interviews, instructional documents, and institutional records. The mapping highlights how planning innovation is operationalized not only through pedagogical design but also through leadership alignment, platform orchestration, and infrastructure preparedness (Gorli et al., 2022; Wong & Li, 2025). Beyond descriptive planning documentation, the findings reveal a structural shift from technology-assisted instruction toward digitally orchestrated pedagogical governance. Planning was not confined to lesson preparation but constituted a multi-layered alignment between institutional vision, curriculum embedding, literacy goal articulation, platform architecture, and infrastructure readiness. This systemic alignment suggests that digital-based classroom management at SMP Negeri 5 Bengkulu Selatan operates as an institutionalized innovation rather than an individual teacher initiative. Such structural integration contrasts with previous studies that describe digital

planning primarily at the instructional design level, without examining the coupling between policy and infrastructure (Ramadhan & Inayati, 2024).

The integration of digital literacy objectives across technical, evaluative, creative, and ethical domains demonstrates conceptual coherence with multidimensional digital literacy models (Wuyckens et al., 2022). However, unlike prior research emphasizing skill acquisition, the present findings show that literacy competencies were embedded as explicit managerial targets within planning documents, indicating a governance-oriented literacy strategy. Each dimension reflects the systemic integration required to sustain literacy-oriented digital classroom management, as summarized in Table 4.

Table 4. Planning Dimensions of Digital Classroom Management

Dimension	Planning Focus	Empirical Evidence	Analytical Meaning
Learning Objectives	Digital literacy integration	Literacy embedded in goals	Literacy as core competence
Instructional Design	Digital modules, projects	LMS-based lesson plans	Innovation in pedagogy
Platform Selection	LMS 1 Cerdas	Centralized learning system	Digital orchestration tool
Institutional Policy	School vision alignment	Leadership directives	Systemic innovation support
Infrastructure	Labs, internet, devices	Facility readiness	Enabling environment

Table 4 demonstrates that innovation is not confined to platform adoption alone but to the relational interactions among five domains: objectives, instructional design, platform selection, institutional policy, and infrastructure. The analytical implication is that digital classroom management functions as a system architecture rather than an isolated pedagogical technique. This systemic configuration reflects what contemporary digital transformation theory identifies as the "institutional embedding" of innovation, in which policy, pedagogy, and technology converge structurally (Wong & Li, 2025).

To conceptualize the systemic architecture underpinning innovative digital classroom management planning, the study synthesized empirical findings into an integrative planning framework. This framework was constructed to illustrate how institutional, curricular, pedagogical, and technological components interact sequentially to produce sustainable digital classroom innovation (Cambay & Paglinawan, 2024). Rather than functioning as isolated planning elements, each component forms a cumulative developmental pathway that shapes the readiness and effectiveness of literacy-oriented digital learning environments, as illustrated in Image 1.

Image 1. Systemic Planning Framework of Digital Classroom Innovation

The planning framework begins with school policy as the macro foundational driver, legitimizing and mandating digital innovation through vision alignment, regulatory support, and strategic programming. This policy foundation enables curriculum integration, where digital literacy

competencies are embedded structurally within learning outcomes, subject content, and instructional mandates (Eliaumra et al., 2024; Nurlita et al., 2025; Wuyckens et al., 2022). The framework then advances toward the formulation of digital literacy objectives, ensuring that classroom innovation targets multidimensional competencies encompassing technical, cognitive, creative, and ethical domains. These objectives operationalize into instructional design and LMS planning, where teachers translate literacy goals into platform-orchestrated pedagogical strategies, digital modules, and project-based learning scenarios (Putri et al., 2024; Shafa, 2024). The framework culminates in infrastructure and teacher readiness, representing the enabling layer that sustains innovation through technological facilities, connectivity ecosystems, and professional capacity development.

Implementation of Innovative Digital Classroom Management

Implementation findings reveal that digital technology functioned not merely as instructional media but as an integrated classroom management ecosystem regulating interaction, communication, monitoring, and assessment through the institutional digital platform 1 Cerdas Application. The platform served as the central orchestration system for managing instructional flow, digital attendance, task submission, discussion forums, and performance tracking. As articulated by an Informatics teacher, "The 1 Cerdas Application helps us control learning activities and monitor students in real time" (KP, Informatics Teacher). Another teacher emphasized its participatory affordances, noting that "Students don't just receive materials; they discuss, submit tasks, and explore resources digitally through the platform" (AR, Informatics Teacher).

Observational data confirmed that the 1 Cerdas Application structured learning sequences through staged content delivery, embedded assignments, and digital monitoring dashboards. Interactive communication patterns intensified through asynchronous discussion spaces. Students acknowledged this communicative expansion, stating "Interaction continues through discussion forums and comment features" (Student AN) and "Learning feels more communicative because we can respond anytime" (Student RR). Project-based collaborative learning was also mediated through the platform, with teachers organizing team outputs, shared documents, and digital presentations. As another teacher expressed, "Students work in teams to create digital projects collaboratively using the platform tools" (YO, Informatics Teacher). These findings confirm that the 1 Cerdas Application functioned as a system-managed classroom environment integrating pedagogy, communication, and assessment within a unified digital infrastructure.

To systematically synthesize the implementation findings, the operational characteristics of innovative digital classroom management were analytically categorized into key functional domains. This classification was developed using triangulated evidence from classroom observations, interview narratives, and platform activity documentation. The mapping highlights how the 1 Cerdas Application functioned not only as a technological tool but also as an instructional management system, shaping learning structures, interaction ecologies, assessment practices, and pedagogical roles.

The implementation phase reveals that the 1 Cerdas Application functioned as a regulatory platform governing instructional temporality, participation density, and transparency in accountability. *This represents a shift from content transmission toward platform-mediated behavioral governance.* Unlike conventional LMS usage described in earlier literature (Johler et al., 2022), where platforms primarily store materials, *the 1 Cerdas Application in this study served as a micro-analytic control system through attendance logs, submission timestamps, participation tracking, and feedback loops.* This aligns with digital learning analytics theory, which argues that data visibility enhances structured engagement. However, the present study extends this argument by demonstrating that analytics-based

orchestration can strengthen literacy habituation when integrated pedagogically rather than administratively. The implementation profile is summarized in Table 5.

Table 5. Implementation Characteristics of Digital Classroom Innovation

Aspect	Observed Practice	Impact on Learning
1 Cerdas Application Utilization	Content distribution, attendance tracking, and task monitoring	Structured and system-managed learning flow
Interaction Management	Discussion forums, comment features, and feedback channels within the platform	Expanded communicative engagement
Instructional Strategy	Platform-mediated project-based and collaborative learning	Collaboration and teamwork development
Assessment	Digital quizzes, e-portfolios, and assignment analytics via the platform	Authentic and process-based evaluation
Teacher Role	Facilitator, mediator, digital learning orchestrator	Student-centered and participatory learning

To conceptualize the sustainability dynamics of digital classroom management innovation, the findings were synthesized into a cyclical institutional model that illustrates how schools respond adaptively to implementation realities. This model positions innovation not as a linear intervention but as a continuous improvement process shaped by feedback, evaluation, and capacity strengthening. Each phase in the cycle represents an interconnected institutional response that collectively sustains and refines digital classroom practices over time, as visualized in Image 2.

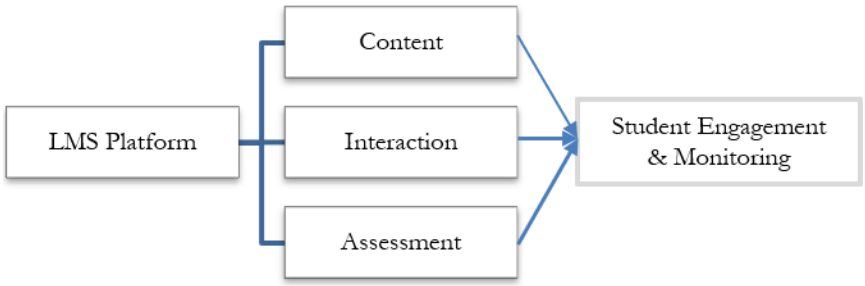

Image 2. Digital Classroom Management Ecosystem

As illustrated in Figure 2, the sustainability cycle begins with the emergence of implementation challenges that arise from technical, pedagogical, or managerial dimensions. These challenges trigger institutional evaluation processes to diagnose gaps and identify strategic priorities. The evaluation outcomes then inform targeted infrastructure development and professional training initiatives designed to strengthen digital capacity. This reinforcement phase subsequently leads to improved digital classroom practices, which enhance instructional quality and literacy outcomes. However, as innovation advances, new challenges emerge, reactivating the cycle. From a digital pedagogy systems perspective, the utilization of Aplikasi 1 Cerdas demonstrates a transition from technology-assisted instruction toward platform-orchestrated classroom governance. The platform did not function as a passive repository of materials but as an active regulatory architecture shaping temporal learning structures, behavioral accountability, and interaction density. Through dashboard analytics, submission timestamps, and participation logs, teachers exercised data-informed classroom control and operationalized digital learning analytics within micro-classroom contexts. Furthermore, the platform enabled the expansion of pedagogical presence beyond the spatial boundaries of the classroom. Interaction continuity through asynchronous forums reflects

the emergence of an extended communicative ecology in which discourse persists beyond scheduled instructional hours. This aligns with contemporary computer-mediated learning theory, which posits that dialogic persistence enhances cognitive elaboration and reflective engagement.

The collaborative project structures mediated by Aplikasi 1 Cerdas also indicate the formation of distributed environments for knowledge production. Students functioned not only as recipients of digital content but also as co-constructors of technological artifacts, reinforcing higher-order competencies such as digital creativity, co-authoring, and problem-solving negotiation. However, platform centrality also introduces governance complexity. Effective orchestration requires teacher proficiency in workflow design, digital feedback literacy, and engagement surveillance without fostering cognitive overload. Thus, implementation effectiveness is contingent upon the interplay between platform affordances, pedagogical design capacity, and institutional infrastructure resilience. In synthesis, the integration of Aplikasi 1 Cerdas within digital classroom management reflects a maturation phase of school digital transformation where innovation is not defined by device presence but by the systemic embedding of platforms into instructional regulation, interaction architecture, and literacy development trajectories.

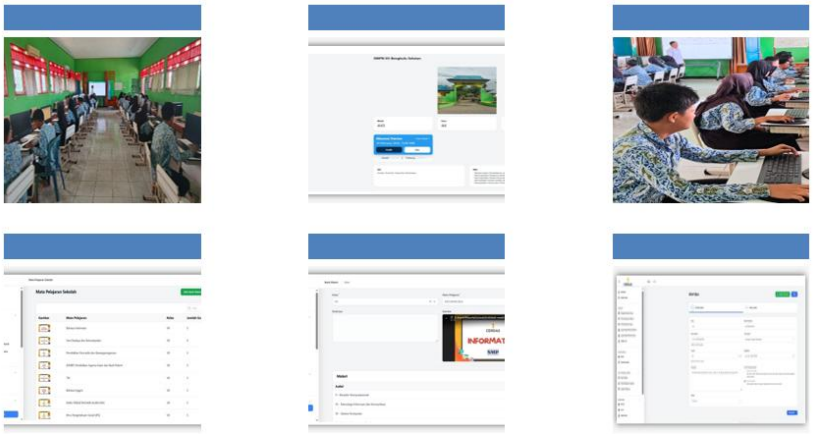

Image 3. Implementation of Informatics Classroom Learning through the 1 Cerdas Application

While prior research has highlighted improvements in digital literacy through e-learning adoption (Made et al., 2024), such studies often isolate instructional strategies from classroom management structures. In contrast, the present findings indicate that literacy development is significantly influenced by how platforms regulate the flow of interaction and collaborative design. Similarly, earlier studies emphasize student-centered learning in digital contexts (Syafitri et al., 2024), yet they rarely analyze the managerial mechanisms that enable such student agency. This study demonstrates that autonomy and collaboration emerge not spontaneously but through structured digital orchestration.

Optimization of Students' Digital Literacy

Findings demonstrate that innovative digital classroom management significantly optimized students' digital literacy across multiple domains. School leadership observed notable shifts in behavior and competence: "*Students now use technology more responsibly and productively*" (RD, Principal). Teachers likewise confirmed both technical and cognitive development. As noted by an Informatics teacher, "*Students are more confident using digital applications*" (KP, Informatics Teacher), while another added, "*They independently search and evaluate online information*" (AR, Informatics Teacher). Ethical awareness also showed measurable improvement, reflected in the statement, "*Students are more aware of credible sources and digital responsibility*" (FA, Informatics Teacher). Creativity and collaboration were strengthened through project-based digital work, as emphasized by "*Digital*

projects enhance teamwork and creativity" (YO, Informatics Teacher). Students' perspectives further reinforced these outcomes. One student remarked, "*Learning through the 1 Cerdas Application makes me more independent*" (Student AN), while another stated, "*Group digital tasks through the platform improve our collaboration*" (Student RR). To present a concise analytical summary of literacy outcomes, the multidimensional impacts of innovative digital classroom management were synthesized into key digital literacy domains. This categorization was developed to capture observable competence development, behavioral shifts, and learning dispositions emerging from platform-mediated instruction, as outlined in Table 6.

Table 6. Digital Literacy Optimization Outcomes

Literacy Dimension	Observed Development	Evidence Source
Technical Skills	Application operation	Observation, tasks
Information Literacy	Source searching, filtering	Interviews
Collaboration	Team digital projects	Observation
Creativity	Content production	Portfolios
Ethics	Responsible technology use	Interviews
Autonomy	Independent learning habits	LMS logs

Table 6 indicates competence development across six literacy domains. Analytically, these domains reveal uneven patterns of maturation. Technical and collaborative competencies showed faster observable development due to repetitive platform engagement and project-based workflows. However, critical information literacy and ethical awareness required explicit scaffolding, suggesting that higher-order literacy layers demand intentional pedagogical reinforcement. This finding aligns with contemporary digital literacy research, which identifies evaluative and ethical dimensions as more cognitively complex and slower to develop than operational skills (Kalyani, 2024).

To theoretically synthesize the developmental trajectory identified in the findings, the study formulated a conceptual model illustrating how innovative digital classroom management systematically cultivates students' digital literacy. The model was constructed based on the sequential relationship between classroom management structures, learning activity design, and literacy practice internalization observed during implementation. It positions digital literacy not as an immediate instructional output but as a cumulative developmental outcome shaped through repeated, structured, and scaffolded digital learning experiences, as visualized in Image 4.

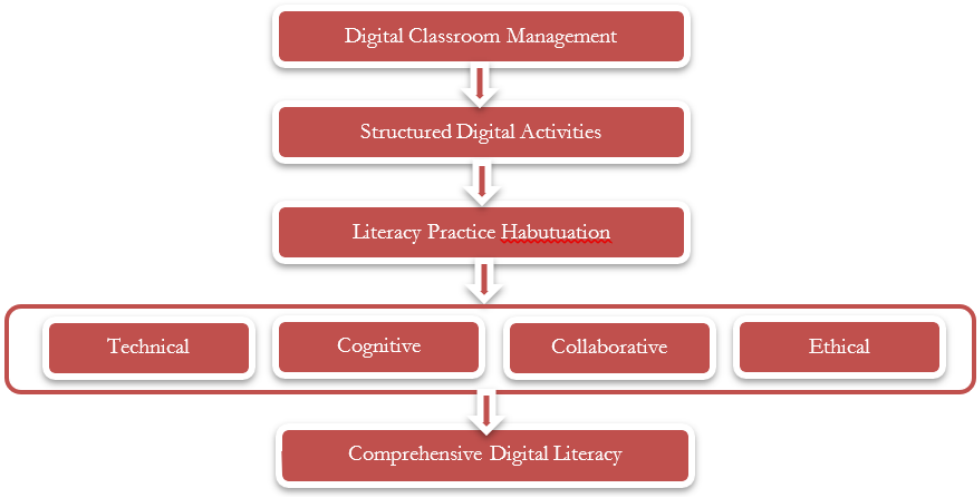

Image 4. Digital Literacy Development Model

Constraints and Follow-Up Strategies

The findings reveal that, despite the positive impacts of digital-based classroom management innovation, its implementation encountered multidimensional constraints spanning technical, competency, pedagogical, and managerial domains. From a technical perspective, infrastructure instability emerged as a recurring challenge to instructional continuity when using the 1 Cerdas Application. One Informatics teacher stated, "*Internet instability sometimes disrupts access to the 1 Cerdas platform*" (KP, Informatics Teacher), while a student similarly noted, "*Network issues affect assignment submission through the application*" (Student AN). These statements were corroborated by classroom observations and institutional documentation, which recorded intermittent connectivity disruptions and bandwidth limitations during synchronous digital learning sessions mediated by the platform (Widana et al., 2020; Ruli Setiyadi et al., 2025).

In terms of competency gaps, variations in students' digital operational skills posed adaptive challenges for teachers in designing and pacing instruction within the 1 Cerdas system environment. As another teacher expressed, "*Students' digital skills vary, requiring adaptation*" (FA, Informatics Teacher). This condition reflects digital divide dynamics not merely in access but in functional technological proficiency, necessitating differentiated instructional scaffolding. Pedagogically, the transition toward digitally managed classrooms through the application required professional adjustment, particularly in sustaining student engagement within platform-based interaction spaces. One teacher explained, "*Digital classroom management requires adaptation time*" (AR, Informatics Teacher), emphasizing the complexity of monitoring participation and mitigating digital distractions.

At the managerial level, school leadership highlighted sustainability concerns, particularly regarding infrastructure resilience and continuous professional development to support effective platform utilization. As articulated by the vice principal, "*Infrastructure and teacher training need continuous strengthening*" (PM, Vice Principal). Collectively, these findings indicate that while digital classroom innovation through the 1 Cerdas Application demonstrates transformative pedagogical potential, its effectiveness remains contingent upon sustained infrastructural investment, competency equalization, pedagogical capacity building, and strategic institutional support.

To illustrate the sustainability dynamics of digital classroom management innovation, the study synthesized empirical findings into a cyclical institutional development model. The cyclical relationship among these components demonstrates how schools maintain continuity of innovation through structured reflection and systemic strengthening, as visualized in Image 5.

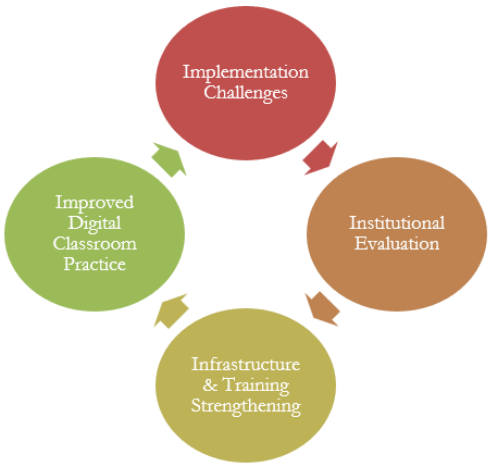

Image 5. Innovation Sustainability Cycle

As depicted in Image 5, the innovation sustainability cycle begins with implementation challenges arising from real classroom practice in the use of the 1 Cerdas Application as the core digital classroom management platform. The emergence of these constraints activates institutional evaluation processes, whereby school leadership, curriculum coordinators, and teachers collectively assess the effectiveness of the 1 Cerdas platform integration, diagnose operational gaps, and formulate strategic improvement priorities. Evaluation findings subsequently inform infrastructure and training strengthening initiatives, including bandwidth upgrades, laboratory optimization, platform feature maximization, and continuous professional development focused on digital pedagogy and platform orchestration competencies.

Synthesizing all findings, digital-based classroom management innovation mediated through the 1 Cerdas Application functioned as an integrated pedagogical managerial system encompassing systemic planning, platform-orchestrated implementation, literacy competency cultivation, and adaptive institutional improvement (Siskawati et al., 2025; Rusmini et al., 2023). Innovation effectiveness did not derive from platform presence alone but from orchestration quality, leadership alignment, instructional design intentionality, and infrastructure enablement (Burden, 2025; Marzano, 2016; Putri et al., 2024). Compared with prior studies that predominantly frame digital innovation in terms of media utilization or e-learning adoption, this study positions classroom management orchestration via a centralized digital platform as the primary structural driver shaping literacy outcomes. This reconceptualization extends digital pedagogy discourse by emphasizing that literacy optimization emerges from how platforms regulate interaction, structure activity flows, scaffold collaboration, and institutionalize digital learning habits (Buchori et al., 2025).

The novelty of the research findings lies in reconceptualizing digital-based classroom management as the primary structural determinant of digital literacy development. Unlike prior studies that frame literacy outcomes as direct products of digital media exposure or instructional strategies, this study demonstrates that literacy optimization is mediated by platform governance mechanisms that regulate interaction, temporality, accountability, and collaboration. This systemic orchestration perspective expands the discourse on digital pedagogy by positioning classroom management architecture as the central driver of innovation (Widana & Ratnaya, 2021).

Despite its contributions, this study has limitations. First, as a single-case qualitative study, findings are context-bound and not statistically generalizable. Second, literacy optimization was interpreted qualitatively without quantitative measurement scales. Third, platform effects were analyzed within a single institutional ecosystem, limiting cross-platform comparisons. Future research may adopt mixed-method designs or comparative multi-school studies to strengthen generalizability.

Theoretically, this study advances digital pedagogy scholarship by integrating classroom management theory with digital literacy frameworks within a unified analytical model. It contributes to understanding how platform orchestration mediates the formation of competence. Practically, the findings provide strategic guidance for schools undergoing digital transformation, emphasizing that sustainable innovation requires institutional alignment, structured orchestration, and continuous capacity strengthening rather than mere technology provision.

Schools should institutionalize digital classroom management standards, integrating platform governance, literacy embedding, and data-informed monitoring. Teacher professional development programs should emphasize workflow design, digital feedback literacy, and ethical scaffolding strategies. Infrastructure sustainability planning should accompany digital innovation initiatives to prevent disruptions to implementation (Marzulina et al., 2025; Hermanto et al., 2023).

Conclusion

Digital-based classroom management in Informatics learning enhances students' digital literacy by serving as a structured, platform-orchestrated system that regulates instructional flow, interaction patterns, assessment processes, and literacy habits. The findings demonstrate that when digital platforms are systematically embedded within planning, implementation, and evaluation processes, students develop multidimensional competencies including technical proficiency, information evaluation, collaboration, creativity, ethical awareness, and learning autonomy. Thus, digital literacy optimization emerges not from the presence of technology alone but from the quality of pedagogical orchestration and institutional alignment that support its use. Although implementation challenges related to connectivity stability and varying digital readiness persist, achieving sustainable impact requires strategic infrastructure strengthening, ongoing teacher professional development in digital orchestration, and explicit integration of higher-order information and ethical literacy scaffolds into classroom management design.

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