Digital Public Infrastructure Construction and Policy Instrument Mix in Japan's "Education DX Roadmap" (2025)

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Abstract: During the period from 2022 to 2025, Japan's digitalization agenda within the field of education underwent a shift. It moved away from the focus on "utilization of education data" and towards "Education DX governance". In this new phase, rather than concentrating solely on the deployment of ICT or the application of isolated technologies in schools, the design of policies places increasing reliance on cross-ministerial coordination as well as digital public infrastructure (DPI). The aim is to bring various types of data such as those related to learning, school administration, research use, and lifelong learning into a unified governance framework. This research looks into Japan's 'Education DX Roadmap' (2025) and the associated policy packages by analyzing policy documents. It uses a framework that combines elements of data governance, policy instruments, and platform governance. Through coding the policy texts according to aspects like goals, instruments, target actors, responsibilities, and risks, it is shown that Education DX is more than just a technological enhancement. It involves a reorganization of governance boundaries, data entitlements, and accountability structures. The implementation of Education DX depends on a mix of instruments which include standardization, platformization, cloud migration, identity/authentication infrastructures, and EBPM. The interplay between these instruments can create structural tensions, such as local disparities, issues related to consent and privacy governance, vendor lock-in, and the redistribution of teachers' workload. The paper concludes by discussing the governance implications and risk-mitigation considerations for the implementation at the municipal and school levels.

Keywords: Education DX; digital governance; education data; digital public infrastructure; platform governance

1. Introduction

1.1 Research Background

Around 2020, Japan's education digitalization policy reached a critical turning point characterized by acceleration, expansion, and a growing emphasis on governance. One important driver was the GIGA School Program, with GIGA standing for "Global and Innovation Gateway for All." The program centered on establishing a one-device-per-student environment supported by high-speed school networks, thereby accelerating the development of digital infrastructure across schools. At the same time, the COVID-19 pandemic brought emergency remote and hybrid learning into the institutional policy agenda. As a result, education digitalization was no longer understood merely as a matter of technological provision; it increasingly became associated with the resilience of public services and the broader capacity of government to respond to social disruption (Brummer & Ueno, 2024).

More importantly, the policy discourse gradually shifted from the informatization of individual schools toward the digital transformation of the education system as a whole. In the Japanese context, "DX" does not simply refer to the introduction of digital tools. Rather, it emphasizes the use of digital technologies to reorganize processes, responsibilities, and value chains. Existing institutional arrangements—including school administration, data circulation, procurement, and technical standards—are thus increasingly incorporated into a sustainable governance framework.

Against this background, the policy agenda concerning the effective use of educational data has gradually converged with Japan's broader governmental digital transformation agenda. The Ministry of Education, Culture, Sports, Science and Technology (MEXT) has discussed education DX and the utilization of educational data from the perspectives of students, teachers, parents, school authorities, and research institutions, highlighting the potential role of data in providing more targeted support and strengthening evidence-based policy making (EBPM) (MEXT, 2022).

1.2 Research Purpose and Significance: From Policy Programs to Governance and Their Implications for Schools, Municipalities, and Industry

This study is concerned not simply with identifying what digitalization projects Japan has implemented. Instead, it examines how the policy agenda has shifted from project-based digital initiatives toward a more governance-oriented configuration as education digitalization has increasingly been framed in terms of "DX." In this study, such a shift toward governance has at least three dimensions.

First, policy objectives have been redefined. Earlier initiatives largely emphasized improvements in classroom efficiency and access to educational resources. More recent policies, however, increasingly seek to reorganize institutional arrangements around data and digital platforms. Japan's experience with government DX demonstrates that crisis windows and political choices can accelerate digital transformation. Yet once an initial policy breakthrough has occurred, subsequent institutionalization depends more heavily on interorganizational coordination, the implementation of common rules, and the reallocation of resources (Brummer & Ueno, 2024).

Second, Education DX produces structural effects through a combination of policy instruments. Its implementation does not depend solely on public investment. It also involves institutional instruments such as technical standards, authentication systems, cloud migration, procurement rules, and evaluation mechanisms. When deployed in combination, these instruments shape the behavioral boundaries of schools and municipalities while also influencing how private-sector actors enter and participate in the public education market.

Third, Education DX involves a redistribution of governance responsibilities. With central coordinating bodies such as the Digital Agency becoming involved, education digitalization can no

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longer be regarded solely as an internal matter of educational administration. Instead, it has become connected to the government's broader development of digital public infrastructure (DPI). Research on government DX in Japan suggests that digital reforms frequently reshape public administration through organizational restructuring and cross-ministerial coordination, while also generating spillover effects across sectoral policy domains.

The academic significance of this study lies in conceptualizing Education DX as a form of governance technology. From this perspective, the study examines how combinations of policy instruments integrate the education system into broader logics of digital government and data governance. Its practical significance lies in providing an analytical framework for examining implementation pressures at the municipal level, the possible redistribution of administrative burdens within schools, and emerging risks associated with platformization and vendor lock-in. This approach also helps avoid reducing the policy vision of DX to a technologically optimistic narrative.

1.3 Research Scope and Questions: Governance Structure, Policy Instruments, and Risk Tensions

1.3.1 Research Scope

This study takes the 2025 Education DX Roadmap and its related policy package as its core texts. At the same time, these documents are situated within a broader sequence of policy development beginning with the GIGA School Program. This sequence extends from the provision of devices and network infrastructure to the integration of school administrative processes and educational data, and ultimately to cross-ministerial arrangements involving DPI and digital governance.

To avoid equating policy aspirations with actual outcomes, this study distinguishes between policy design and policy implementation. Its primary concern is the governance logic and configuration of policy instruments embedded in the policy documents. It does not assume that the intended outcomes have already been realized in schools. Questions concerning implementation effects and local variation are therefore addressed separately through evidence examined in subsequent sections.

1.3.2 Research Questions

The analysis is organized around three major dimensions.

First, with regard to governance structure, how have the division of responsibilities and coordination mechanisms among the Digital Agency, MEXT, other relevant ministries, and local governments been reconfigured? What forms of centralization and platformization have emerged in the organizational processes of Education DX (Iwabuchi et al., 2024)?

Second, with regard to policy instruments, how does the Education DX Roadmap translate broad policy visions into an operational roadmap through instruments such as standardization, infrastructural tools, cloud migration, and procurement rules? Why are these instruments deployed as a policy mix rather than as independent measures?

Third, with regard to risk, what major points of tension are most likely to emerge under a governance model centered on data and digital platforms (OECD, 2023)?

1.3.3 Conceptual Definitions and Analytical Orientation

In this study, "Education DX" refers to a system-level transformation of digital governance. Its central concern is not whether particular digital technologies are technologically advanced, but whether institutional arrangements enable data to be portable, interoperable, and accountable within clearly defined security boundaries.

Correspondingly, digital public infrastructure (DPI) is understood not as a single technological platform, but as an institutional foundation composed of standards, identity and authentication mechanisms, data rules, public cloud infrastructure, and procurement arrangements. "Platform governance," meanwhile, refers to the incorporation of multiple actors into a common rule system through platforms

and standards, thereby reshaping both the provision and regulation of public services.

1.4 Structure of the Paper

The paper consists of six sections. Section 1 introduces the research background, research problem, and significance of the study. Section 2 reviews the literature on digital governance, data governance, and policy instruments, and develops an analytical framework based on the three-level relationship among policy vision, institutional arrangements, and school-level implementation. Section 3 explains the research design, data sources, methods of policy text analysis, and strategies for ensuring analytical validity. Section 4 presents the main findings, focusing on the reconstruction of policy objectives, the combination of policy instruments, changes in governance structure, and major risk points. Section 5 discusses the three dimensions of Education DX as a governance technology, evaluates the limitations of document-based research, and develops practical implications. Finally, Section 6 summarizes the main findings, identifies their implications for education digital governance, and outlines directions for future research.

2. Literature Review and Analytical Framework

2.1 Digital Governance and Data Governance: From Informatization to Public Infrastructure

2.1.1 A Shift in Governance Perspective: From System Deployment to the Expansion of the Governance Toolkit

Within the existing literature, the significance of "digital governance" for educational policy research lies not primarily in the scale of investment in hardware, but in the structural transformation of policy processes and modes of governance. Traditionally, governments shaped the behavior of schools largely through regulations, administrative directives, and public funding. In increasingly digitalized policy environments, however, governments have begun to rely more heavily on instruments such as data visualization, predictive analytics, and real-time indicators. These instruments embed governance within continuous cycles of monitoring, feedback, and adjustment, thereby altering both how educational problems are identified and how policy responses are organized (Williamson, 2016).

This change suggests that education digitalization should not be understood merely as the introduction of new technologies into schools. Rather, it involves an expansion of the governance toolkit itself. Digital systems increasingly function as infrastructures through which governments observe educational processes, coordinate actors, allocate resources, and evaluate policy outcomes. In this sense, the transition from informatization to digital governance also represents a transition from discrete technological projects toward more continuous and data-mediated forms of governance.

2.1.2 The Japanese Path and Its Institutional Foundations: From Data Linkage and Standardization to Public Infrastructure

In Japan, the development of digital governance in education has increasingly centered on the question of how educational data can be securely linked across systems and institutional actors while preserving decentralized forms of management. In its empirical research on educational data linkage, the Digital Agency frames the core policy challenge as how to establish secure interoperability across different systems and stakeholders and, at the same time, generate evidence and implementation models that can support subsequent institutionalization and wider policy diffusion (Digital Agency, 2025).

Materials issued by the Ministry of Education, Culture, Sports, Science and Technology concerning the standardization of educational data similarly place standardization within a continuous logic linking interoperability, burden reduction, and sustainable governance. Without common vocabularies, data fields, codes, and technical specifications, data linkage can easily become dependent on repeated manual entry and fragmented system design. Such fragmentation

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may, in turn, reinforce vendor lock-in and transform digitalization itself into an additional administrative burden rather than a mechanism for reducing workload (MEXT Elementary and Secondary Education Bureau, Education DX Promotion Office, 2022).

From this perspective, standardization is not simply a technical matter. It forms part of the institutional foundation through which educational data can circulate across organizational boundaries in a predictable and accountable manner. The Japanese approach therefore demonstrates a broader movement from isolated information systems toward a more infrastructural model of digital governance.

2.2 Policy Instruments for Education Digitalization: Standards, Platforms, Regulation, Funding, and Evaluation

2.2.1 Policy Instrument Mix: Reading the Roadmap as an Executable Governance Architecture

Policies for education digitalization generally do not operate through a single policy instrument. Instead, implementation depends on combinations of instruments that make it possible to mobilize actors, translate policy goals into operational arrangements, and correct problems that emerge during implementation. Drawing on Japanese policy documents and relevant research, this study classifies Education DX instruments into five major categories.

First, standard-setting instruments include common data fields, codes, interfaces, and interoperability models. Their function is to institutionalize the minimum conditions necessary for data linkage across systems.

Second, platform instruments include catalog systems, authentication and verification mechanisms, and pilot projects for data linkage. These instruments organize the broader digital ecosystem within which educational actors and service providers interact.

Third, regulatory instruments establish boundaries for data governance, generative artificial intelligence, security, and other areas of uncertainty. Their primary function is to define acceptable practices and reduce governance risks.

Fourth, funding instruments support investment in networks, digital devices, and the modernization of school administrative environments. They also provide coordination mechanisms through which implementation can be promoted across different administrative levels.

Fifth, evaluation instruments, including EBPM, dashboards, and pilot evaluations, help create continuous cycles of monitoring, feedback, and policy adjustment.

Within this policy mix, standards and platforms together constitute the infrastructural foundation of Education DX. Regulatory instruments define the boundaries within which digital systems may operate; funding instruments provide the resources necessary for mobilization; and evaluation instruments enable continuous correction and policy learning. This configuration helps explain why Education DX is frequently articulated in the form of a "roadmap." A roadmap does not merely list separate projects. Rather, it coordinates the sequence, interdependence, and coupling of multiple policy instruments.

2.2.2 The Boundaries of Platform Governance: Digital Ecosystems and Generative AI

Research associated with the Information Processing Society of Japan has used the concept of a "digital ecosystem" to explain Education DX. From this perspective, a digital learning environment consists of multiple interconnected components rather than a single unified system. The central challenge is therefore to integrate these components through international technical standards and interoperability arrangements so that they can develop as part of a sustainable ecosystem. This perspective complements the Digital Agency's research on educational data linkage. Whereas the former places greater emphasis on ecosystem design and technical standards, the latter focuses on models of interconnection and the institutional conditions under which such models can be verified and scaled.

Together, these approaches point toward a policy logic of platform governance in which the government uses standards, certification, and verification mechanisms to reshape both market supply structures and schools' procurement behavior (Digital Agency, 2025; MEXT Elementary and Secondary Education Bureau, Education DX Promotion Office, 2021).

The growing use of generative AI further complicates this governance environment. Educational data are no longer used only for storage, retrieval, and sharing; they are increasingly used for inference, prediction, and content generation. Watanabe (2025) argues that governance frameworks for generative AI must therefore be reconsidered in terms of data provenance, purpose limitation, responsible actors, and risk management. Without such arrangements, technologies that initially appear convenient and efficient may quickly become difficult to control.

2.3 Analytical Framework: A Three-Level Governance Chain from Vision to Institutional Arrangements and School-Level Practice

2.3.1 The Three-Level Governance Chain: Turning Policy Vision into an Empirically Examined Structure

Roadmap-style policy documents tend to be strongly vision-oriented. However, policy analysis cannot stop at the level of policy aspiration. It must examine how policy visions are institutionalized and how institutional arrangements subsequently enter school-level practice. On this basis, the present study adopts a three-level governance chain as its core analytical framework.

The first level concerns policy vision and problem definition. At this level, the analysis examines how policymakers define problems relating to learning quality, fragmented systems, teacher workload, and other policy concerns, as well as how they prioritize competing values such as efficiency, equity, security, and sustainability. The logic of real-time policy instruments and problem visualization identified in digital governance research provides a useful way to understand how broad policy visions are transformed into objects that can be monitored and governed (Williamson, 2016).

The second level concerns institutional arrangements and combinations of policy instruments. Standards include data fields, codes, interfaces, interoperability rules, and verification mechanisms. Platforms involve data-linkage pilots, catalog systems, and mechanisms for organizing digital ecosystems. Regulation addresses the boundaries of generative AI use and data governance, among other issues. This level therefore examines how abstract policy objectives are translated into concrete institutional devices and operational rules (MEXT Elementary and Secondary Education Bureau, Education DX Promotion Office, 2021; Digital Agency, 2025; Watanabe, 2025; Jiang, 2023; MEXT, 2019).

The third level concerns school-level practice and the conditions of implementation. Once policy instruments enter schools and municipalities, the question is whether they actually reduce repetitive data entry, alter procurement and training practices, or instead shift and accumulate administrative burdens for teachers and local staff. This level therefore moves the analysis from policy design toward the organizational consequences of implementation (Yamada, 2023; Digital Agency, 2025).

Taken together, these three levels provide a framework for tracing how policy visions are translated into institutional arrangements and how those arrangements are subsequently experienced in practice. The framework is intended to prevent the analysis from treating policy declarations as equivalent to policy outcomes.

2.3.2 Coding Dimensions: Constructing a Reviewable Chain of Evidence

To ensure that the subsequent analysis remains evidence-based and open to verification, this study applies a five-dimensional coding framework consisting of goals, instruments, actors, responsibilities, and risks. These dimensions are

mapped onto the three-level governance framework described above.

The first dimension, goals, concerns the core objectives articulated at the policy-vision level, including policy priorities, milestones, and possible key performance indicators. The second dimension, instruments, includes standards, platforms, regulation, funding mechanisms, evaluation procedures, and related policy measures. The third dimension, actors, identifies the principal stakeholders involved in Education DX, including learners, teachers, schools, municipalities, private firms, and research institutions.

The fourth dimension, responsibilities, examines who is responsible for implementation, who bears financial costs, and who is accountable for adverse outcomes. Particular attention is paid to high-risk areas such as data breaches, algorithmic errors, and the misuse of artificial intelligence. The fifth dimension, risks, covers issues including privacy, regional disparities, vendor lock-in, the redistribution of administrative burdens, and the possible loss of quality control.

By linking these five coding dimensions to the three-level governance chain, the study seeks to construct a reviewable chain of evidence connecting policy objectives, institutional mechanisms, responsible actors, implementation conditions, and potential risks. This framework provides the analytical basis for the empirical examination developed in the following chapters.

3. Research Methodology

This chapter examines the mechanisms through which policy texts are translated into institutional arrangements and how these arrangements, in turn, reshape relationships among actors and redefine boundaries of responsibility (Bowen, 2009; Beach & Pedersen, 2019).

3.1 Research Design: Policy Text Analysis and Institutional Arrangement Analysis

This study adopts a combined research design integrating policy text analysis, institutional arrangement analysis, and tool-assisted quantitative text analysis. Roadmap documents contain a distinctive governance grammar structured around problems, objectives, policy instruments, and milestones. They also frequently specify, either explicitly or implicitly, the actors responsible for implementation, the allocation of responsibilities, and the boundaries of potential risks. These characteristics make such documents particularly suitable for systematic decomposition and examination (Bowen, 2009).

In this study, policy is understood as a form of governance technology embodied in institutional arrangements. Standards, platforms, verification mechanisms, interfaces, dashboards, and evidence-based policy making (EBPM) do not function independently. Instead, they collectively constitute an ongoing cycle of monitoring, feedback, and adjustment. The analytical task is therefore to identify the individual components of these institutional arrangements and examine how they are coupled with one another, rather than limiting the analysis to the policy visions articulated in official documents (Krippendorff, 2019).

This research design thus distinguishes between policy aspirations and the institutional mechanisms through which those aspirations may be operationalized. By combining qualitative interpretation with limited quantitative assistance, the study seeks to identify both the explicit structure of the policy documents and the underlying relationships among policy objectives, instruments, actors, responsibilities, and risks.

3.2 Data Sources and Sample: The 2025 Education DX Roadmap, Its Policy Prehistory, and Supporting Documents

The dataset consists primarily of policy and institutional documents. For analytical purposes, the materials are divided into three categories: core texts, historical or preceding policy texts, and supporting texts. A document inventory is maintained throughout the research process to ensure traceability and consistency in the use of sources (Bowen, 2009).

First, the core text is the publicly available version of the Education DX Roadmap. During data preparation, the specific version of the document is identified, individual paragraphs are numbered, and thematic labels are assigned. This procedure enables subsequent quotations, coding decisions, and analytical claims to be traced back to their precise locations in the source material (Higuchi, 2020; Arima, 2021).

Second, preceding policy texts are used to reconstruct the transition from a discourse of "informatization" toward one of "governance." These materials help identify how policy priorities gradually shifted from the use of technology to enhance learning toward cross-organizational data linkage, standardization, accountability, and risk management. In this way, historical policy documents provide the contextual basis necessary for interpreting changes in the governance logic of Education DX (Krippendorff, 2019).

Third, supporting documents are used to translate the broad terminology of the roadmap into more concrete and operational elements, including data fields, administrative procedures, technical requirements, and responsibility arrangements. To reduce interpretive noise introduced by secondary commentary, the dataset is restricted, as far as possible, to accessible official or quasi-official documents (Bowen, 2009).

The three-layer source structure therefore enables the study to distinguish between long-term policy development, the current policy blueprint, and the institutional mechanisms intended to support implementation.

3.3 Text Analysis: Thematic Coding of Goals, Instruments, Actors, Responsibilities, and Risks

3.3.1 Coding Framework and Decision Rules

A five-dimensional thematic coding framework is employed, consisting of goals, instruments, actors, responsibilities, and risks. This framework is designed to separate the policy visions, institutional arrangements, and implementation schedules that are often interwoven within roadmap-style documents and to transform them into identifiable and reviewable analytical units. Such a procedure reduces the risk of treating policy declarations as established institutional realities (Krippendorff, 2019; Arima, 2021).

The coding dimensions are defined as follows.

Goals include policy visions, key performance indicators (KPIs), milestones, and stated priorities. This dimension identifies what a policy seeks to achieve and how its objectives are ranked or sequenced.

Instruments include standards, platforms, regulatory measures, funding mechanisms, evaluation procedures, and pilot programs. This dimension captures the specific means through which policy objectives are expected to be translated into implementation.

Actors include learners, teachers, schools, municipalities, private companies, and research institutions. Coding this dimension makes it possible to identify which groups are positioned as beneficiaries, implementers, regulators, service providers, or other relevant stakeholders.

Responsibilities concern the distribution of authority and accountability, including who is responsible for implementation, who bears the associated costs, and who assumes responsibility when adverse consequences occur. Particular attention is given to high-risk areas involving educational data and artificial intelligence.

Risks encompass privacy concerns, regional disparities, vendor lock-in, the redistribution of administrative burdens, and potential losses of quality control.

By defining these categories in advance and applying explicit coding rules, the study seeks to reduce interpretive arbitrariness and strengthen the traceability of its analytical conclusions (Wu & Zhang, 2020).

3.3.2 Analytical Procedure: Qualitative Analysis as the Primary Approach with Quantitative Support

The analysis follows a mixed strategy in which qualitative coding and interpretation constitute the primary analytical approach, while quantitative text

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analysis is used mainly to identify structural patterns and check for potential interpretive bias (Li & Wang, 2016). The analytical procedure consists of six steps.

First, the documents are cleaned and their versions verified, after which paragraphs are numbered and relevant metadata are recorded (Higuchi, 2020).

Second, an initial round of open coding is conducted to identify recurring concepts and expressions. These preliminary codes are used to construct a codebook containing definitions and representative examples (Arima, 2021).

Third, the initial codes are consolidated through axial coding into the five-dimensional analytical framework of goals, instruments, actors, responsibilities, and risks. During this stage, conceptual boundaries among categories are further clarified to ensure consistency in coding (Krippendorff, 2019).

Fourth, KH Coder is employed to conduct supplementary analyses of word frequencies, co-occurrence patterns, and textual clusters. These analyses are used to identify patterns of conceptual coupling and to reassess issues identified during qualitative coding. Following the logic of quantitative content analysis, numerical results are used to locate analytically important sections of the documents rather than being treated as sufficient evidence for substantive conclusions in themselves (Higuchi, 2016, 2020; Motegi, 2020).

Fifth, key passages are reread in their original context and interpreted in relation to the analytical framework. Where necessary, selected procedures from SCAT (Steps for Coding and Theorization) are used to clarify ambiguous value priorities or unclear distributions of responsibility. SCAT is employed only as a supplementary procedure rather than as the principal analytical method (Otani, 2011; Nakatsubo et al., 2019).

Sixth, an "evidence chain table" is constructed and archived. The table records the location of the original text, assigned codes, analytical propositions, and any relevant limitations or counterexamples. This step enables subsequent interpretations to be traced back to their documentary basis and facilitates later review of the analytical process (Krippendorff, 2019; Bowen, 2009).

3.4 Validity Control: Cross-Document Verification, Conceptual Operationalization, and Avoiding the Equation of Policy Rhetoric with Policy Reality

Several procedures are adopted to improve analytical validity and reproducibility.

First, institutional claims are subject to cross-document verification. A claim concerning an existing institutional arrangement must be supported by relevant supporting or preceding policy documents. If a statement appears only in a visionary or aspirational section of a policy document, it is classified as a policy objective rather than treated as evidence of actual implementation (Bowen, 2009).

Second, key concepts are operationalized before systematic coding. Terms such as DX, data governance, interoperability, platforms, standards, and responsibility are assigned explicit conceptual boundaries, and these definitions are incorporated into the coding rules. This procedure is intended to prevent conceptual meanings from shifting during the analytical process (Krippendorff, 2019; Arima, 2021).

Third, mechanism-based interpretations are formulated conditionally. Rather than assuming that a particular policy instrument necessarily produces a particular outcome, the analysis specifies the conditions under which a proposed mechanism may operate and simultaneously considers possible countervailing effects. This approach is consistent with the methodological logic of process tracing, which emphasizes the identification of mechanisms and the conditions under which causal processes can plausibly occur (Beach & Pedersen, 2019).

Fourth, particular attention is paid to potential bias and reproducibility. Results generated through KH Coder are used to check whether qualitative interpretation relies disproportionately on selectively chosen passages. Recoding procedures and iterations of the codebook are documented, while data-cleaning rules and outputs generated by

analytical tools are retained for subsequent review and replication (Higuchi, 2016; Wu & Zhang, 2020; Zhang & Lin, 2022).

Through these procedures, the study seeks to maintain a clear distinction between what policy documents state, what institutional mechanisms they establish, and what outcomes may reasonably be inferred from them. The methodological design therefore provides a traceable basis for the subsequent analysis of the governance structure, policy instrument mix, and implementation risks associated with Education DX.

4. Results and Analysis

4.1 Reconstruction of Policy Objectives: Integrating Learning, School Administration, Research, and Lifelong Learning into a Unified Governance Framework

From a policy perspective, Japan's digitalization agenda in recent years has increasingly redefined educational data from a supplementary resource for teaching and learning into an object of governance that extends across the entire educational process. This transformation reflects a broader shift in the role assigned to data within the education system. Rather than being used only to support specific classroom activities, educational data are increasingly positioned as an infrastructural resource through which learning, administration, research, and other educational processes can be connected and coordinated.

One important dimension of this policy reconstruction is the growing emphasis on learner-centered and individually optimized forms of learning and support. Data are expected to contribute to a more detailed understanding of learners' needs and to enable educational institutions to provide more differentiated forms of assistance. At the same time, the scope of digitalization has expanded beyond classroom learning. School administrative procedures, the forms and delivery of educational materials, and the production of evidence for educational research are increasingly incorporated into the same institutional field of governance (Ministry of Education, Culture, Sports, Science and Technology [MEXT], 2021).

The significance of this development lies in the expansion of the object of education governance. When learning data, administrative data, research evidence, and potentially lifelong learning data are considered within a common governance framework, Education DX no longer concerns the digitalization of isolated educational functions. Instead, it concerns the construction of an institutional environment in which multiple forms of educational activity can be connected through common standards, infrastructures, and governance arrangements. Policy objectives are therefore being reconstructed around not only the use of technology, but also the organization and circulation of data across different educational domains.

4.2 Policy Instrument Mix: Standardization, Platformization, Cloud Migration, Authentication Infrastructure, EBPM, and Research Use

At the level of policy instruments, Japan's DX governance can be understood as a configuration of interconnected institutional mechanisms. Standardization defines interfaces and the boundaries within which data can be exchanged. Platforms and cloud-based infrastructures facilitate the centralized or coordinated provision of digital services. Authentication and identity infrastructures regulate access to systems and help establish chains of responsibility. Evidence-based policy making (EBPM) and the research use of educational data, meanwhile, provide an evidentiary basis through which policy interventions may be evaluated and legitimized.

These instruments do not operate independently. Rather, their significance lies in the ways in which they are combined. As studies of the relationship between infrastructures and platforms have demonstrated, contemporary digital systems increasingly acquire characteristics of both: platforms may gradually become infrastructural, while infrastructures may increasingly adopt platform-like organizational forms (Plantin et al.,

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2018). In the context of Education DX, this means that standards, platforms, cloud services, authentication systems, and evaluation mechanisms together constitute an institutional architecture through which digital governance can operate.

A comparison with China's Education Informatization 2.0 Action Plan reveals a broadly comparable emphasis on the construction of an educational digital ecosystem. The Chinese policy highlights principles such as "application-driven development," "integrated innovation," and "institutional safeguards," seeking to coordinate the supply and application sides of education digitalization while integrating platforms, resources, and governance mechanisms (Ministry of Education of the People's Republic of China, 2018). Although the institutional contexts of China and Japan differ, both approaches illustrate a movement away from isolated technological deployment toward more systematic coordination among infrastructure, resources, applications, and governance arrangements.

As the policy instrument mix becomes more comprehensive, interoperability becomes increasingly important. The central question is how different institutions, government departments, technical systems, and digital services can remain compatible with one another at both the regulatory and technical levels. Standardization and cloud migration therefore perform functions that extend beyond technical modernization. They establish preconditions for data to move across organizational boundaries and for policy coordination to take place among multiple actors.

From this perspective, interoperability is not merely a technical property of information systems. It is also a governance condition. Without common standards and compatible infrastructures, the expansion of digital services may reproduce fragmentation rather than overcome it. Japan's efforts to develop standards, cloud-based services, and shared infrastructures can therefore be interpreted as institutional preparations for broader forms of cross-organizational data circulation and policy coordination.

4.3 Governance Structure: Coordination and Division of Responsibilities Among the Digital Agency, MEXT, MIC, and METI

The implementation of Education DX does not represent a simple linear expansion of the responsibilities of the education authorities. Instead, it involves a recombination of functions across government departments. The Digital Agency functions as a central actor in horizontal digital governance, introducing concepts associated with digital public infrastructure, rules for data connectivity, and broader governmental capabilities for digital transformation into the education sector.

MEXT, by contrast, remains responsible for translating these broader digital governance arrangements into the institutional context of education and school-level practice. Other ministries also perform significant functions. The Ministry of Internal Affairs and Communications (MIC) plays an important role in information and communications infrastructure, while the Ministry of Economy, Trade and Industry (METI) is relevant to industrial supply, technological markets, and the participation of private-sector actors.

This cross-ministerial configuration changes the way education policies are implemented. Implementation is no longer driven solely through conventional administrative directives from education authorities. Increasingly, cross-level governance is pursued through combinations of standards, platforms, infrastructural arrangements, and evaluation mechanisms. Such arrangements enable actors operating at different levels of government and in different sectors to be incorporated into a shared governance structure.

However, deeper dependence on platforms and data services can also alter the distribution of governance authority. Platform providers may acquire continuing influence through their control over data, technical systems, and infrastructural arrangements. Educational institutions may consequently face a new structural tension between the convenience provided by platform services and the preservation of institutional autonomy.

Komljenovic (2021) describes the rise of "education rentiers" in relation to the growing authority of digital platforms and data infrastructures in education, illustrating how infrastructural dependence can generate sustained forms of economic and organizational power.

Platformization may also contribute to the spread of entrepreneurial forms of organizational logic. Its effects are not confined to the procurement of particular digital tools. Rather, platforms can increasingly shape the ways in which management, evaluation, and resource allocation are organized by embedding institutional activities within standardized platform structures (Komljenovic, 2022).

Cross-ministerial coordination may therefore improve the efficiency and coherence of policy implementation while simultaneously transferring parts of governance capacity to digital platforms and their providers. This produces a central governance question: how can public authorities cooperate with technological and market actors while retaining the capacity to establish rules, determine public objectives, and define clear boundaries of responsibility? The governance structure of Education DX must consequently be understood not only in terms of administrative coordination, but also in terms of the changing distribution of authority between public institutions and digital infrastructures.

4.4 Key Risk Areas: Local Disparities, Privacy and Consent, Vendor Lock-In, and the Redistribution of Teacher Workload

The first major risk concerns local disparities. When Education DX is implemented through common platforms, standards, and digital infrastructures, differences in the financial and technical capacities of municipalities may be translated directly into differences in data governance capacity. Municipalities with greater financial resources, technical expertise, and organizational capacity may be better positioned to adopt, operate, and evaluate digital systems. By contrast, less well-resourced municipalities may encounter greater difficulties in implementation. Such differences may ultimately affect whether schools can obtain digital services and institutional support of comparable quality.

The second area of risk concerns privacy and consent. MEXT's Points to Note Regarding the Utilization of Educational Data (First Edition) repeatedly emphasizes the protection of personal information and privacy as well as the importance of information security, while assigning schools and boards of education significant compliance responsibilities (MEXT, 2023). In practice, however, consent cannot necessarily be resolved through a one-time act of agreement. As the purposes for which educational data are used continue to expand, questions of consent, legitimate use, and responsibility may have to be reconsidered continuously. Data that were originally collected for one educational purpose may acquire additional functions as they become connected to new platforms, research activities, or analytical technologies.

The third risk concerns vendor lock-in and platform dependence. Once digital platforms acquire infrastructural characteristics, the cost of leaving an established technological ecosystem may increase substantially. Data formats, interfaces, administrative routines, and staff practices may all become embedded within a particular platform environment. As a result, public educational institutions may find themselves continuously paying for participation in an established ecosystem even when alternative services become available. The infrastructuralization of platforms can therefore create forms of long-term dependency that constrain future institutional choices (Plantin et al., 2018; Komljenovic, 2021).

The fourth risk involves the redistribution of teachers' workload. Digital technologies are often introduced with the expectation that automation and data integration will reduce administrative work. However, digitalization may also generate new responsibilities, including data entry, system management, information security, verification, and compliance. Consequently, the relevant question is not simply whether digitalization reduces teachers'

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workload, but how existing and newly created tasks are redistributed among teachers, administrators, technical personnel, and platform providers.

The expansion of generative AI makes this issue even more complex. Technologies such as generative AI can enter education simultaneously through research practices, commercial interests, and policy narratives. Their expansion may therefore introduce new conflicts concerning educational values, professional responsibility, and inequality (Williamson, 2024). The governance challenge lies not merely in deciding whether such technologies should be adopted, but in determining who controls their use, who evaluates their consequences, and who assumes responsibility when problems arise.

Taken together, these four areas demonstrate that the expansion of Education DX does not automatically produce more efficient or equitable governance. Digitalization can improve coordination and expand institutional capacity, but it can also redistribute resources, responsibilities, risks, and authority. Local inequality, privacy governance, platform dependence, and changes in teachers' workload should therefore be treated not as secondary technical problems, but as structural tensions embedded within the governance architecture of Education DX itself.

5. Discussion

5.1 Core Findings: Three Dimensions of Education DX as a Governance Technology

The first major finding is that Education DX represents an institutional transformation closely associated with digital government. In Japan, education digitalization has moved beyond the conventional logic of informatization and has increasingly developed into a cross-ministerial governance project. Policies concerning educational data have gradually formed a more systematic framework of rules, coordination mechanisms, and institutional arrangements. This transformation has the potential to improve governance efficiency, but it also changes how educational resources are distributed and how governance boundaries are defined. Cross-ministerial coordination therefore functions not merely as an administrative device, but as a mechanism through which existing institutional responsibilities and resource relationships are reorganized (Shayo et al., 2025).

The second dimension is the growing tendency toward the "platformized school" and infrastructuralized governance. Leander and Pahl (2025) argue that schools are gradually shifting from environments characterized by a patchwork of multiple platforms toward more integrated forms of platformization. Under such conditions, rules, resources, services, and data flows within education systems are increasingly organized through platform-based infrastructures. In the context of Japan, this development is also consistent with the broader policy tendency to integrate school digitalization, educational data, and administrative systems within common standards and institutional arrangements (MEXT, 2020).

The significance of platformization lies in the fact that platforms no longer function merely as external technological tools. As they become embedded in school administration, teaching, evaluation, and resource allocation, they begin to shape the institutional environment itself. The school is therefore not simply using platforms; rather, its organizational routines are increasingly structured through platform-based systems and standards. This development strengthens the infrastructural character of digital governance and makes questions of platform design, interoperability, and public accountability increasingly important.

The third dimension concerns the integration of data governance and risk governance. Education DX turns data into a central institutional resource, but at the same time increases the complexity of governance. This observation is consistent with research in China concerning the tension between privacy protection and data sharing. Effective data governance requires a balance between regulatory compliance and the efficient use of educational data (Tian, 2020). The expanding application of generative AI further intensifies this challenge. As

AI systems make greater use of educational data for prediction, generation, and automated decision support, protecting personal information while maintaining the benefits of technological development becomes an increasingly difficult governance problem (Qiu, 2024).

Taken together, these three dimensions suggest that Education DX should be understood not merely as technological modernization. It is simultaneously a transformation of governmental organization, an infrastructural process of platformization, and a form of data- and risk-centered governance.

5.2 Limitations: The Boundaries of Document-Based Research and Directions for Future Empirical Work

This study has several limitations. The first concerns the gap between policy documents and actual implementation. Policy roadmaps and related documents typically describe intended pathways and preferred institutional arrangements. However, implementation may vary substantially depending on local fiscal conditions, procurement procedures, staffing, technical capacity, and organizational culture. As a result, the outcomes observed in practice may differ from those anticipated in policy design (Shayo et al., 2025; World Bank, 2019).

The second limitation is that the present study does not sufficiently examine strategic interactions among schools, municipalities, platform providers, and other actors during implementation. Issues such as contract design, platform selection, procurement criteria, and resource allocation cannot be fully understood through policy texts alone. These dimensions require fieldwork, interviews, and case-based investigation in order to capture how formal policy arrangements are negotiated and adapted in specific local contexts (Leander & Pahl, 2025).

The third limitation concerns the visibility of practical problems related to privacy, data governance, and workload. Incidents such as information leakage, inappropriate data use, or excessive administrative burdens are often difficult to identify through official policy documents. This creates an unavoidable gap between document-based analysis and the everyday realities of schools and local education authorities (Takase et al., 2018).

Future research can therefore proceed in at least three directions. First, comparative studies across municipalities are needed to examine differences in budgeting, platform procurement, data governance capacity, and implementation strategies. Such comparisons would help clarify how local institutional conditions shape the actual consequences of national digitalization policies (World Bank, 2021).

Second, empirical research should be conducted at the school level to investigate changes in teachers' digital competence, professional practices, and workload. Such work would make it possible to evaluate whether digitalization actually reduces administrative burdens or simply redistributes them in new forms (Sakakibara, 2019).

Third, future studies should collect empirical evidence concerning educational data governance and risk management. This is particularly important for assessing whether the risk-control principles contained in official guidance documents are effectively implemented in practice and whether schools have sufficient organizational capacity to comply with them (Tian, 2020).

5.3 Practical Implications: Recommendations for Municipalities, Schools, Platform Companies, and Research Institutions

For municipalities, the most important practical implications concern rules and compliance. During the implementation of Education DX, clear requirements for interoperability and data portability should be established in order to reduce the risk of technological lock-in (World Bank, 2021). Municipal governments should also integrate privacy protection and data-minimization principles into procurement procedures and contractual arrangements through standardized processes. Doing so would help ensure that local governments remain compliant with relevant requirements when collecting, processing, and sharing educational data (MEXT, 2025).

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Municipalities should also consider adopting a human-centered GovTech framework so that the perspectives of teachers and students are reflected in policy implementation. Digital transformation should not be designed exclusively around administrative efficiency or technical capability. The experience of end users should be incorporated into the evaluation and adjustment of digital systems so that technological reform remains aligned with public-service objectives (World Bank, 2019).

For schools, the central issue is the development of teachers' practical capacity. Teacher training should include differentiated forms of digital-capacity development that address both technical operation and compliance awareness. Teachers need not only the skills required to use digital systems, but also an understanding of appropriate data use, privacy protection, and institutional responsibility (Sakakibara, 2019).

Schools should also provide regular information-security training and practical exercises. Such measures can strengthen awareness of cybersecurity risks and reduce the likelihood of human error, especially in contexts where teachers and administrators increasingly handle sensitive educational data through digital platforms (Takase et al., 2018).

For platform companies, long-term governance responsibility should become a central principle of product design. Platforms should provide open interfaces and reliable data-export functions so that schools are not excessively constrained by proprietary systems. These design principles can help reduce switching costs and lower the risk of vendor lock-in (World Bank, 2021).

Platform providers should also clearly define the operational boundaries and potential risks of their AI-enabled functions. Responsibility for technological errors, inappropriate outputs, or failures of automated systems should not simply be transferred to schools or educational institutions. As Education DX deepens, platform companies increasingly participate in the governance process itself and should therefore assume corresponding responsibilities (Shayo et al., 2025).

For research institutions, Education DX creates important opportunities in the areas of data governance and privacy protection. Research institutions should promote data-sharing agreements that make educational data available for legitimate research while remaining compliant with legal and ethical requirements (Tian, 2020). They should also develop interdisciplinary evaluation frameworks that avoid directly equating technological adoption with educational quality. Without such frameworks, digital indicators may be overinterpreted and may ultimately distort policy evaluation and decision making (Zhu & Dai, 2024).

5.4 Future Research: From Policy Blueprints to the Politics of Implementation

Future research should move from the analysis of policy blueprints toward the "politics of implementation." Particular attention should be paid to budgeting, procurement, professional capacity, and risk management. Education digitalization is not simply a technological transformation; it also depends on the professional capabilities of teachers and on sustained institutional support for teaching quality (Sakakibara, 2019; MEXT, 2020).

The politics of risk governance also requires closer examination. Issues such as data protection, privacy breaches, and platform dependence cannot be addressed solely through technical solutions. They require institutionalized forms of regulation, oversight, and compliance capable of correcting governance failures that may arise during digital transformation (Tian, 2020; World Bank, 2021).

The long-term success of Education DX will therefore depend on whether implementation can balance three competing public values: efficiency, equity, and accountability. Digital transformation may improve service delivery and administrative coordination, but these gains should not come at the expense of equal access, institutional autonomy, or clear responsibility. A more equitable form of digital transformation requires sustained negotiation among government agencies, schools,

municipalities, platform providers, and other stakeholders (World Bank, 2021; Shayo et al., 2025). Future research would also benefit from incorporating contracts, budgets, professional capacity, and risk incidents directly into empirical analysis. Doing so would make it possible to explain more precisely how Education DX enters the everyday operation of schools and how different public values are negotiated in practice. Such research could move beyond policy rhetoric and provide a more testable account of implementation processes and institutional trade-offs (MEXT, 2021; Digital Agency, 2022; Digital Agency, 2025).

6. Conclusion

6.1 Summary of the Main Findings

This study has examined the central role of Education DX in the transformation of educational governance in Japan, with particular attention to its implications for policy objectives, governance instruments, and platform-based forms of administration. Through an analysis of the Education DX Roadmap and related policy arrangements, the study finds that Education DX has contributed not only to a transformation in educational data governance, but also to a broader restructuring of how educational services are organized, delivered, and managed.

This restructuring has been driven through a combination of standardization, platformization, and the development of digital public infrastructure. These mechanisms enable data, services, and institutional responsibilities to be coordinated across organizational boundaries, while also creating new dependencies and governance challenges. Education DX should therefore be understood not simply as a process of technological modernization, but as a broader transformation in the institutional architecture of education governance.

6.2 Policy Implications

First, the reconstruction of policy objectives has important implications for public governance. Education DX is not merely the application of digital technologies to existing educational processes; it also reshapes the public values embedded in education administration. In order to achieve educational governance that is equitable, transparent, and efficient, governments need to establish unified standards for data governance, strengthen cross-ministerial coordination, and ensure that educational data are handled in a secure and compliant manner (Digital Agency, 2024; Ministry of Education, Culture, Sports, Science and Technology [MEXT], 2025).

Second, platform governance has direct implications for educational practice. Educational institutions should strengthen the integration of digital platforms while simultaneously improving teachers' information and communication technology capabilities and increasing the automation of school administrative procedures. If appropriately designed and implemented, such measures may help reduce teachers' administrative workload and create more favorable conditions for improving educational quality (Shayo et al., 2025; Leander & Pahl, 2025).

Third, regional disparities remain an important governance concern. Differences in local fiscal capacity, technical expertise, and institutional resources may create unequal conditions for digital transformation across municipalities. Governments should therefore adopt targeted measures to support local digitalization and strengthen cooperation between central and local authorities so that digital transformation does not further widen existing inequalities in educational provision (Digital Agency, 2026; World Bank, 2021).

6.3 Directions for Future Research

One important direction for future research concerns differences in local governance and digital practice. Further studies should compare the implementation of Education DX across municipalities and regions, with particular attention to disparities in technological resources, fiscal support, and professional staffing. Such comparative research would help explain how

differences in local institutional capacity shape the implementation and outcomes of national digitalization policies (Chatham House, 2025; Chetty et al., 2025).

A second area concerns platform governance and teachers' workload. As educational systems become increasingly platformized, the relationship between teaching responsibilities and administrative work requires closer empirical examination. Future studies should investigate teachers' adaptation to digital transformation, changes in ICT competence, and the actual redistribution of workload produced by platform-based reforms. Such research is necessary to determine whether digitalization genuinely reduces burdens or simply shifts them into new forms of administrative and technical responsibility (Sakakibara, 2019; Takase et al., 2018).

A third direction concerns data governance and privacy protection. As Education DX continues to develop, questions of data privacy and information security are becoming increasingly prominent. The rapid expansion of generative AI and large-scale data use makes it especially important to establish governance frameworks that can balance innovation, data utilization, privacy protection, and accountability. This will remain a central issue in the future development of educational data governance (Tian, 2020; European Union, 2023).

Contributor Details

Y. Xie designed the study, conducted the document analysis, analyzed the data, interpreted the findings, and drafted and revised the manuscript.

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Conflicts of Interest

Y. Xie declares no conflicts of interest

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