

# Digital-Intelligent Technology Empowerment and the Integrated Development of Education, Science and Technology, and Talent in Zhejiang Province: A Mechanism-Based Study

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**Abstract:** With the deepening of the new round of scientific and technological revolution and industrial transformation, digital-intelligent technologies such as artificial intelligence, big data and cloud computing are profoundly reshaping the way the economy and society operate, while continuously advancing the deep integration of education, science and technology, and talent. The Report to the 20th National Congress of the Communist Party of China states that education, science and technology, and talent are foundational and strategic pillars for building a modern socialist country in all respects; coordinated advancement of this “trinity” has therefore become an important strategic requirement of Chinese modernization. At present, Zhejiang still faces problems such as insufficient data sharing, inadequate multi-actor coordination, and weak alignment between the education chain and the industrial chain, which to some extent constrains the deep integration of education, science and technology, and talent. Empowering their integrated development with digital-intelligent technologies is not only an important component of Digital China, but also a practical requirement for promoting high-quality regional development. From the perspective of digital-intelligent technology empowerment, this paper analyzes the integrated development of education, science and technology, and talent in Zhejiang, with a focus on how platform connectivity, data sharing, collaborative innovation and intelligent governance promote coordinated development among the education chain, innovation chain, industrial chain and talent chain.

**Keywords:** Digital-Intelligent Technologies; Educational Technology Talents; Coordinated Development; Zhejiang Practice

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## 1. Introduction

In recent years, relying on the construction of “Digital Zhejiang”, Zhejiang has built a strong development foundation in areas such as the digital economy, digital government, smart education and the artificial intelligence industry. The scale of Zhejiang’s core digital-economy industries has continued to expand; major platforms such as the Hangzhou City Brain, Zhejiang Lab and the West Hangzhou Science and Technology Innovation Corridor have continued to advance; and the artificial intelligence industry represented by DeepSeek has developed rapidly. As a result, the integration of digital technologies with educational governance, scientific and technological innovation, and talent cultivation has continued to

deepen<sup>[1]</sup>. Meanwhile, Zhejiang has steadily advanced educational digitalization reform and the construction of its science and technology innovation system, gradually fostering closer coordination among the education chain, innovation chain, industrial chain and talent chain. Digital-intelligent technologies have become an important driving force for high-quality regional development.

At the same time, however, the integrated development of education, science and technology, and talent in Zhejiang still faces practical obstacles. On the one hand, education, science and technology, industry, and talent resources are distributed across different departments and platforms, while substantive platform connectivity and data-feedback mechanisms remain insufficient. On the other hand, the alignment between university research outcomes and real industrial demand remains weak, and there is still room to improve the efficiency with which scientific and technological achievements are transformed into talent cultivation and industrial applications. As artificial intelligence, big data and other technologies are being applied at a faster pace, issues such as data security, algorithmic norms and rules for intelligent governance have also become more prominent. How to use digital-intelligent technologies to improve resource integration, strengthen data transformation capacity, deepen multi-actor collaborative innovation and improve risk-governance mechanisms has become an important issue for Zhejiang in promoting the integrated development of education, science and technology, and talent.

## 2. Literature Review

The rapid development of digital-intelligent technologies, including artificial intelligence, big data and cloud computing, is continuously transforming the modes of resource allocation, organizational coordination and governance operation<sup>[3]</sup>. Particularly in the context of Digital China, digital platforms, data governance and artificial intelligence technologies have become deeply embedded in educational governance, scientific and technological innovation and talent-development systems, while the interaction among the education chain, innovation chain, industrial chain and talent chain has been further strengthened.

Existing studies mainly discuss the topic from the perspectives of collaborative innovation, digital transformation and educational digitalization. The Triple Helix theory holds that, in the knowledge-economy era, innovation increasingly depends on dynamic coordination among government, universities and enterprises, and that the traditional linear innovation model is gradually being replaced by a networked innovation structure<sup>[2]</sup>. Etzkowitz subsequently further pointed out that universities are no longer merely traditional institutions for talent cultivation, but are increasingly becoming important actors in scientific and technological innovation<sup>[1]</sup>. This indicates that education, science and technology, and talent have begun to form a coordinated operating structure. Later studies have found that digital platforms and data governance are changing traditional coordination models. Vial argues that digital transformation does not simply mean technological upgrading; rather, digital technologies drive systemic changes in organizational structures, governance logic and value-creation modes, with resource allocation shifting from traditional administrative allocation toward platform-based and data-driven allocation<sup>[3]</sup>. At the same time, artificial intelligence has become further embedded in educational governance and talent-cultivation systems. Relevant studies suggest that AI technologies are changing the allocation of educational resources and the structure of educational governance<sup>[4]</sup>, and that their application in higher education has expanded from learning support to research collaboration, talent profiling and educational decision-making<sup>[5]</sup>. This shows that digital-intelligent technologies are no longer merely educational tools; they have become an important force for advancing the coordinated development of education, science and technology, and talent.

Compared with international research, domestic studies pay greater attention to the practical issues of educational digitalization, digital governance and the coordinated development of education, science and technology, and talent. Zuo Chongliang argues that education, science and technology, and talent have formed a clear interactive relationship, and that universities are gradually becoming important components of the national innovation system<sup>[9]</sup>. Hu Hang and Yang Lin also point out that digitalization and intelligentization are driving the coordination model of education, science and technology, and talent to shift from traditional administrative promotion toward intelligent coordination<sup>[8]</sup>. In the field of educational digitalization, existing research mainly focuses on smart education, platform governance and data-driven governance<sup>[7]</sup>. Studies on digitally empowered governance further indicate that digital platforms and data connectivity are promoting a

transformation in governance structures from traditional departmental governance toward holistic governance<sup>[11]</sup>.

Overall, existing research has formed a foundation in areas such as collaborative innovation, digital governance and educational digitalization, but certain deficiencies remain. Most current studies focus on a single field, while research on how digital-intelligent technologies promote the integrated development of education, science and technology, and talent through mechanisms such as platform connectivity, data sharing, collaborative innovation and intelligent governance remains relatively insufficient. Mechanism-oriented research that is grounded in Zhejiang's practice of digital reform is also lacking.

### **3. Coordinated Mechanisms through Which Digital-Intelligent Technologies Empower the Integrated Development of Education, Science and Technology, and Talent in Zhejiang**

Using digital-intelligent technologies to promote the integrated development of education, science and technology, and talent is not a matter of simply applying technology to a single field. Rather, it requires strengthening the links among the education chain, innovation chain, industrial chain and talent chain through digital platforms, data sharing, artificial intelligence, algorithmic models and other technological means<sup>[10]</sup>. In the past, the education system, the science and technology innovation system and the talent-development system were characterized by dispersed resources, weak information connectivity and low coordination efficiency, making it easy for disjunctions to arise among talent cultivation, scientific and technological innovation and industrial demand. The development of digital-intelligent technologies has changed the modes of interaction among different actors and has also promoted the sharing and integration of education, science and technology, industry and talent resources on a broader scale, thereby improving overall coordination efficiency.

Specifically, digital-intelligent technologies promote the integrated development of education, science and technology, and talent in Zhejiang mainly through four mechanisms: platform connectivity, data-driven coordination, collaborative innovation and intelligent governance. Based on this logic, this paper constructs a mechanism transmission diagram for digital-intelligent technologies empowering the integrated development of education, science and technology, and talent in Zhejiang, as shown in Figure 3-1.

#### **3.1 Platform Connectivity Mechanism**

Traditional education, research and industrial systems have long lacked stable information-exchange mechanisms. Universities mainly undertake talent-cultivation tasks, research institutions focus on technology research and development, while enterprises place greater emphasis on industrial application and market demand<sup>[2]</sup>. Because information flows inefficiently among different actors, universities find it difficult to grasp industrial technological changes in a timely manner, and enterprises also struggle to participate deeply in research collaboration and talent cultivation. As a result, gaps easily emerge among education and training, scientific and technological innovation and industrial demand, while the efficiency of transforming research outcomes is also constrained to a certain extent.

Platforms serve as information channels that connect education, science and technology, and talent collaboration. The construction of digital platforms promotes interconnection among educational platforms, research platforms and industrial platforms. Enterprises' technological needs can enter university curricula and research processes more quickly, while university research outcomes can enter industrial application scenarios in a more timely manner<sup>[3]</sup>. Research institutions can also use platforms to share educational resources and industrial data, significantly shortening the information-transmission chain among different actors and further strengthening the coordinated relationship among education, science and technology, and talent.

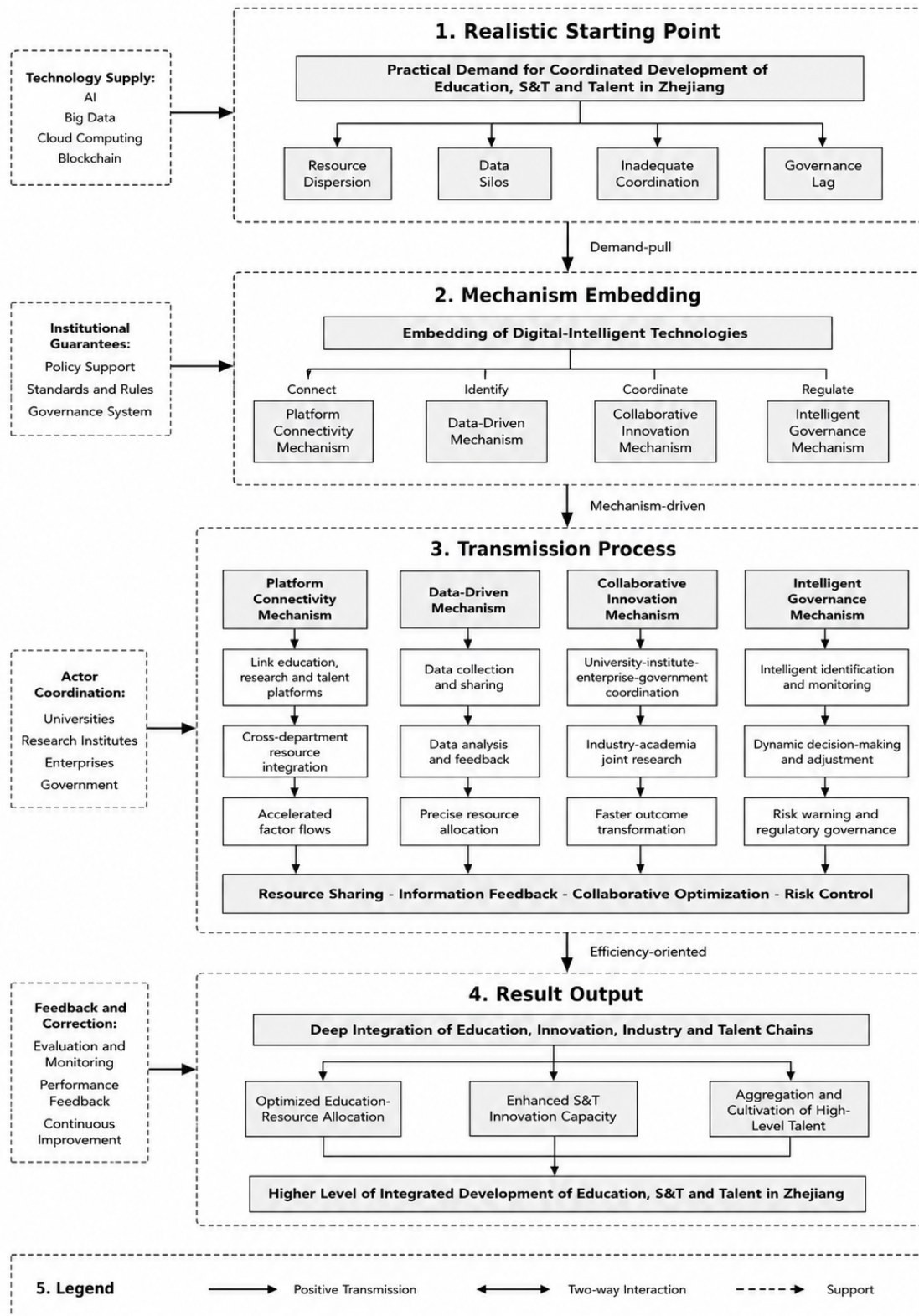
#### **3.2 Data-Driven Mechanism**

Traditional educational and scientific governance relies on experiential judgment, and changes in industrial demand are often difficult to feed back promptly into education and research systems<sup>[4]</sup>. There is a lack of real-time feedback mechanisms among university program adjustment, research-direction planning and talent-policy formulation. Consequently, the structure of talent cultivation can easily become misaligned with industrial demand, and the efficiency of educational-resource allocation remains relatively limited.

Through the extensive application of artificial intelligence, big data and algorithmic technologies, the speed of information

transmission among the education system, the science and technology innovation system and the industrial system can be significantly improved. Universities can adjust their program structures according to employment data and changes in industrial demand, while research platforms can identify technological hotspots and innovation directions through data analysis<sup>[5]</sup>. At the same time, enterprises' talent-demand information can more rapidly enter university curriculum reform and research collaboration processes.

Figure1: Mechanism Transmission Diagram of Digital-Intelligent Technologies Empowering the Integrated Development of Education, Science and Technology, and Talent in Zhejiang



### 3.3 Collaborative Innovation Mechanism

In the past, innovation activities were mostly promoted independently by universities, research institutions or enterprises, and the depth of cooperation among different actors was relatively limited<sup>[6]</sup>. Universities placed greater emphasis on theoretical research, while enterprises paid more attention to practical application. Therefore, the cycle for transforming research outcomes was relatively long, and talent cultivation was prone to becoming disconnected from industrial demand.

After the rapid development of the digital economy and the artificial intelligence industry, scientific and technological innovation has created an increasing demand for multi-actor coordination. Enterprises have begun to participate more deeply in university research and talent-cultivation processes, while universities can acquire industrial technology needs and market-change information in a timelier manner<sup>[7]</sup>. The development of university-enterprise joint laboratories, industrial colleges and collaborative R&D platforms has further strengthened resource linkages among universities, research institutions and enterprises. Industrial demand can directly enter the research and talent-cultivation processes, while university research outcomes can enter industrial application scenarios more quickly.

### 3.4 Intelligent Governance Mechanism

As the connections among educational governance, science and technology governance and talent governance continue to strengthen, traditional hierarchical governance models have become increasingly unable to meet the operational needs of complex coordination systems<sup>[8]</sup>. In the past, information feedback among different governance actors was relatively slow, and resource adjustment relied heavily on manual management, resulting in limited overall coordination efficiency.

With the promotion of digital-intelligent technologies, the information-linkage capacity among educational governance, science and technology governance and talent governance has been significantly enhanced. The government can use digital platforms to coordinate educational, research and talent resources; universities can obtain industrial and policy information in a timelier manner; and enterprises can participate more directly in research collaboration and talent governance<sup>[9]</sup>. Coordination among educational-resource allocation, research management and talent services has also continued to improve. Industrial demand can be fed back more quickly into the education system and the science and technology innovation system, and the efficiency of information linkage among different governance actors has accordingly increased.

## 4. Measurement Design for the Support Level of Digital-Intelligent Technology Empowerment Mechanisms

### 4.1 Measurement Indicator System

Focusing on the four mechanisms of platform connectivity, data-driven coordination, collaborative innovation and intelligent governance, this paper constructs a measurement system for the mechanism-support level of the integrated development of education, science and technology, and talent in Zhejiang. The purpose is to observe, from a data perspective, the practical foundation and operational intensity of digital-intelligent technology empowerment mechanisms. The system includes four first-level indicators, eight second-level indicators and sixteen third-level indicators. The specific indicators, calculation methods, indicator attributes and data sources are shown in Table 1.

*Table 1: Measurement Indicator System for Digital-Intelligent Technology Empowerment Mechanisms in the Integrated Development of Education, Science and Technology, and Talent in Zhejiang*

First-level Indicator	Second-level Indicator	Third-level Indicator	Attribute	Data Source
Platform Connectivity Mechanism	Network Access Foundation	Number of fixed broadband Internet access users	Positive	Zhejiang Statistical Communiques; Zhejiang Statistical Yearbook
		Mobile Internet access traffic	Positive	Zhejiang Statistical Communiques; Zhejiang Statistical Yearbook
	Resource Carrying Pressure	Student-teacher ratio in regular higher education institutions	Negative	Zhejiang Statistical Yearbook
		Urban registered unemployment rate	Negative	Zhejiang Statistical Communiques; Zhejiang Statistical Yearbook

First-level Indicator	Second-level Indicator	Third-level Indicator	Attribute	Data Source
Data-Driven Mechanism	Digital Industry Foundation	Added value of core digital-economy industries	Positive	Zhejiang Statistical Communiques; Zhejiang Statistical Yearbook; provincial public digital-economy data
		Added value of information transmission, software and information technology services	Positive	Zhejiang Statistical Yearbook
	Digital Application Diffusion	Online retail sales of physical goods	Positive	Zhejiang Statistical Communiques; Zhejiang Statistical Yearbook; provincial e-commerce public data
		Express delivery volume	Positive	Zhejiang Statistical Communiques; Zhejiang Statistical Yearbook; postal administration public data
Collaborative Innovation Mechanism	Innovation Input Capacity	R&D expenditure	Positive	National Bureau of Statistics; National Statistical Communique on R&D Expenditure; Zhejiang Statistical Yearbook
		R&D intensity	Positive	National Bureau of Statistics; National Statistical Communique on R&D Expenditure; Zhejiang Statistical Yearbook
	Innovation Transformation Pressure	R&D input per patent authorization	Negative	Zhejiang Statistical Yearbook; CNIPA; Zhejiang Intellectual Property Administration public data
		R&D input per invention patent authorization	Negative	Zhejiang Statistical Yearbook; CNIPA; Zhejiang Intellectual Property Administration public data
Intelligent Governance Mechanism	Governance Actor Carrying Capacity	Cumulative number of valid high-tech enterprises	Positive	Zhejiang Provincial Department of Science and Technology and relevant annual public data
		Asset-liability ratio of industrial enterprises above designated size	Negative	Zhejiang Statistical Yearbook
	Institutional Supply Capacity	Number of national enterprise technology centers	Positive	Zhejiang Provincial Development and Reform Commission, economic and information departments, and national enterprise technology center lists
		Cost per RMB 100 of operating revenue of industrial enterprises above designated size	Negative	Zhejiang Statistical Yearbook

## 4.2 Measurement Method

After constructing the indicator system, this paper further adopts range standardization, the entropy weight method and the linear weighted method to measure the support level of Zhejiang’s digital-intelligent technology empowerment mechanisms. Through these treatments, indicators of different types and units can be transformed into comparable data results, thereby providing a basis for the subsequent assessment of operational differences and weak links among the four mechanisms.

### 4.2.1 Data standardization:

(1)Formula for standardizing positive indicators:

$$X'_{ij} = \frac{X_{ij} - X_{\min}}{X_{\max} - X_{\min}} \times 0.99 + 0.01$$

(2)Formula for standardizing negative indicators:

$$X'_{ij} = \frac{X_{\max} - X_{ij}}{X_{\max} - X_{\min}} \times 0.99 + 0.01$$

**4.2.2 Determining indicator weights by the entropy weight method:**

$$p_{ij} = \frac{r_{ij}}{\sum_{i=1}^m r_{ij}}$$

$$e_j = -\frac{1}{\ln m} \sum_{i=1}^m p_{ij} \ln p_{ij}$$

$$g_j = 1 - e_j$$

$$w_j = \frac{g_j}{\sum_{j=1}^n g_j}$$

**4.2.3 Building the comprehensive evaluation model based on the linear weighted method:**

$$y_i = \sum_{j=1}^n w_j \cdot r_{ij}$$

**4.3 Descriptive Statistics**

From 2015 to 2024, the relevant indicators for digital-intelligent technologies empowering the integrated development of education, science and technology, and talent in Zhejiang generally show a sound growth foundation. Zhejiang’s digital infrastructure has reached a certain scale, and its network access and carrying capacity have continued to improve. The average number of fixed broadband Internet access users is 28.202 million, and mobile Internet access traffic increased from 620 million GB to 18.670 billion GB. However, pressure on educational-resource carrying capacity and talent matching still requires attention. According to the data, the average student-teacher ratio in regular higher education institutions is 17.04, and the average urban registered unemployment rate is 2.58%. Meanwhile, Zhejiang’s digital-industry foundation and digital-application scenarios have continued to expand. The average added value of core digital-economy industries is RMB 745.119 billion; the average added value of information transmission, software and information technology services is RMB 345.200 billion; online retail sales of physical goods average RMB 1,531.150 billion; and express delivery volume averages 16.207 billion pieces. Zhejiang has also maintained a relatively high level of investment in scientific and technological innovation. Its average R&D expenditure is RMB 184.996 billion, with a maximum of RMB 290.140 billion, and its average R&D intensity is 2.74%. However, average R&D input per 10,000 patent authorizations is RMB 5.524 billion, and average R&D input per 10,000 invention patent authorizations is RMB 41.347 billion, indicating that pressure remains in transforming innovation input into innovation output. The scale of Zhejiang’s innovation actors is continuing to expand: the average number of valid high-tech enterprises is 23,547.40, the average number of national enterprise technology centers is 125.90, the average asset-liability ratio of industrial enterprises above designated size is 54.45%, and the average cost per RMB 100 of operating revenue is RMB 84.84. Nevertheless, enterprise operating pressure and governance-operation pressure still need to be further alleviated. Overall, Zhejiang already has a strong practical foundation for digital-intelligent technologies to empower the integrated development of education, science and technology, and talent. However, educational-resource carrying capacity, talent matching, innovation-transformation efficiency and industrial operating pressure remain key areas for subsequent mechanism optimization

Table2: Descriptive Statistics

Variable	Mean	SD	Min	p25	p50	p75	Max
Fixed broadband Internet access users (10,000 households)	2820.20	731.15	1316.00	2510.75	2860.50	3329.25	3767.00
Mobile Internet access traffic (100 million GB)	94.13	71.14	6.20	30.65	89.05	156.53	186.70

Variable	Mean	SD	Min	p25	p50	p75	Max
Student-teacher ratio in regular HEIs (students/teacher)	17.04	0.53	16.47	16.59	16.91	17.41	17.95
Urban registered unemployment rate (%)	2.58	0.14	2.38	2.48	2.58	2.67	2.82
Added value of core digital-economy industries (RMB 100 million)	7451.19	2081.59	4680.00	5930.00	7094.95	8819.75	11060.00
Added value of information transmission, software and IT services (RMB 100 million)	3452.00	1217.14	1850.00	2470.00	3320.00	4427.50	5320.00
Online retail sales of physical goods (RMB 100 million)	15311.50	3914.82	7611.00	13751.75	16376.50	17742.25	20210.00
Express delivery volume (100 million pieces)	162.07	96.01	38.30	84.50	150.25	228.75	322.00
R&D expenditure (RMB 100 million)	1849.96	658.59	1011.20	1311.15	1764.85	2352.03	2901.40
R&D intensity (%)	2.74	0.35	2.36	2.44	2.62	3.07	3.22
R&D input per patent authorization (RMB 100 million/10,000 patents)	55.24	9.65	43.03	48.27	52.80	59.02	72.35
R&D input per invention patent authorization (RMB 100 million/10,000 patents)	413.47	37.41	371.97	382.96	409.46	435.23	491.12
Cumulative valid high-tech enterprises (enterprises)	23547.40	14154.26	7905.00	12258.75	19237.00	33708.75	47500.00
Asset-liability ratio of industrial enterprises above designated size (%)	54.45	0.84	53.10	53.85	54.35	55.05	55.80
National enterprise technology centers (centers)	125.90	15.49	105.00	113.50	126.00	135.75	152.00
Cost per RMB 100 operating revenue of industrial enterprises above designated size (RMB)	84.84	0.30	84.40	84.62	84.85	85.05	85.30

## 5. Analysis of the Support Level and Weak Links of Digital-Intelligent Technology Empowerment Mechanisms

### 5.1 Analysis of Mechanism Weight Results

The weight results show that the intelligent governance mechanism has the highest weight, totaling 0.2702. This indicates that governance-actor carrying capacity, industrial operating pressure and institutional supply capacity have an important impact on digital-intelligent technologies empowering the integrated development of education, science and technology, and talent in Zhejiang. It is followed by the collaborative innovation mechanism, with a total weight of 0.2593. In this mechanism, R&D input per patent authorization and R&D input per invention patent authorization indicate that pressure remains in Zhejiang's innovation transformation. The data-driven mechanism ranks next, with a total weight of 0.2541, showing that the digital-industry foundation and the diffusion of digital applications provide strong support for mechanism operation. The platform connectivity mechanism ranks last, with a total weight of 0.2163. Platform foundations, educational-resource carrying capacity and talent-matching pressure jointly affect resource-connection efficiency. These results indicate that Zhejiang needs to further alleviate pressure on innovation transformation, enterprise operations and talent matching, so that digital-intelligent technologies can better serve the integrated development of education, science and technology, and talent.

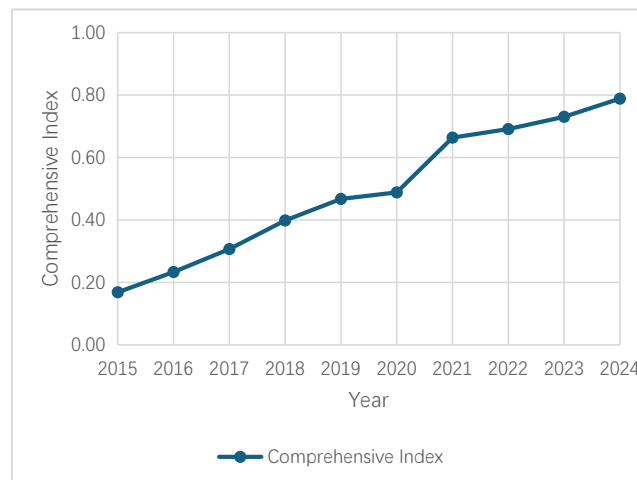
Table3: Indicator Weight Results Based on the Entropy Weight Method

First-level Indicator	Second-level Indicator	Third-level Indicator	Weight
Platform Connectivity Mechanism	Network Access Foundation	Fixed broadband Internet access users (10,000 households)	0.0356
		Mobile Internet access traffic (100 million GB)	0.0847
	Resource Carrying Pressure	Student-teacher ratio in regular HEIs (students/teacher)	0.0499
		Urban registered unemployment rate (%)	0.0461
Data-Driven Mechanism	Digital Industry Foundation	Added value of core digital-economy industries (RMB 100 million)	0.0686
		Added value of information transmission, software and IT services (RMB 100 million)	0.0722
	Digital Application Diffusion	Online retail sales of physical goods (RMB 100 million)	0.0394
		Express delivery volume (100 million pieces)	0.0739
Collaborative Innovation Mechanism	Innovation Input Capacity	R&D expenditure (RMB 100 million)	0.0759
		R&D intensity (%)	0.1008
	Innovation Transformation Pressure	R&D input per patent authorization (RMB 100 million/10,000 patents)	0.0473
		R&D input per invention patent authorization (RMB 100 million/10,000 patents)	0.0353
Intelligent Governance Mechanism	Governance Actor Carrying Capacity	Cumulative valid high-tech enterprises (enterprises)	0.0944
		Asset-liability ratio of industrial enterprises above designated size (%)	0.0518
	Institutional Supply Capacity	National enterprise technology centers (centers)	0.0675
		Cost per RMB 100 operating revenue of industrial enterprises above designated size (RMB)	0.0565

### 5.2 Analysis of the Comprehensive Index

From 2015 to 2024, the comprehensive index of digital-intelligent technologies empowering the integrated development of education, science and technology, and talent in Zhejiang generally showed a continuous upward trend. From 2015 to 2020, the basic conditions for digital-intelligent technology empowerment in Zhejiang gradually took shape, and the comprehensive index rose steadily from 0.1684 in 2015 to 0.4883 in 2020. After 2021, the index increased at a faster pace, the comprehensive effects of the various mechanisms were further strengthened, and the index reached 0.7886 in 2024, representing a notable overall improvement. The continuous rise of the comprehensive index shows that Zhejiang has moved from the earlier stage of digital infrastructure construction into a stage characterized by mechanism coordination and capacity enhancement.

Figure2: Changes in the Comprehensive Index from 2015 to 2024



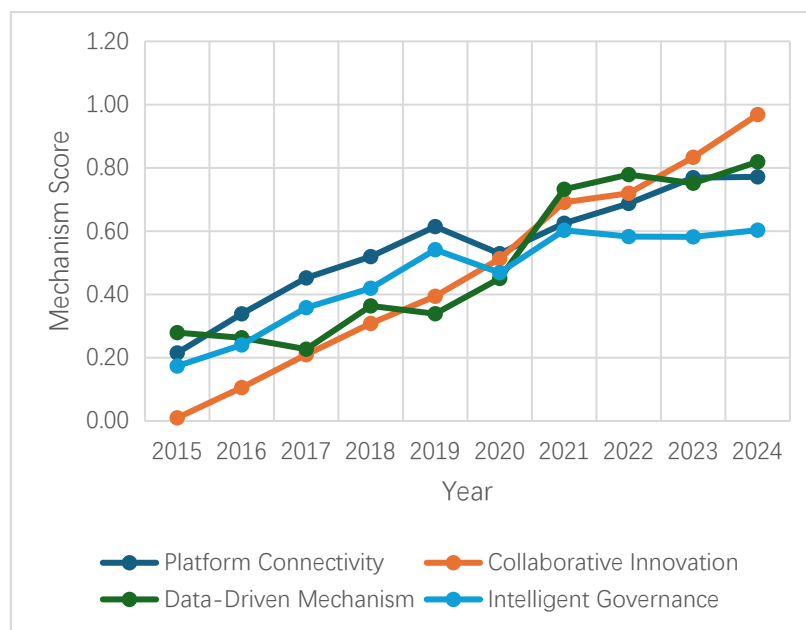
### 5.3 Analysis of the Support Levels of the Four Mechanisms

As shown in Figure 5-4, the support levels of the four mechanisms have all increased over the past decade, indicating that platform connectivity, data-driven coordination, collaborative innovation and intelligent governance have continuously strengthened their support for integrated development. In 2024, the platform connectivity mechanism scored 0.7717, the data-driven mechanism scored 0.9686, the collaborative innovation mechanism scored 0.8193, and the intelligent governance mechanism scored 0.6032. Overall, the gaps among the four mechanisms have gradually narrowed, and Zhejiang already has a solid comprehensive foundation for the integrated development of education, science and technology, and talent empowered by digital-intelligent technologies.

Specifically, the platform connectivity mechanism improved relatively early, reflecting Zhejiang’s strong foundation in network access and platform carrying capacity. Nevertheless, indicators such as the student-teacher ratio in regular higher education institutions and the urban registered unemployment rate also suggest that educational-resource carrying capacity and talent matching still need to be optimized. The data-driven mechanism maintained an overall upward trend, indicating the continuous expansion of the digital-industry foundation and digital-application scenarios. However, improvement in the data-driven mechanism does not mean that data have been fully utilized; functional departments still need to strengthen data sharing and feedback. The collaborative innovation mechanism also continued to improve, while data on R&D input per patent authorization and per invention patent authorization show that pressure remains in transforming research input into innovation output. The intelligent governance mechanism improved more rapidly in the later period, reflecting the continuous strengthening of actor support from high-tech enterprises and enterprise technology centers. However, enterprise operating pressure and governance-adjustment pressure still require attention.

Therefore, future practical pathways should, on the basis of continuing to enhance collaborative innovation capacity, further improve data sharing, substantive platform connectivity and intelligent-governance rules. At the same time, attention should be paid to educational-resource carrying capacity, talent matching, innovation-transformation efficiency and enterprise operating pressure, so as to promote the four mechanisms to shift from “basic strengthening” toward “coordinated efficiency enhancement”.

Figure3: Changes in the Support Levels of the Four Mechanisms from 2015 to 2024



## 6. Practical Pathways for Digital-Intelligent Technologies to Empower the Integrated Development of Education, Science and Technology, and Talent in Zhejiang

At present, Zhejiang still faces problems such as insufficient depth of collaborative innovation, inadequate data sharing and feedback, the need to further strengthen substantive platform connectivity, and the need to improve rules for intelligent

governance. In the future, Zhejiang should further leverage digital-intelligent technologies in resource integration, data transformation, collaborative innovation and risk governance. Specifically, it should improve practical pathways in four respects: platform connectivity, data sharing, collaborative innovation and intelligent governance, thereby promoting the deep integration of the education chain, innovation chain, industrial chain and talent chain.

### **6.1 Improving the Platform Connectivity System to Promote Coordinated Integration of Education, Science and Technology, and Talent Resources**

Platform connectivity is the basic prerequisite for digital-intelligent technologies to empower the integrated development of education, science and technology, and talent. Under the traditional governance model, education platforms, research platforms and talent-service platforms often operate independently. The lack of a unified connectivity mechanism among different departments can easily lead to problems such as resource dispersion, information barriers and insufficient coordination efficiency. With the continuous advancement of digital reform, digital platforms have gradually become important carriers of resource integration and collaborative governance<sup>[2]</sup>.

The key to platform connectivity lies in using a unified platform system to promote the optimization of the governance structure. At present, platforms such as Zheli Ban, Zhejiang Government DingTalk and the Hangzhou City Brain have formed a certain foundation for digital governance. However, education governance, science and technology governance and talent governance still face some degree of platform fragmentation. Zhejiang should continue to improve its unified platform system by unifying data standards, optimizing platform interfaces and improving platform operating mechanisms, thereby continuously strengthening the coordinated allocation capacity among educational, scientific and technological, and talent resources<sup>[3]</sup>. At the same time, universities, research institutions, enterprises and the government also need to rely on digital platforms to establish long-term coordination mechanisms that promote the coordinated operation of education, science and technology, and talent.

### **6.2 Improving the Data-Sharing Mechanism to Enhance the Allocation Efficiency of Education, Science and Technology, and Talent Resources**

Data sharing is a core support for promoting the coordinated development of education, science and technology, and talent. Although Zhejiang has already developed strong digital-governance capacity, certain data barriers still exist among different departments and platforms. Some data resources have not yet achieved effective connectivity, making it difficult to form precise matching relationships among education and training, scientific and technological innovation and industrial demand. Improving data-sharing capacity requires promoting a shift in resource allocation from traditional experience-driven approaches toward data-driven approaches. Zhejiang should strengthen public-data openness and data-resource integration, and continuously improve data development and utilization capacity through artificial intelligence, big-data analysis and intelligent algorithms<sup>[5]</sup>. Specifically, universities can use industrial data analysis to dynamically adjust program structures and talent-cultivation plans; research institutions can rely on data connectivity to optimize research directions and pathways for achievement transformation; and the government can use data analysis to improve the precision of talent policies and resource allocation. Meanwhile, universities, research institutions and enterprises should strengthen data coordination and resource sharing, so as to achieve coordinated connectivity among educational data, research data and industrial data and improve resource-allocation efficiency as well as collaborative-governance capacity.

### **6.3 Deepening the Construction of a Collaborative Innovation System to Promote Deep Integration of the Education Chain and the Industrial Chain**

Collaborative innovation is a key pathway for promoting the integrated development of education, science and technology, and talent. Zhejiang has already formed a collaborative innovation system represented by Zhejiang Lab, the West Hangzhou Science and Technology Innovation Corridor and artificial intelligence industrial clusters. However, some university-enterprise cooperation still remains at the level of project collaboration, and a stable coordination structure among the education chain, innovation chain and industrial chain has not yet truly taken shape.

The focus of constructing a collaborative innovation system is to create a coordinated linkage mechanism among education and training, scientific and technological innovation and industrial application. Universities need to dynamically optimize

their program structures and curriculum systems in light of the development needs of emerging industries such as the digital economy, artificial intelligence and intelligent manufacturing, and strengthen the cultivation of interdisciplinary digital talent<sup>[6]</sup>. At the same time, enterprises need to participate more deeply in talent cultivation and research collaboration, gradually forming a coordinated development model of “education and training - scientific and technological innovation - industrial application”. Through platform connectivity, resource sharing and joint research and development, relevant functional departments can form a stable innovation ecosystem, thereby continuously improving regional innovation capacity and the quality of talent cultivation.

#### **6.4 Improving the Intelligent Governance System to Enhance Coordinated Governance Capacity for Education, Science and Technology, and Talent**

Intelligent governance is an important guarantee for digital-intelligent technologies to empower the coordinated development of education, science and technology, and talent. At present, artificial intelligence technologies have been widely applied in areas such as educational evaluation, research management and talent services. However, problems including data security, algorithmic bias and the digital divide have also gradually emerged. Therefore, Zhejiang needs to continue improving systems for data security, privacy protection and algorithmic regulation, and strengthen the construction of digital-governance institutions<sup>[8]</sup>.

The construction of an intelligent governance system aims to promote a shift in governance models from traditional departmental governance toward holistic governance<sup>[12]</sup>. On the one hand, Zhejiang needs to strengthen the security governance of educational data, research data and talent data, improve standards for data collection, storage and use, and prevent data leakage and information-security risks. On the other hand, it also needs to strengthen algorithmic ethics governance, promote the standardized application of artificial intelligence technologies, and avoid algorithmic bias and digital-divide problems<sup>[9]</sup>. At the same time, Zhejiang should continue to improve digital-governance capacity and digital literacy, so that educational governance, science and technology governance and talent governance become fairer, more transparent and more intelligent.

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#### **Conflict of Interests**

The authors declare that there is no conflict of interest regarding the publication of this paper.

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