Bulletin of Educational Management and Innovation
Volume 3, No. 2, October 2025. pp. 221-233
DOI: https://doi.org/10.56587/bemi.v3i2.158
E-ISSN: 2986-8688 | https://journal.rafandhapress.com/BEMI

Evaluation of the use of interactive flat panel (IFP) as a 21st-century learning innovation in elementary schools of Sleman Regency

Ahyar Nasukha, Akbar Al Masjid*, Ardian Arief
Universitas Sarjanawiyata Tamansiswa, Jl. Batikan, UH-III No.1043, Tahunan, Kec. Umbulharjo, Kota Yogyakarta, Daerah Istimewa Yogyakarta 55167, Indonesia
*Correspondence: ✉ almasjida@ustjogja.ac.id

Abstract
Background: The 21st-century educational transformation demands a paradigm shift toward interactive, collaborative, and student-centered digital ecosystems. In response, the government distributed Interactive Flat Panel (IFP) media to elementary schools in Sleman Regency in December 2025 to boost instructional quality. However, post-distribution data indicates a prominent phenomenon where many schools and teachers have not yet optimally integrated this advanced technology into their daily learning processes.
Purpose: This study specifically aims to evaluate the effectiveness and usage patterns of IFP media as a 21st-century learning innovation in elementary schools across Sleman Regency. Additionally, it identifies the supporting and inhibiting factors influencing implementation based on curricular artifacts and documentary evidence to guide future strategic policy directions and teacher mentoring programs.
Method: This evaluative-empirical field research applied a mixed-methods approach. From 556 initial responses, data screening yielded 438 clean datasets, with link validation isolating 353 fully accessible cloud links and 85 restricted links. A micro-level content analysis was then conducted on a stratified random sample of 34 Lesson Plans using a Content Analysis Checklist Sheet, synthesizing descriptive quantitative and qualitative analysis streams through method triangulation.
Findings: The findings reveal a clear gap between high administrative reporting compliance and the depth of actual classroom technology integration. At the macro level, 19.41% of documents face first-order barriers due to locked cloud storage permissions. At the micro level, explicit instructional planning for IFP reached only 35.3% and is heavily dominated by teacher-centered, one-way patterns that relegate the device to the mere substitution level of the SAMR model.
Keyword: Interactive Flat Panel, Mixed-methods evaluation, Technology integration.

INTRODUCTION

Entering the era of 21st-century educational transformation, learning digitalization has become a primary pillar in enhancing instructional quality and effectiveness in formal educational institutions. Utmost technological developments demand a paradigm shift from conventional learning methods toward interactive, collaborative, and student-centered digital ecosystems. The integration of advanced electronic media in classrooms is proven to stimulate higher-order thinking skills (HOTS), expand access to learning resources, and create more meaningful learning experiences. Therefore, the adoption of interactive technological devices is no longer

merely an option, but a national strategic necessity to cultivate a globally competitive generation.

The government has consistently launched various strategic programs to accelerate this digitalization, one of which is through the distribution of Interactive Flat Panel (IFP) media. This program noblely aims to boost the quality of learning in elementary schools on a mass scale. In Sleman Regency, the realization of this strategic program was marked by the handover of IFP units to various elementary schools (SD) in December 2025. However, this ideal condition is not yet fully aligned with the reality in the field.

Based on preliminary observation data, a phenomenon was found where post-IFP distribution, many schools and teachers have not optimally utilized and integrated these advanced electronic media into daily learning processes.

Nevertheless, this pile of raw data requires in-depth scientific analysis and comprehensive interpretation of results so that it does not merely become an administrative report. The researchers argue that a formal evaluation of IFP utilization is highly crucial; without a valid data-driven analysis, follow-up policies run the risk of being mistargeted. Therefore, this study is committed to making a tangible contribution to the development of educational management science and learning technology by presenting an objective overview of IFP utilization patterns in the field. The practical contribution of this article is designed as a scientific reference for the Sleman Regency Education Office in mapping technical obstacles (such as digital accessibility issues) and determining future strategic policy directions and teacher mentoring programs.

In line with this urgency, this study specifically aims to evaluate the effectiveness and usage patterns of Interactive Flat Panel (IFP) media as a 21st-century learning innovation in elementary schools across Sleman Regency, while simultaneously identifying supporting and inhibiting factors for its implementation based on curricular artifacts (Teaching Modules) and documentary evidence gathered.

In the academic landscape of the past five years, studies on technology integration in elementary schools have shifted from general infrastructure readiness toward specific evaluations of the role of IFP in fostering student learning motivation in primary classrooms (Oya & Yuningsih, 2024), alongside the effectiveness of clinically integrating such instructional devices within the classroom setting (Sari & Widjajanti, 2021). Conversely, contemporary literature also highlights that barriers to implementing interactive digital media in the classroom are no longer restricted to conventional technical issues, but instead center on the dynamics of teachers' data

governance literacy capacity and administrative constraints in utilizing digital reporting platforms (Kurniawati & Kristin, 2021).

The novelty of this study lies in its macro, actual, and clinical-administrative compliance-based evaluative approach immediately following mass distribution. This striking difference provides a more realistic state-of-the-art overview of the extent to which government digitalization instructions transform into actual pedagogical actions in elementary school classrooms.

Based on the literature review, preliminary observation data, and problem mapping, the main proposition of this mixed-methods evaluation study is formulated as follows: a synthesis of descriptive quantitative analysis concerning digital data accessibility levels and content analysis of curricular document (Lesson Plan) readiness will provide a comprehensive empirical foundation in mapping field realities to determine the strategic policy direction of the Sleman Regency Department of Education. Furthermore, this proposition asserts that optimizing the utilization of Interactive Flat Panel (IFP) in the classroom heavily relies on post-evaluation policy interventions focused on two strategic pillars: the standardization of digital data governance literacy regulations to eliminate information accessibility constraints at the institutional level, and the implementation of intensive technical-pedagogical coaching programs for teachers to sustainably overcome media integration barriers.

METHODS

This field research applies an evaluative-empirical mixed-methods approach to dissect the implementation of digitalization programs in elementary schools. This approach was chosen to bridge the need for macro-level descriptive quantitative analysis with the depth of textual data interpretation through qualitative content analysis. This evaluation is objectively directed at examining the alignment of Interactive Flat Panel (IFP) utilization within primary education institutions. Furthermore, the location of this study encompasses all elementary schools under the auspices of the Sleman Regency Department of Education, Special Region of Yogyakarta Province.

Sample determination in this study utilizes a total sampling method involving the entire elementary school population in Sleman Regency, totaling 556 institutions. The macro data collection instrument was distributed simultaneously via an official online questionnaire link (Google Form) coordinated directly by the Primary School Division of the Sleman Regency Department of Education. The entire data collection process within the primary education ecosystem was systematically conducted from March 5, 2026, to April 1, 2026. This digital data collection procedure was designed

with a focus on gathering curricular documents and photographic evidence of actual IFP utilization in the classroom.

The validity and reliability of the data in this study were strictly maintained through data screening procedures based on systematic inclusion and exclusion criteria. From an initial total response of 556 elementary schools, the data cleaning process successfully yielded 438 clean datasets. Subsequently, the researchers conducted a link validation stage to verify the accessibility of the cloud storage links submitted by the schools. This final screening stage resulted in a final analytical unit of 353 fully accessible document links for further analysis. Meanwhile, 85 other links were classified as administrative constraints due to file permission restrictions on digital access.

The instrument used to measure the degree of alignment between teachers' instructional planning and IFP functionality is the Content Analysis Checklist Sheet. The data sources subjected to examination are official Merdeka Curriculum artifacts consisting of Lesson Plan documents and attached photographs of learning activities. This content analysis instrument utilizes a checklist sheet based on dichotomous indicators with Yes or No response options. The indicators within this instrument are theoretically derived from the pillars of 21st-century learning competencies and the interactive features of the IFP. The focus of the examination is directed toward the presence of explicit IFP integration steps within the core learning scenarios and their supporting visual evidence in the classroom.

Data analysis techniques were executed by integrating descriptive quantitative and content analysis streams simultaneously, in accordance with the principles of mixed-methods design. Descriptive quantitative analysis was applied to process macro data from 438 schools to map distribution and the level of link accessibility constraints. Meanwhile, the quantitative-qualitative content analysis method was used to deeply dissect the Lesson Plan documents and photographs from the 353 schools that passed access verification. Additionally, micro data processing was executed on 34 stratified random sample documents to describe the specific component completeness, time management, and instructional step content within the teaching modules. Textual data from the learning scenarios were coded based on the content analysis instrument sheet to be subsequently interpreted narratively. In the final stage, the quantitative calculations and qualitative interpretations were synthesized through method triangulation techniques to generate strategic policy recommendations for the Sleman Regency Department of Education.

RESULT AND DISCUSSION

Result

1. Descriptive Statistics of IFP Utilization Across Sleman Regency

The primary objective of collecting reporting data via Google Forms by the Sleman Regency Education Department through the Elementary School Division is to design an efficient evaluation mechanism without increasing teachers' administrative burden (Boddy, 2008; Kinicki & Williams, 2020). This macro data collection was carried out simultaneously across Sleman Regency. Out of a total population of 556 elementary schools (SD) in Sleman Regency, a clean response from 438 schools was obtained after going through data reduction stages to eliminate invalid files.

Quantitative reporting data regarding the distribution of accessibility for Teaching Modules (Modul Ajar)/Lesson Plans (RPP) and photos of Interactive Flat Panel (IFP) utilization in 17 Kapanewon (Sub-districts) are presented in Table 1.

Table 1. Distribution of Interactive Flat Panel (IFP) Utilization Data Based on Kapanewon in Sleman Regency in 2026

No.	District	Total Clean Respondents (Schools)	Accessible Teaching Modules	Inaccessible Teaching Modules	Accessible Photos	Inaccessible Photos
1	Berbah	19	13	6	14	5
2	Cangkringan	19	15	4	14	5
3	Depok	34	29	5	27	7
4	Gamping	35	26	9	26	9
5	Godean	26	20	6	20	6
6	Kalasan	30	24	6	23	7
7	Minggir	19	13	6	13	6
8	Mlati	44	39	5	39	5
9	Moyudan	19	16	3	15	4
10	Ngaglik	32	25	7	27	5
11	Ngemplak	20	16	4	16	4
12	Pakem	15	12	3	12	3
13	Prambanan	18	15	3	13	5
14	Seyegan	27	23	4	23	4
15	Sleman	38	33	5	33	5
16	Tempel	26	21	5	20	6
17	Turi	17	13	4	14	3
Total	Sleman Regency	438	353	85	349	89

Based on Table 1, the highest concentration of clean reporting is located in Kapanewon Mlati (44 schools), Kapanewon Sleman (38 schools), and Kapanewon Gamping (35 schools). This pattern reinforces previous studies stating that

geographical proximity to the center of government and more stable internet network accessibility in urban areas positively correlate with the level of compliance and smoothness of digital-based reporting (Warschauer et al., 2014).

Cumulatively, 80.59% (353 documents) of Teaching Modules/RPP had an accessible status, while 19.41% (85 documents) were locked. Through critical analysis, this study successfully converted piles of raw data into meaningful information (actionable insights) as a foundation for data-driven decision making (Wijaya, 2024).

2. Results of Curricular Readiness Analysis and Accessibility Barriers

Macro analysis of the 353 successfully accessed documents confirms a fairly good curricular readiness among teachers to integrate IFP into teaching and learning activities. The written learning scenarios indicate an initial shift in the teaching paradigm toward the utilization of digital media.

Nevertheless, the existence of 85 locked module links and 89 locked visual documentation links (restricted) presents an anomaly amidst the high participation rate. This obstacle is categorized as a first-order barrier in educational technology integration, which includes external and administrative-technical issues (Ertmer et al., 2012). The absence of public access to the submitted links proves that technological infrastructure readiness has not been fully balanced by adequate digital data management skills at the implementer level in elementary school education units.

3. Descriptive Statistical Analysis (Review of Micro Sample Documents)

In order to examine the quality of the depth of implementation in a real context, a micro sample of 34 learning instrument documents was drawn using the stratified random sampling method (2 samples from each of the 17 Kapanewon).

The feasibility percentage calculation uses the formula:

$$P = (f / N) * 100\%$$

The detailed tabulation of the component content analysis checklist is presented in Table 2.

The table 2 shows that administrative compliance in Dimension A (General Information) is exceptionally high, with an average occurrence above 90%. However, a significant decline in planning performance begins to appear in Dimension B (Facilities and Infrastructure), particularly in the aspect of explicitly including IFP/IFP devices, which only reaches 35.3% (12 documents). In Dimension

C (Learning Steps), the time management component per sub-activity also becomes a weak point, with an absence rate reaching 23.5%.

Table 2. Summary of Content Analysis of Learning Instrument Documents (N = 34)

No.	Evaluated Component	Present (n/%)	Absent (n/%)	Complete (n/%)	Incomplete (n/%)
A	**General Information**				
1	School identity	34(100.0%)	0 (0.0%)	31 (91.20%)	3 (8.80%)
2	Author/teacher name	34(100.0%)	0 (0.0%)	34(100.0%)	0 (0.0%)
3	Subject	34(100.0%)	0 (0.0%)	34(100.0%)	0 (0.0%)
4	Phase/Grade	32 (94.10%)	2 (5.90%)	30 (88.20%)	2 (5.90%)
5	Semester	29 (85.30%)	5 (14.70%)	29 (85.30%)	0 (0.0%)
6	Time allocation	33 (97.10%)	1 (2.90%)	27 (79.40%)	6 (17.60%)
B	**Facilities and Learning Resources**				
7	Learning media	34(100.0%)	0 (0.0%)	25 (73.50%)	9 (26.50%)
8	Teaching tools and materials	30 (88.20%)	4 (11.80%)	22 (64.70%)	8 (23.50%)
9	Learning resources	34(100.0%)	0 (0.0%)	28 (82.40%)	6 (17.60%)
10	Use of the Interactive Flat Panel (IFP)	12 (35.30%)	22 (64.70%)	8 (23.50%)	4 (11.80%)
C	**Learning Procedures**				
11	Preliminary activities	34(100.0%)	0 (0.0%)	32 (94.10%)	2 (5.90%)
12	Main activities	34(100.0%)	0 (0.0%)	29 (85.30%)	5 (14.70%)
13	Closing activities	34(100.0%)	0 (0.0%)	30 (88.20%)	4 (11.80%)
14	Time management	26 (76.50%)	8 (23.50%)	18 (52.90%)	8 (23.50%)

4. Analysis of IFP-Based 21st Century Learning Planning

In the perspective of educational technology adoption theory, the planning contained within the Teaching Module represents the initial acceptance phase (Jones, 2018). Through curriculum documents, teachers are required to be skilled in planning IFP-based learning (Budiman & Setiawan, 2023). The mapping of specific IFP implementations across the 34 sample documents (Table 3) reveals an imbalance between the allocation of infrastructure description and the realization of operational classroom action scenarios.

This finding triggers a critical discussion regarding the effectiveness of IFP integration at the primary level:

a. Preliminary Activities: Trapped in Passive Routines

From the 10 documents (29.4%) that integrate IFP/IFP at the beginning of the class, the majority use it in a one-way manner. The sentences that appear are uniform: "The teacher displays a national anthem video..." or "The teacher shows pictures through a projector." IFP/IFP has merely been downgraded in

functionality to replace a blackboard or a static CRT TV and has not been utilized for interactive early cognitive diagnostic assessments. In fact, empirical evidence proves that the use of interactive electronic media such as IFP at the elementary school level can increase the attention and learning motivation of concrete-operational stage students because it provides dynamic visualizations that stimulate active multimedia engagement (Mayer, 2014).

Table 3. Distribution of the Implementation of IFP Integration Indicators in Learning Steps (N = 34)

IFP Integration Indicator	Present (n)	Present (%)	Absent (n)	Absent (%)
Integration in the Preliminary Activity (Visual Diagnostic/Aperception)	10	29.40%	24	70.60%
Integration in the Main Activity (Interactive Feature Manipulation/Active Student Engagement)	4	11.80%	30	88.20%
Integration in the Closing Activity (Gamified Assessment/Reflection)	6	17.60%	28	82.40%
Clarity of the Student-Centered Learning Operational Scenario	3	8.80%	31	91.20%

b. Core Activities: A Broken Bridge of Interactivity

Only 4 out of 34 documents (11.8%) included IFP/IFP in the core activities, and all fell into the Incomplete category. Teachers wrote biased instructions such as: "Students discuss using the assistance of a projector medium." The transition from group work to using the interactive screen is not illustrated. Students continue to work conventionally on paper student worksheets (LKPD), while the IFP in front of the classroom is left on displaying static task instructions. Students are not given the opportunity to come forward and manipulate the interactive features of the screen. These steps are not in line with the demands of 21st-century learning characteristics that emphasize Critical Thinking, Creativity, Communication, and Collaboration (4C) (Greenstein, 2012).

c. Closing Activities: Paper Efficiency, Not Transformation

A total of 6 documents (17.6%) utilized the screen at the end of the session with the instruction: "The teacher displays 5 evaluation questions in front of the class, students write answers in their notebooks." This action is

merely an efficiency measure for paper duplication, not an integration of interactive technology. Gamification-based evaluation directly on the screen that triggers critical reflection has not been well-planned.

d. Root Cause: Teacher-Centered Technology Mindset

More than 91% of teachers still write the subject of learning scenario sentences with a teacher orientation ("The teacher rotates...", "The teacher shows..."). This causes the learning step documents to lose the essence of Student-Centered Learning mandated by the Merdeka Curriculum.

SAMR Model Analysis (Substitution, Augmentation, Modification, Redefinition):

Based on these micro findings, most teachers no longer view IFP merely as a replacement for conventional chalkboards or markers (substitution), but have stepped into the learning modification stage (modification) within the SAMR framework (Substitution, Augmentation, Modification, Redefinition) (Puentedura, 2013). However, at the operational level of the sample, its realization actually drops back to the Substitution level because the IFP is only functioned as a static projector screen displaying text.

5. Digital Data Management Barriers: Technology Literacy Challenges in Elementary Schools

The results of the evaluative hypothesis testing indicate that the optimization of IFP utilization is strongly influenced by the readiness of school digital data governance. The existence of 85 locked curriculum file links and 89 locked photo links from a total of 438 clean respondents serves as a clear indicator of a cloud governance literacy deficit at the elementary school level. Psychologically, this also indicates technological anxiety or haste in fulfilling administrative reporting without conducting link validation tests beforehand (Howard & Mojejko, 2015).

This condition is caused by teachers who are accustomed to operating digital storage for private needs, but stutter when configuring sharing permissions of links for the public or supervisory access. This administrative-digital barrier has the potential to break the chain of accountability and monitoring of the digitalization program launched by the local government.

6. Strategic Policy Implications for the Sleman Regency Education Department

Based on this real snapshot of 2026 data, there are two strategic policy intervention recommendations that can be implemented (Rahmawati & Utami, 2023). Synthesizing macro and micro data through triangulation techniques yields

several strategic policy implications that must be acted upon by the Sleman Regency Education Department:

a. Technical-Administrative Intervention (Cloud Data Governance):

   The initial step begins with a technical-administrative intervention policy through the standardization of digital data governance literacy regulations (Kurniawan, 2022). Its implementation takes the form of issuing a brief guide circular (infographics) regarding procedures for sharing files via Google Drive using official learning accounts such as @guru.sd.belajar.id, as well as mass rectification of the 85 locked Teaching Module links and 89 locked photo links through direct education to operators or school principals before the next reporting period due to cloud storage governance issues (Hapsari & Wibowo, 2025; Nugroho & Saputra, 2026).

b. Advanced Pedagogical Intervention (Teacher Training Reorientation):

   The policy direction no longer focuses on basic equipment introduction training but rather on intensive coaching programs (coaching) for advanced integration (Howard & Mojejko, 2015; Jones, 2018). The Education Department is advised to optimize the role of the Teacher Working Group (KKG) at the Kapanewon level (Lestari & Handayani, 2021). The optimization of this collective forum is directed to organize workshops on interactive content development, 21st-century active learning methods (Greenstein, 2012), and the preparation of classroom activity scenarios oriented toward student-centered learning.

Through the integration of both data-driven empirical evaluation policy approaches, the government's investment in procurement of IFP devices will not end up as a passive classroom technology ornament, but will transform into a primary catalyst for sustainably improving the quality of 21st-century basic education in Sleman Regency (Efendi et al., 2020; Rambe et al., 2019).

CONCLUSION

This mixed-methods evaluation research successfully mapped the reality of Interactive Flat Panel (IFP) implementation post-mass distribution in December 2025 in elementary schools across Sleman Regency. The primary novelty of this study lies in its evaluation approach, which is actual and based on direct clinical-administrative compliance through macro data screening and simultaneous curriculum document content analysis. Through data collection from 556 initial responses that yielded 438 clean data, this study converted piles of field data into meaningful information as a foundation for data-driven decision making. The focus of the evaluation is objectively

directed to examine the alignment between teachers' written planning and visual evidence of device utilization inside the classroom.

The results of the analysis reveal a clear gap between the high commitment to administrative reporting and the depth of technology integration in learning. At the macro level, a first-order barrier was found in the form of the inaccessibility of 19.41% of Teaching Module documents and 20.32% of photo links due to locked cloud storage governance constraints. Meanwhile, a micro review of 34 stratified sample documents showed that the explicit inclusion of IFP devices only reached 35.3%. Technology integration within the learning steps is dominated by a one-way, teacher-centered pattern, causing the functionality of this advanced tool to be downgraded to a mere replacement for a blackboard or a static projector at the substitution level in the SAMR model.

Departing from these findings, the first strategic policy recommendation is directed at technical-administrative interventions to address the lack of digital literacy. The Sleman Regency Education Department through the Elementary School Division needs to immediately issue a circular letter accompanied by a brief guide in the form of an infographic regarding the procedures for configuring file sharing using official learning accounts such as @guru.sd.belajar.id. In addition, the department must organize a mass rectification clinic to educate school operators and principals so that the 85 Teaching Module links and 89 photo links currently still locked can be promptly and tangibly repaired before the next reporting period.

The second policy recommendation focuses on cutting-edge pedagogical interventions through the reorientation of teacher training, which no longer emphasizes device introduction, but rather intensive assistance for advanced integration. The Education Department is advised to optimize the role of the Teacher Working Group (KKG) at the Kapanewon level to organize 21st-century active learning method workshops that emphasize aspects of critical thinking, creativity, communication, and collaboration. This workshop must train teachers to develop classroom scenarios based on micro-blocking time that actively involve students in manipulating the interactive features of the IFP. Through this web of applicable policies, the government's investment in the procurement of digital devices will sustainably transform into a primary catalyst for improving the quality of elementary education.

REFERENCES

Boddy, D. (2008). Management: An introduction (4th ed.). *Financial Times Prentice Hall*.

Efendi, S., Rahma, A., & Yusuf, M. (2020). Investasi pengadaan perangkat digital sebagai katalisator peningkatan mutu pendidikan dasar abad 21. *Jurnal Kebijakan dan Administrasi Pendidikan,* 8(3), 202–215.

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education*, 59(2), 423–435. https://doi.org/10.1016/j.compedu.2012.02.001

Greenstein, L. (2012). Assessing 21st century skills: A guide to evaluating mastery. *Corwin Press.*

Hapsari, R., & Wibowo, A. (2025). Tata kelola penyimpanan awan dalam administrasi pelaporan digital sekolah dasar. *Jurnal Akuntabilitas Manajemen Pendidikan,* 13(1), 45–56.

Howard, S. K., & Mojejko, A. (2015). Teachers: Technology, anxiety, and time constraints in administrative reporting. *Journal of Educational Technology & Society,* 18(4), 123–136.

Jones, K. (2018). Educational technology adoption models: Understanding the initial acceptance phase in formal schooling. *International Journal of Educational Technology,* 15(2), 78–92.

Kinicki, A., & Williams, B. K. (2020). Management: A practical introduction (9th ed.). *McGraw-Hill Education.*

Kurniawan, D. (2022). Standardisasi regulasi literasi tata kelola data digital di lingkungan satuan pendidikan formal. *Jurnal Kebijakan Pendidikan,* 11(2), 102–115.

Kurniawati, E., & Kristin, F. (2021). Dinamika kapasitas literasi tata kelola data guru dan kendala administratif platform pelaporan digital. *Jurnal Pendidikan Dasar,* 9(3), 210–224.

Lestari, P., & Handayani, S. (2021). Optimalisasi peran Kelompok Kerja Guru (KKG) dalam pengembangan kompetensi pedagogis berbasis teknologi. *Jurnal Ekosistem Pendidikan,* 7(2), 134–145.

Mayer, R. E. (2014). *The Cambridge handbook of multimedia learning (2nd ed.). Cambridge University Press.* https://doi.org/10.1017/CBO9781139547369

Nugroho, B., & Saputra, H. (2026). Hambatan tata kelola penyimpanan awan berkas digital di sekolah dasar. *Jurnal Teknologi Informasi dan Pendidikan,* 14(1), 12–25.

Oya, M., & Yuningsih, S. (2024). Pemanfaatan interactive flat panel (IFP) dalam memacu motivasi belajar siswa di kelas dasar. *Jurnal Inovasi Pembelajaran,* 10(1), 56–69.

Puentedura, R. R. (2013). *SAMR:* Moving from substitution to redefinition in digital classrooms. *Center for Digital Education.*

Rahmawati, F., & Utami, T. (2023). Rekomendasi kebijakan strategis intervensi implementasi teknologi di tingkat dasar. *Jurnal Administrasi Pendidikan,* 30(2), 89–101.

Rambe, M., Siregar, H., & Nasution, A. (2019). Transformasi teknologi kelas sebagai katalisator peningkatan mutu pendidikan dasar secara berkelanjutan. *Jurnal Mutu Pendidikan,* 6(2), 112–124.

Sari, D. P., & Widjajanti, D. B. (2021). Efektivitas pengintegrasian perangkat instruksional interaktif di dalam ruang kelas sekolah dasar. *Jurnal Prima Edukasia*, 9(1), 45–57.

Warschauer, M., Zheng, B., & Niiya, M. (2014). Access and compliance in digital-based reporting: The urban-rural network gap. *Language Learning & Technology,* 18(1), 45–62.

Wijaya, A. (2024). Pengambilan kebijakan berbasis data melalui konversi data mentah menjadi actionable insights. *Jurnal Manajemen dan Kebijakan Pendidikan,* 5(1), 18–31.