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Policy Instrument Preferences and Optimization Strategies: Based Text Analysis of Provincial-Level Education Digitalization Policy from China

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Abstract: In the context of world education digitalization, the Chinese government has formulated China's education digitalization strategy. The education digitalization policy tools of provincial governments are an important factor affecting the effectiveness of education digitalization policies. In this study, a text quantification and content analysis is conducted on educational digital policy documents released by eight provinces of China during the 14th Five-Year Plan period in China. This is based on a two-dimensional analysis framework of "instruments-value" using instrument types and policy principles, and NVivo software. The research outcomes reveal the following: (1) The distribution of educational digital policy instrument types is uneven, with an excess of supply-side instruments and a noticeable shortage of demand-side instruments. (2) Different policy instruments exhibit varying degrees of preference in implementing policy principles. There is a stronger emphasis on technology application and balanced development, while the emphasis on service principles promoting diverse participation is relatively weaker. (3) The policy instruments that facilitate interaction between policymakers and educational entities require further strengthening. In light of these findings, local governments in China should strengthen the use of demand-side policy instruments to achieve comprehensiveness and sustainability in educational digitalization. Policymakers should pay more attention to the demands of educational entities to shift educational digitalization from being technology driven to being demand driven. Furthermore, policy instrument selection should adhere to the value of serving and supporting individuals and reinforce the concept of multi-participation in their development, ultimately improving the precision and coordination of policies, and achieving a harmonious integration of technological and value aspects of policy instruments.

Keywords: educational digitalization; policy instruments; policy principles; policy text analysis; China



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1. Introduction

1.1. Backgrounds

In recent years, information technology has been rapidly integrated with education, and promoting the digital transformation of education has become a crucial theme across various levels and types of education worldwide [1,2]. The emergence of COVID-19 has accelerated the existing process of digitizing education, with digital technologies increasingly entering the realm of education and the teaching process [3]. A variety of 4IR (the Fourth Industrial Revolution) instruments were unleashed from primary education to higher and tertiary education where educational activities switched to remote (online) learning in South Africa [4]. "Suspending Classes Without Stopping Learning" was launched by the Chinese government [5]. The Hungarian Government closed the schools and universities and the classes were held in the online form [6]. Education digitalization is facing both opportunities and challenges.

The European Union unveiled the “Digital Education Action Plan (2021–2027)”, aiming to “establish education and training systems adapted to the development of the digital era, achieving more effective, sustainable, and equitable development of digital education” [7]. In July 2021, the “Guiding Opinions on Promoting the Construction of New Infrastructure for Education and Building a High-Quality Education Support System” was proposed by the Ministry of Education and Five Other Departments. It aims at thoroughly applying new-generation information technologies such as 5G, artificial intelligence, big data, cloud computing, and blockchain to fully leverage the role of data as a new factor of production, and promote the digital transformation of education [8]. The UK has developed “Framework for Digital Transformation in Higher Education” for transformation, addressing new environmental changes through three dimensions: knowledge, digital culture, and digital infrastructure [9].

In 2022, China initiated the implementation of the “National Education Digitalization Strategy”. As of December 2023, China has established a national smart education platform, with a total of 88,000 educational resources for primary and secondary schools, 10,000 high-quality online courses for vocational education, and 27,000 high-quality online courses for higher education [10]. Significant achievements have been made in the provision of educational digital infrastructure and digital resources. The digitalization of education presents different characteristics in different regions. Shanghai has accelerated the construction of new educational infrastructure, with a focus on digital base, and has established 10 scenarios including teaching, learning, management, examination, and evaluation [11]. Zhejiang Province fully leverages digital technology to empower education and teaching. It has established virtual Art Internet Schools to promote educational equity and conduct educational and teaching assessments for precision teaching. For educational digital transformation to achieve positive outcomes, it is not only important to focus on infrastructure and platform development but also on the involvement of stakeholders such as education administrators, teachers, and parents. We are required to study and reflect on educational digitalization policies.

The utilization of digital technology in the field of education may enable learners from different backgrounds to access high-quality educational resources, thus reducing educational disparities. This is particularly important for China, where regional disparities exist. Additionally, new technologies enable more personalized and precise teaching, allowing administrators to make scientifically informed decisions based on dynamic data. The Chinese government has corresponding policies which are issued from the central government to local governments to promote this process and achieve high-quality development in education.

Shanghai, as a pilot city, is the first to release the “Shanghai Education Digital Transformation Implementation Plan”. It is important to accelerate the digital transformation of education, develop more educational application scenarios, and continuously deepen reforms in educational concepts, management methods, and teaching models in Shanghai. Subsequently, other regions like Zhejiang Province and Jiangsu Province formulated the “14th Five-Year Plan for Educational Digitalization” and other policies to provide policy assurance for advancing educational digitalization.

1.2. Literatures

Existing research overwhelmingly affirms the value of educational digitalization, particularly with the emergence of a plethora of studies on online education and teaching during the COVID-19 pandemic.

The survey of university teachers in multiple countries indicates a positive and responsible attitude towards digital education [12]. In order for learners to have a better learning experience, education must embrace new technologies, and teachers should receive support from various stakeholders [13].

With digital transformation in the flipped class, digital cooperative learning (DCL), gamification, augmented reality, virtual reality, or mixed reality have become prominent

in education. At the same time, personalized education, personalization of content, and developing one's own skills are possible in social learning [2]. Technology provides the foundation for education, but it is important to note that the use of new information and communication technologies is only the initial condition for the further development of digital learning. The practicality for students in the technological environment must be taken into consideration [14].

Concerns about the digitalization of education, lack of genuine educational materials, shortcomings compared to face-to-face education, and a deficiency in digital literacy are prevalent. In the process of digitizing education, it becomes crucial to leverage technological opportunities to organize educational content, create educational materials combined with virtual reality, and apply gamification in education. These factors are essential for the effectiveness of education [15]. A recent school survey conducted by the UK Department of Education reveals discrepancies in the perceptions, expectations, and confidence levels among school administrators and teachers regarding the actual process of educational digitalization [16].

When the COVID-19 crisis arrived, most universities had operating digital solutions to handle the crisis. Research has also shown a high degree of online learning readiness among students during the crisis [17]. Furthermore, the concept of a shared learning space based on educational digitalization and subject digitalization has been proposed [18].

Chinese scholars have conducted specific research on policies related to educational digital transformation. They have mainly conducted macro-level research on education digitalization policies in two aspects: firstly, from a vertical perspective, focusing on the development and evolution of education digitalization policies [19], including research on developmental stages and characteristics of policy stages [20]; secondly, from a horizontal perspective, addressing dimensions such as digitalization policies for preschool education [21]; basic education [22], vocational education [23], and higher education [24]. These studies indicate that scholars have produced rich research results, particularly in the comparative study of education digitalization policies during different periods.

The effectiveness of regional practices in educational digitalization largely depends on the soundness and comprehensiveness of digital policies, with policy instruments serving as fundamental techniques, methods, and channels to achieve policy objectives. Provincial governments execute national policies through policy reformulation. The choice and application of policy instruments are crucial for policy implementation. Policies are made and pursue their goals through policy instruments [25]. Policy texts directly reflect the selection outcomes and configuration structures of different types of educational policy instruments, serving as the "physical carriers" of policy instrument choices [26]. Researchers believe that Chinese educational digitalization policy tools need to strengthen information service, public service, and experiential learning demonstration projects [27]. A study by Chinese scholars indicates that the current structure of educational digitalization policy tools is imbalanced, and shows a tendency of singular selection [28]. There is a higher usage of mandatory tools, while incentive tools and systemic reform tools are used less frequently in policy instruments of vocational education and higher education [23,24].

However, the aforementioned studies on policy tools are all based on policies at the national level. There is a lack of focused and in-depth research on provincial-level education digitalization policies during the "14th Five-Year Plan" period (2021–2025). The provincial government serves as a key executor of digitalization policies in education. Only through analyzing from the diverse provincial level, which encompasses various differences, can we uncover the issues surrounding education digitalization. The examination of policy instruments can provide a feasible perspective for evaluating the effectiveness of digital education policies. Therefore, through the study of provincial educational digitalization policy instruments, the current state and issues of regional educational digitalization policies can be revealed, providing corresponding recommendations for policy optimization.

Based on existing research, this study primarily addresses the following questions:

- (1) What preferences exist in the utilization of education digitalization policy instruments by provincial-level governments in China during the “14th Five-Year Plan” period?
- (2) What characteristics are observed in the implementation of policy principles (value orientations) by provincial-level governments in China through education digitalization policy instruments?
- (3) How can provincial-level governments optimize their education digitalization policy instruments further?

The main contributions of this study are summarized as follows:

- (1) Analyzing this topic from both horizontal and vertical perspectives allows for a more comprehensive understanding of the issues present in the execution of educational policies, encompassing both factual observations and the values they reflect. This approach helps us delve deeper into the problems existing in educational policy implementation, such as neglecting human-centered approaches and overemphasizing technological innovation.
- (2) It pays attention to recently issued policy texts at the local level, unlike previous studies that often use national-level data. The provincial government is the main body responsible for implementing China’s education digital transformation strategy. Only by examining provincial policy texts can we understand the true state of policy implementation.
- (3) Distinguishing itself from previous qualitative research, this study utilizes NVivo software for data coding, enabling quantitative analysis.

China is currently implementing a comprehensive digitalization strategy. As the country with the world’s largest population, China’s effective implementation of digitalization in education can play a crucial role in promoting equity, quality, and sustainable development in global education. Moreover, in this era of globalization, other countries and China are facing similar challenges in their education digitalization processes. Research on the implementation of China’s education digitalization policies can provide insights and lessons for other countries and regions undergoing digitalization in education.

2. Education Digital Policy Text Analysis Framework

Policy instruments and education digital transformation have an inherent logic in terms of talent demand, ethical risk prevention, and education standard formulation, with policy instruments providing external driving forces for digital transformation in education. In existing research on policy instruments, the policy instrument classification method by Rothwell and Zegveld has gained widespread recognition. Given the broad scope of the areas involved in education digital transformation, this paper will adopt this policy instrument classification as the X-dimension. At the same time, considering the perspective of policy principles, this instrument can make the specific situations of policy formulation and implementation more transparent, thus constructing a two-dimensional analytical framework of policy instruments–principles to analyze and discuss education digital policy texts.

2.1. X-Dimension: Policy Instrument Dimension

Based on Rothwell and Zegveld’s classification of supply-side, demand-side, and environment-side policy instruments [29], an X-dimension is formed for the study of digital education policies.

Supply-side instruments mainly refer to policies that directly drive the development of digital education [30]. They reflect the implementation of government leadership and responsibility and can satisfy plans for financial investments, financial support, infrastructure, technical support, talent support, and platform development.

Demand-side instruments primarily refer to policies that have a positive pulling effect on digital education development. These policies are aimed at reducing unfavorable factors and avoiding interfering factors. They can include feedback and expression, government procurement, public services, promotion and branding, and collaborative participation.

Environment-side instruments refer to policies that indirectly promote digital education development. They encompass areas like asset management, industry integration, digital ideologies, legal regulations, international perspectives, special actions, standards and norms, organizational leadership, policy subsidies, sound mechanisms, monitoring and evaluation, and goal planning.

Supply-side instruments, demand-side instruments, and environment-side instruments work together to promote the transformation of digital education. Supply-side policy instruments primarily affect the production factors and have a direct role in driving technological integration and innovation in digital education. Demand-side policy instruments focus on educational applications, and both technological advancement and demand are indispensable. Only when there is a substantial market demand expectation can the emergence of new technologies become feasible. Environment-side instruments have a comprehensive and indirect impact on both supply and demand instruments (Figure 1). All three types of instruments are essential components of digital education policies.

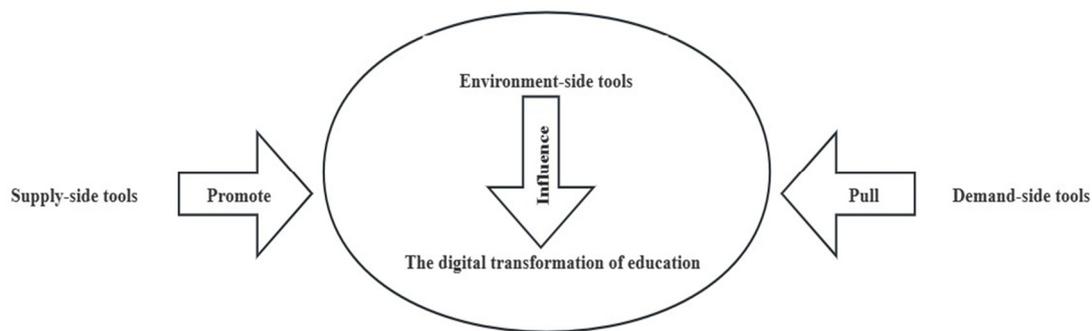


Figure 1. Mechanism of policy instruments on the digital transformation of education.

At the same time, according to their connotations, the above three types of policy tools can be divided into the following sub-tools (Table 1).

Table 1. Classification of sub-tools for three types of policies.

Supply-Side Tools	Demand-Side Tools	Environment-Side Tools
Platform construction	Collaborative participation	Standards and regulations
Talent support	Demonstration brand	Monitoring and evaluation
Technical support	Promotion and publicity	International outlook
Infrastructure	Government purchases	Organisational leadership
Financial support	Feedback expression	Sound mechanisms
Capital investment	Public service	Laws and regulations
		Policy subsidies
		Target planning
		Special operation
		Digital philosophy
		Asset management
		Industrial integration

2.2. Y-Dimension: Policy Principles

The basic principles in policy texts exist between guiding ideologies and primary objectives, reflecting the fundamental philosophies and standards of action in policy design and implementation. They describe each policy’s value orientation. Policy instruments act as effective bridges between basic principles and implementation outcomes.

Therefore, evaluating policy principles as the Y-dimension can reveal the value pursuit status of different digital education policy instruments and their combinations. In other words, it assesses the extent to which various instruments adhere to the value guidance of digital policies.

The principles of digital education policies embody characteristics such as serving society, shared benefits for everyone, reliance on society, and empowerment of citizens through technology. These principles represent the fusion of human-centric and technology-centric aspects. Human centrality reflects the fundamental value attribute of socialist education, while technology centrality serves the needs of human centrality. Ultimately, policy principles represent the human-centric nature of digital education.

Furthermore, the choice of policy principles is based on the uniqueness of digital education. Digital education cannot replace humans but should be aimed at human development. It should be conducted through the human agent, rely on it, and be for humans. The measure of its effectiveness is based on whether it promotes human development [31]. In studying digital education policies, it is essential to focus on the essential differences between digital education and digitalization in other fields, as well as to focus on the value issues of digital education.

The same policy instruments may have different effects in the context of digital education if they fail to adhere to the principles of educational activities and the values of nurturing individuals. Therefore, in the framework of evaluating digital education policy instruments, it is crucial to consider the basic principles that reflect policy philosophies and value orientations. This forms the Y-Dimension: policy principles, with specific operational details outlined in Table 2.

Table 2. Classification and Operational Content of the Y-Dimension.

Basic Principle	Operational Content
Service centered, student centered	Implementing the learner-centered education philosophy, strengthening the concept of information for both teachers and students, and enhancing their application abilities. Tailoring education to individual needs, utilizing digitalization to lead modern education, supporting high-quality education development, and constructing a new modern educational ecosystem.
Application driven, innovative integration	Promoting the integration of information technology and education through innovation, such as big data and artificial intelligence. Establishing new educational and teaching models, emphasizing the routine application of information technology, and continuously enhancing the ability to train innovative skillful individuals.
Coordinated planning, balanced development	Leading the development through strengthened coordination among various sectors. Promoting the coordinated digitalization of education in regions, urban and rural areas, and at all levels and types of schools.
Diverse participation, open sharing	Creating a mechanism for multiple stakeholders, including government, schools, businesses, and social organizations, to participate. Promoting international exchanges and cooperation to achieve distinctive and sustainable development.

Data Source: compiled and organized by the authors based on official policy documents, conference reports, and relevant literature.

2.3. Two-Dimensional Analytical Framework

The two-dimensional analytical framework is used to analyze provincial-level digital education policy texts. It takes the supply-side, demand-side, and environment-side policy instruments as one dimension and the “basic principles” that reflect the values of digital education policies as the other dimension, as illustrated in Figure 2.

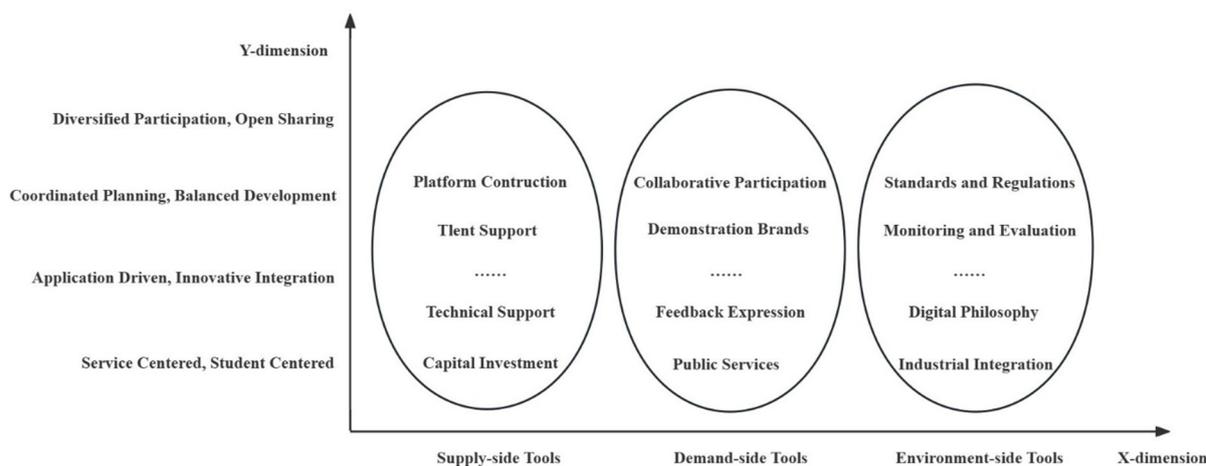


Figure 2. Two-dimensional analytical framework.

This framework allows for an analysis of government preferences in selecting policy instruments and approaches to digital education policies from the perspective of instrument effectiveness. It also explores the value guidance and service direction of policy instrument usage from the perspective of “whom the service is for”. This framework combines rationality in instruments and rationality in values to analyze digital education policy texts. It is more in line with the inherent characteristics and goals of educational activities that seek comprehensive individual development and promote societal development.

Additionally, this framework corresponds, among others, to the “focus on technology and neglect of individuals” and excessive technological dependence that exists in current digital education practices. By improving and adjusting policies, it aims to achieve a more profound transformation of digital education.

3. Policy Sample Selection and Research Design

3.1. Policy Samples

This study has selected eight provincial-level special policies related to digital (information) education. It is worth noting that currently, at the provincial level, only eight provinces have publicly released special policies related to digital education for the “14th Five-Year Plan” period (as listed in Table 3). Shanghai, as a pilot city, explicitly introduced the term “digital education”, while other provinces continue to use “educational informatization”. Based on the background of the digitalization strategy, this study uniformly refers to these policies as “digital education” policies. To ensure the authenticity of the samples, all the selected policy documents are official documents issued by the provincial education authorities, and the original policy texts can be publicly accessed on the official websites of the respective provincial governments and education departments.

Table 3. Database of digital education policy documents.

No.	Policy Document Title	Issuing Authority	Release Date
01	“Zhejiang Province 1 ‘4th Five-Year Plan’ for the Development of Education Informatization”	Zhejiang Provincial Department of Education	30 July 2021
02	“Special Plan for the Development of Education Informatization in Jiangsu Province for the ‘4th Five-Year Plan’”	Office of the Leading Group for Educational Network Security and Informatization of Jiangsu Province	1 November 2021

Table 3. Cont.

No.	Policy Document Title	Issuing Authority	Release Date
03	“Tianjin Municipal 1 ‘4th Five-Year Plan’ for Education Informatization”	Tianjin Municipal Education Commission	30 December 2021
04	“Beijing 1 ‘4th Five-Year Plan’ for Education Informatization”	Beijing Municipal Education Commission	28 February 2022
05	“Shanghai 1 ‘4th Five-Year Plan’ for Educational Digital Transformation”	Shanghai Municipal Education Commission	7 March 2022
06	“Development Plan for Education Informatization in Henan Province for the 1 ‘4th Five-Year Plan’”	Henan Provincial Department of Education	26 April 2022
07	“Shaanxi Province 1 ‘4th Five-Year Plan’ for Educational Network Security and Informatization”	Shaanxi Provincial Department of Education	6 May 2022
08	“Shandong Province 1 ‘4th Five-Year Plan’ for Education Informatization”	Shandong Provincial Department of Education	26 May 2022

3.2. Research Methods

This study primarily utilizes NVivo software to organize and analyze policy texts. It employs content analysis to provide an objective, systematic, and quantitative description of the policy content. First, a database is established based on the collected policy texts. Second, an open coding process is conducted for the content of policy texts, and the reliability is verified. Frequency counts and comparative analysis are performed through text searching and word frequency statistics. Finally, content analysis is applied to explore the characteristics of policy texts.

3.3. Policy Text Coding

This step involves transforming policy content into quantifiable text analysis units. The logic here is to use NVivo to code policy texts following a three-level coding format: “Policy Text Identifier—Policy Instrument—Specific Policy Instrument”.

First, an open coding of policy text content is performed, line by line, to identify different node types. Furthermore, the content is categorized and counted based on the policy instrument types corresponding to different nodes. In this coding scheme, 01, 02, and 03 represent the policy text identifiers, A, B, and C represent policy instrument types, and a, b, and c represent specific sub-instruments within the policy.

For example, “01-A-b” contains information from the “Zhejiang Province’s 14th Five-Year Plan for the Development of Education Informatization”, specifically within the supply-side policy instrument category related to financial support, and the policy content corresponds to “innovate investment mechanisms, enrich digital education supply methods; local education administrative departments and schools can explore ways to guide and attract social forces to participate through financing, leasing, etc., to establish a multi-channel funding guarantee mechanism”.

During the coding process, each coding event creates a reference point. It allows the same content from a policy text to be categorized into multiple sub-nodes, resulting in several reference points. To avoid subjective judgments interfering with the open coding stage, the coding process is carried out collaboratively by two researchers. After the first round of three-level coding is completed in a double-blind fashion, the coding results of

the two researchers are compared and adjusted to some extent, leading to the final second round of three-level coding results.

4. Results

4.1. Word Frequency Analysis

High-frequency thematic words exhibit clear correlations. Thematic words with a frequency of over 450 appearances include education, development, informatization, system, development, and supervision. Thematic words with frequencies ranging between 350 and 450 include “network”, “service”, “responsibilities”, “data”, and “application”. Thematic words with frequencies ranging between 250 and 350 include information, security, foundation, innovation, and standards. From this, several conclusions can be drawn.

First, the focal points and main measures of policy planning for digital education development are identified. Apart from supervision and evaluation, development becomes the guiding direction for digital education construction.

Second, the implementation strategy for digital education development emphasizes the construction of network systems and platforms and the improvement of infrastructure. It also underscores the allocation of educational resources and the importance of educational information security.

Third, the concept of collaborative innovation in digital education development needs further reinforcement.

4.2. X-Dimension Analysis of Digital Education Policy

The analysis of policy instruments in the X-dimension can be conducted from two perspectives: the structure of the usage of supply-side, demand-side, and environmental policy instruments, and the specific focus within each category.

4.2.1. Analysis of the Structural Layout of the Three Categories of Policy Instruments

- Provincial governments tend to favor the use of supply-side and environmental policy instruments, with limited use of demand-side policy instruments, resulting in an uneven distribution of the three categories of policy instruments. Examining the use of policy instrument types, a significant difference in distribution is evident (see Figure 3).

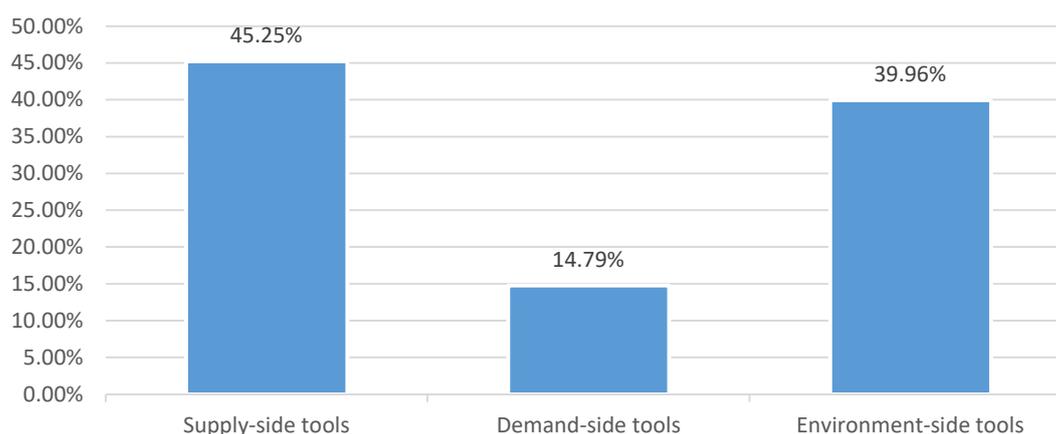


Figure 3. Distribution of policy instruments for digitalization of education.

Supply-side policy instruments are used most extensively, accounting for 45.25%, followed by environmental policy instruments at 39.96%, while demand-side policy instruments have the lowest usage, at 14.79%. The preference for supply-side and environmental policy instruments in the process of educational digitalization is apparent, while the use of demand-side policy instruments is relatively limited, indicating an imbalance in the usage proportions among the three categories of policy instruments. Of particular concern

is the underutilization of demand-side policy instruments, which have the potential to drive progress.

- Different provinces exhibit significant variations in the utilization of policy instruments for educational digitalization. Using the reference point ratio of supply-side policy instruments to demand-side policy instruments, it becomes apparent that Zhejiang Province maintains a relatively balanced approach between supply-side and demand-side instruments as seen in Figure 4. In contrast, provinces like Tianjin, Beijing, and Shandong show a pronounced imbalance in favor of predominantly using supply-side instruments.

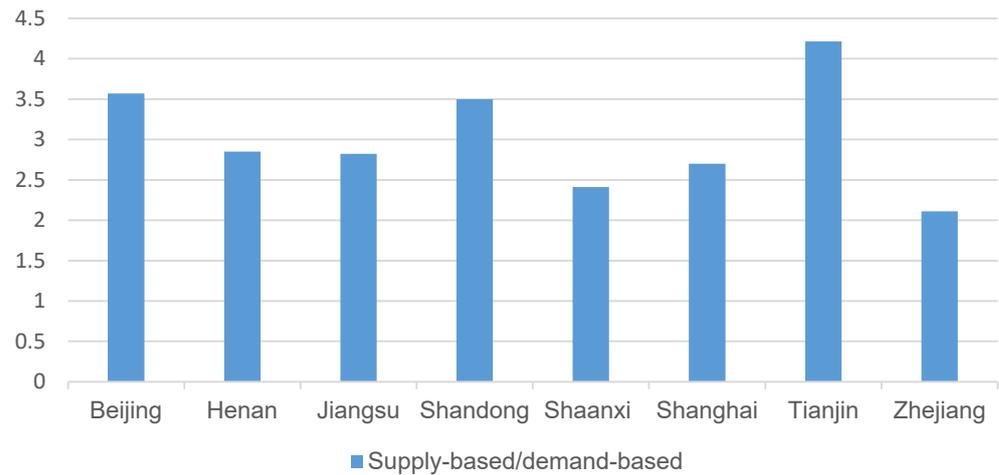


Figure 4. The ratio of supply-side policy instruments to demand-side policy instruments in different provinces.

At the same time, there are significant variations in the distribution of the 24 policy sub-instruments within the three categories of policy instruments in education digital policies.

- Supply-oriented policy instruments prioritize the “technical support” sub-instrument. Supply-oriented policy instruments have the highest usage percentage in directly driving education digital development (see Figure 3). Among these instruments (see Figure 5), “technical support” has the highest reference points, accounting for 39.74%. The reference points for “platform construction”, “infrastructure”, and “talent support” are relatively close, accounting for 19.21%, 18.54%, and 17.00%, respectively. On the other hand, “funding investment” and “financial support” have the fewest reference points, at 3.31% and 2.21%, respectively.

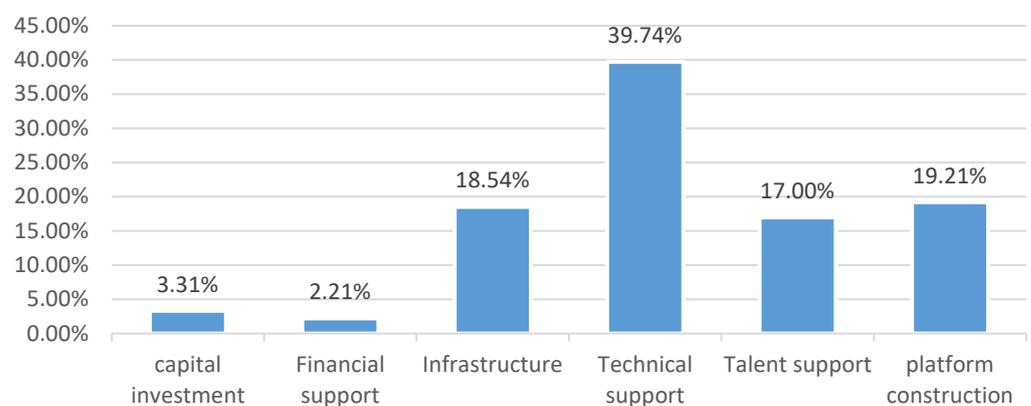


Figure 5. Distribution of supply-oriented policy instrument codes.

This indicates that the four major supply-oriented sub-instruments are relatively balanced and emphasize technological empowerment. They also prioritize platform optimization, infrastructure improvement, and talent support, aligning with the development strategy of promoting deep integration between information technology and educational instruction and supporting schools in using information technology for talent development and teaching reform [32].

- Demand-oriented policy sub-instruments pay more attention to “demonstration brands” and pay less attention to “feedback expression”.

Demand-oriented policy instruments are primarily aimed at directly driving digital education development policies, with a relatively low usage rate, accounting for only 14.79% of all policy instruments. Among these demand-oriented policy instruments (Figure 6), “Demonstration Brands” have the highest usage rate at 44.59%, followed by “Collaborative Participation” at 36.49%. On the other hand, the usage rates of “Promotion and Publicity”, “Public Services”, “Government Procurement”, and “Feedback Expression” decrease progressively, revealing a noticeable imbalance. Notably, “Feedback Expression” receives little to no attention. This indicates that provincial governments prioritize showcasing and promoting demonstrative initiatives in digital education but pay limited attention to policy feedback and the effectiveness of implementation.

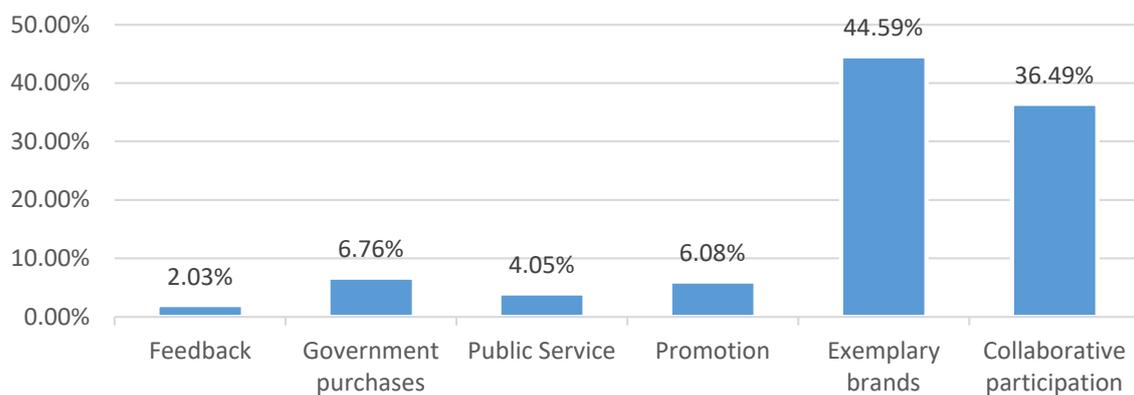


Figure 6. Distribution of demand-oriented policy instrument codes.

- Environment-oriented policy instruments primarily focus on “monitoring and evaluation”, “sound mechanisms”, and “standards and regulations”.

Environment-oriented policy instruments play an indirect role in promoting educational digitalization, with a moderate usage rate of 39.96%. Among these instruments (as shown in Figure 7), “monitoring and evaluation”, “sound mechanisms”, and “standards and regulations” occupy the top three positions, accounting for 22.25%, 21.50%, and 9.75% respectively. In contrast, “asset management”, “industry integration”, and “laws and regulations” each have a usage rate of below 2.00%. This indicates that during the 14th Five-Year Plan period, educational digitalization places significant emphasis on monitoring and evaluation, sound mechanisms, and standardization. In comparison, policy instruments related to asset management, industry integration, and laws and regulations are underutilized.

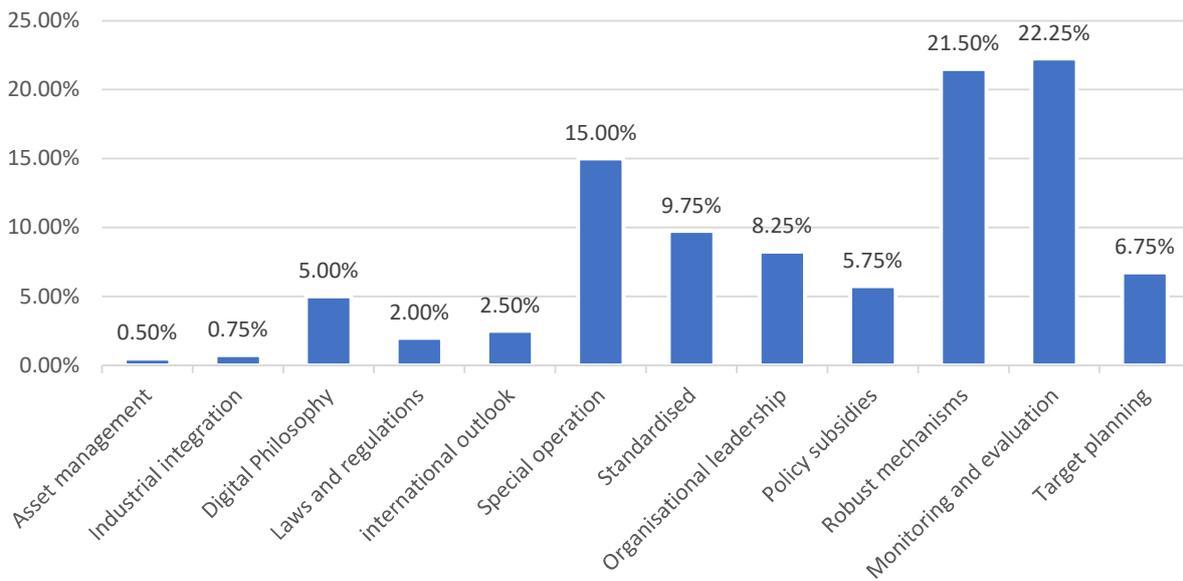


Figure 7. Distribution of environment-oriented policy instrument codes.

4.2.2. Y-Dimension Analysis of Education Digitalization Policies

The policy principles were established using NVivo20 software and categorized into four major nodes: “Service-Oriented, Student-Centered”, “Application-Driven, Innovation-Integrated”, “Coordinated Planning, Balanced Development”, and “Diverse Participation, Open Sharing”. The data processing results reveal an uneven distribution of these policy principles (Figure 8). More specifically, there are 126 reference points for “Service-Oriented, Student-Centered”, 476 reference points for “Application-Driven, Innovation-Integrated”, 239 reference points for “Coordination and Planning, Balanced Development”, and 173 reference points for “Diverse Participation, Open Sharing”, totaling for 1014 policy reference points.

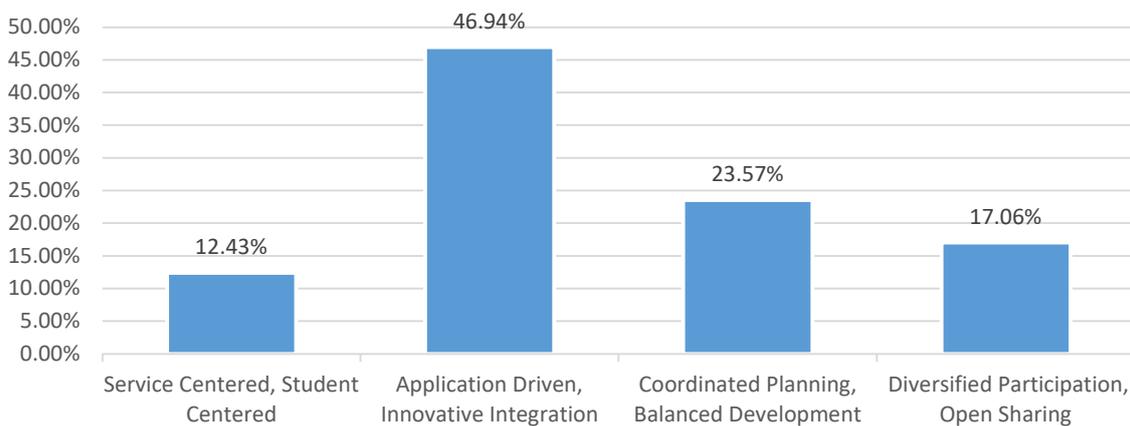


Figure 8. Distribution of policy principal codes.

Among these principles, “Application-Driven, Innovation-Integrated” has the highest proportion at 46.94%, followed by “Coordinated Planning, Balanced Development” at 23.57%. These two principles make up nearly two-thirds of the total reference points. “Service-oriented, Student-Centered” and “Diverse Participation, Open Sharing” have proportions of 12.43% and 17.06% respectively.

4.2.3. The Two-Dimensional Cross-Analysis of Educational Digitalization Policies

To further explore the internal logic of education digitalization policy texts, a two-dimensional cross-analysis was conducted by combining policy instruments and policy principles. Based on this, the various policy instruments and their corresponding policy principles within the current policy texts were counted. If a particular policy text incorporated two or more basic elements, then the repetitive coding was selected. After verification and examination, the following two-dimensional cross-analysis table was obtained.

Firstly, from the perspective of supply-side policy instruments, the key emphasis on technical support, infrastructure, and platform construction aligns with the realization of the fundamental principles of “application-driven, innovation integration” and “overall coordination, balanced development”. Particularly noteworthy is the prominence of technical support, accounting for 182 out of a total of reference points, with a percentage of 17.95%. This indicates that the construction of digital education is fundamentally based on technology, primarily relying on the continuous iteration and innovative application of digital technologies [33].

Secondly, concerning demand-side policy instruments, the sub-instruments exhibit a certain degree of aggregation effects: demonstration brands are concentrated towards “application-driven, innovation integration”; collaborative participation is concentrated towards “diverse participation, open sharing”. The combined number of nodes for these two aspects accounts for approximately two-thirds of the demand-side policy instruments. This implies that collaborative innovation involving multiple entities is a crucial guarantee for promoting the development of digital education.

Finally, regarding environmental policy instruments, apart from monitoring and evaluation, which focuses on “application-driven, innovation integration,” the distribution of other policy sub-instruments is relatively balanced. It is worth noting that some policy sub-instruments exhibit a “zero correspondence” to certain policy principles. For example, the distribution of policy principles related to asset management, industrial integration, and international perspectives indicates a need for increased attention in these areas.

5. Discussion

5.1. Application of Three Policy Instrument Types

In educational digital policy texts, supply-side policy instruments are the most frequently used, followed by environmental policy instruments, and demand-side policy instruments are used the least. The distribution of policy instrument types is significantly unbalanced, with both instrument oversupply and instrument deficiency present. Despite being based on different tool classifications, the imbalance in the selection of provincial-level educational digitalization policy tools is consistent with existing research on national-level imbalances [28].

Provincial governments tend to choose supply-side policy instruments such as technical support, platform construction, infrastructure, and talent support. But they pay less attention to the demands of stakeholders such as feedback expression, government purchases, and collaborative participation. The process of digital transformation in education profoundly reflects the comprehensive changes in the entire field, with all elements, processes, and operations of education triggered by information technology [34]. As a systematic project, digital education requires the coordinated and orderly development of various elements. According to the mechanisms of policy instruments [35], the dynamic balance of policy instruments is crucial to achieving educational digital transformation. Therefore, more attention should be placed on the selection and use of demand-side instruments to meet the needs of various stakeholders. Previous research has shown that teachers have a positive attitude towards online learning and are able to continuously improve their digital teaching capabilities over time [12]. Policy tools should be selected to focus on this reality, paying attention to the needs of frontline teachers for educational teaching.

The reasons for this observation are twofold. First, an increasing number of information technologies are being applied in education and teaching, but educators and other

educational stakeholders are unfamiliar with and not adapting to the digital technology instruments and the information environment [36], failing to achieve the necessary integration. As existing research suggests, schools, technology companies, professional associations, and others need to support teachers and strengthen efforts to embrace technology [13]. Second, the demands and expressions of the public have not received timely attention, leading to an overemphasis on supply-side policy instruments and insufficient emphasis on demand-side policy instruments.

In addition, an interesting result is that there are differences in the proportion of supply tools and demand tools used in different provinces. The imbalance in the use of supply and demand tools in Tianjin, Beijing, and Shandong provinces is more prominent. These disparities might be attributed to differences in local government priorities, resource allocation, or strategies for implementing educational digitalization plans. At present, scholars have not made a clear empirical analysis on the influencing factors of regional education digitalization in China.

Prolonged development in this direction may lead to an overemphasis on technological empowerment, neglecting the genuine needs of educational stakeholders. Certain indicators, such as feedback expression, government procurement, asset management, international perspective, and industrial integration, have zero reference points in different policy elements. This indicates a risk of neglect by policymakers and implementers. These missing policy sub-instruments require urgent attention. Over-reliance on these instruments could lead to issues such as an oversupply of resources and a homogenization of the educational digital development subject.

5.2. Principles of Policy Instruments

The high proportion of “Application-Driven, Innovation-Integrated” suggests a strong emphasis on the application of information technology in education and driving innovation. The significant representation of “Coordinated Planning, Balanced Development” indicates a focus on the coordinated progress of digitalization among different types of schools. The government regards new technologies as an important force in driving the high-quality development of education, especially during the COVID-19 epidemic. It ensures students’ effective learning through infrastructure construction of online teaching and MOOCs. At the same time, they attach great importance to the learning opportunities brought by new technologies for different groups, especially students in rural areas, to eliminate the digital divide in education and promote educational equity. This is consistent with the recent trend of international education digitalization [37].

However, “Service-Oriented, Student-Centered” and “Diverse Participation, Open Sharing” receive comparatively less attention. In the process of education digitalization, insufficient attention is paid to teachers’ information competency, students’ information literacy, and resource sharing at the micro level. The role of teachers, students, businesses, and other social organizations in policy formulation has not been fully played in China. These are the fundamental core and software that ensure the effectiveness of digital education.

For example, teachers, students, parents, and other education stakeholders have not paid sufficient attention to their attitudes and cognitive concepts towards educational digitalization [12]. This is consistent with recent survey results released by the UK Department for Education, where leaders and management are more optimistic about technology, while teachers are less involved [16].

This study also found that the current education digitalization policy does not pay enough attention to the value of “people-oriented” and “student-oriented” technology. Technology is only an initial condition [14], and the effectiveness of educational technology should be judged by students. Recently, UNESCO’s “Guidelines for the Use of Generative Artificial Intelligence in Education and Research” proposed that we should adhere to the core concept of humanism in the use of technology, emphasize the subject status of people, and promote the all-round development of people [35].

5.3. Subject Interaction in the Policy Formulation Process

The aforementioned analysis of policy instruments indicates that the current education digital transformation policies exhibit a strong characteristic of government-led and forceful promotion. The data literacy of educational stakeholders is not high, with deficiencies in digital concepts and the ability to integrate, analyze, and apply digital information. The level of understanding of the actual needs of policy users is not deep enough.

This is evident in the types of demand-driven policy instruments, where the reference points for feedback expression are only four, accounting for a mere 0.39%. This indicates that there is space for further deepening in the interaction and communication between policymakers and educational stakeholders in the context of education digitalization. It further confirms the government-led tendency of China's educational digitalization policies [22–24]. There should be more emphasis placed on expanding channels for feedback expression, especially in fostering the digital concepts and capabilities of educational stakeholders.

Education, as a significant force for promoting the comprehensive development of individuals and social progress, ultimately serves the fundamental mission of high-quality education and nurturing individuals in the digital realm. Therefore, it is essential to emphasize the needs of educational stakeholders and achieve the transition to digital education from a government-driven model to one driven by internal forces among educational stakeholders [22]. Due to the existence of time constraints, provincial governments face significant political pressure in the formulation and implementation of policy tools. As a result, they often select tools from the toolbox that can achieve tangible results in the short term, such as platform resource construction and infrastructure. With the Chinese government's efforts to streamline administration and delegate power, provincial governments have gained increased autonomy. They consciously encourage multiple stakeholders to participate in the policymaking process, thereby shifting from government-led policy tool preparation to multi-stakeholder involvement.

5.4. Limitation of the Research

This study also has some limitations.

First, the above results come from eight provinces in China that have enacted education digitalization policies; thus, the sample size is relatively limited. So far, only these eight provincial governments in China have promulgated this policy. This also fills the existing research gaps to a certain extent. More in-depth case studies will be conducted in the future.

Second, there are limitations to the classification of policy instruments. This article uses the classification of supply, demand, and environmental tools, and on this basis, the value orientation of the tools is classified based on principles. Although there can be multiple classifications, in view of the complexity of educational digital policy tools, the paper chooses the two categories of "tools-value", since the dimensional structure is more consistent with the research questions.

Third, the content coding of policy texts will be affected by the researcher's ability and cultural background.

Nonetheless, this article still conducts innovative research on the topic of the use of education digitalization policy tools by Chinese provincial governments, providing evidence for existing problems in current education digitalization policy tools. The research results can serve as inspiration for governments in China and other countries to promote educational digitalization practices. Future research will involve a more comprehensive tracking study.

6. Conclusions and Suggestions

6.1. Conclusions

The research provides insights into the preferences, characteristics, and potential improvements in the utilization of education digitalization policy instruments by provincial-

level governments in China during the specified period. This is of great significance for the selection of policy tools in the process of education digital transformation and for grasping the value direction of education digitalization policies that conform to the laws of education.

This study believes that China's provincial governments have excessively used supply-oriented policy tools in the selection of education digitalization policy tools, such as technological innovation and application, and platform construction, which are the premise and basis for the implementation of digitalization policies; while for demand-based policy tools, there is less attention, such as neglecting the information literacy capacity building of teachers and students, and feedback on the educational digital needs of teachers, students, parents, and other entities. In terms of value orientation, it shows attention to the instrumental value and fair value of technology, but does not pay attention to issues such as the people-centered concept and multi-subject participation in the use of new technologies. According to the mechanism of push-pull and guaranteed forces, the digital transformation of education should adopt relatively balanced supply, demand, and environmental policies. Provincial local governments in China need to optimize policies based on the above issues in future education digitalization policy practice.

6.2. Suggestions

- In the process of digitalization, the government should actively cooperate effectively with schools, social organizations, educational technology enterprises, clarify the responsibilities of different entities in the cooperation process, and accurately purchase high-quality third-party services after fully assessing the needs of schools and existing technical foundations. At the same time, they should regularly organize experts to supervise and evaluate the digital effects.

Policymakers should focus on the environmental impact of educational digitalization and formulate corresponding environmental policy instruments to ensure the sustainable development of educational digitalization, for example, encouraging schools to adopt energy-efficient equipment and technologies to reduce energy consumption, promoting environmentally friendly transportation methods to minimize traffic pollution, and strengthening cybersecurity measures to protect student privacy and information security.

- Policymakers should pay attention to the needs of educational stakeholders to shift educational digitalization from being technology driven to being demand driven. They should recognize that the process of educational digitalization should not be limited to the mere provision of single technologies and educational solutions. Instead, they should emphasize the integration of various digital platforms, resource sharing, and addressing the needs of educational stakeholders. Policies should adhere to the student-centered concept and provide students with personalized education. Provincial governments should strengthen training and support for teachers and students to enhance their abilities in using digital technologies. They should set up special projects to carry out teacher information literacy training through cooperation with relevant university majors and enterprises to improve teachers' digital level. In the curriculum, information technology is regarded as an important part of science education to improve students' ability to use information technology.
- The selection of policy instruments should prioritize the value of serving education and strengthen the concept of multi-stakeholder participation in development.

It is essential to consider supporting individuals as the primary value of educational digitalization to make them truly effective. Ultimately, digitalization transformation needs to be implemented at the human level, achieving a transformation at the level of individuals [38]. The choice of instruments should start from the fundamental purpose of serving education, enhancing interaction and communication with educational stakeholders, promptly addressing, and responding to the feedback and needs of teachers and

students, and formulating policies from a student-centered perspective to facilitate student growth and development.

Additionally, advocating for the implementation of a human-centered approach at the policy level and enhancing a service-oriented mindset at the practical level will continually help educational stakeholders better adapt to the new requirements of educational digitalization transformation. The government should increase investment in educational research and innovation, supporting universities, research institutions, and enterprises in conducting research and development related to educational digitalization. Interdisciplinary and cross-sector collaboration and communication should be encouraged to foster innovation and development in both the theory and practice of educational digitalization.

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