Chapter 5
Report on China Smart Education Development Index 2022 (Composite Index)

The digital transformation in education has become an important topic of common concern of the international community. In September 2022, the 2022 United Nations Transforming Education Summit launched an initiative, hoping that the international community can focus on digital learning and its transformation, jointly promote the construction of digital learning platforms, and make education more inclusive, equitable, effective and sustainable.

Right now, changes of the world, of our times and of history are unfolding in education. China follows the trend, firmly promotes the digitalization in education, explores the form of intelligent education, and lays a solid foundation for building a society and country of learning where lifelong learning is pursued by all.

In order to gather consensus, evaluate progress, and effectively promote the vivid practice of smart education, CNAES have explored and constructed China Smart Education Development Index and China Smart Education Development Index for three sub-sectors (basic education, vocational education, and higher education), named as the "1 + 3" China Smart Education Development Index. The Index is based on the reality and characteristics of China's smart education development, on the basis of absorbing relevant research results and work experience at home and abroad, and committed to objectively reflecting the development level of China's smart education. The Index provides China's solutions for the vigorous development of global smart education.

The indicator system of China Smart Education Development and three sub-sector indicator systems are consistent in the dimensions and sub-dimensions. The third level indicators are different among three subfields according to the characteristics of education development in each field. Each index is independent and incomparable. See Chaps. 6–8 for the development index of smart education in each subfield.

Chapter 1 focuses on the construction process and measurement methods of China Smart Education Development Index. The current chapter and the following chapters

intend to present the results of the measurement, analyze the main achievements and deficiencies of China's smart education development in combination with Chinese context, and look forward to the important trend of China's smart education development in the future. Part II as a whole provides indicator analysis and data support for the overall understanding of China's smart education development.

5.1   Indicators

The Smart Education Development Index is calculated based on the Indicator System of Smart Education Development. The evaluation index system of smart education development is a bridge connecting the theory and practice of smart education, a yardstick to measure the development level of smart education, and an important tool to guide and lead the development of smart education.

The Indicator System of Smart Education Development takes the core index model as the design framework. Based on fully reflecting the connotations and characteristics of intelligent education, it consists of four primary dimensions: environment, teaching and learning, governance, and talent literacy, and 12 sub-dimensions, including facilities, equipment, and digital education resources, with a total of 32 indicators (see Table 5.1). For the specific data source of each indicator, see "Appendix A: Explanations for the Indicator System of Smart Education Development".

The measured data of China Smart Education Development Index is mainly from the departments of Ministry of Education, such as the Department of Development Planning, the Department of Science, Technology and Informatization, the Department of Basic Education, the Department of Vocational and Adult Education, the Department of Higher Education, the Department of Teacher Education. Data also comes from the Center for Scientific Research and Development in Higher Education Institutes, Ministry of Education, National Center for Educational Technology (National Resource Center for Basic Education, Ministry of Education), Higher Education Evaluation Center, Higher Education Press, Educational Informatization Strategy Research Base (Central China), Ministry of Education and other relevant departments, bureaus and units, as well as some data in Digital Economy and Social Index, 2019 Global Competitiveness Report, 2022 Global Digital Overview Report.

In the data collection and calculation process of China Smart Education Development Index, the missing data is processed according to different situations. For indicators that data cannot be collected but have alternative indicator with available data, the alternative indicator data is used in the calculation. For indicators that both its data and alternative indicator data are not available temporarily, the indicators are not used in calculation. The indicators of which data cannot be normalized due to no theoretical optimal value are not included in the index calculation. For indicators with available but insufficient data, existing data is used to calculate the index. As a result, 20 out of the 32 indicators engage in the calculation of China Smart Education Development Index.

Table 5.1 Indicator system of smart education development

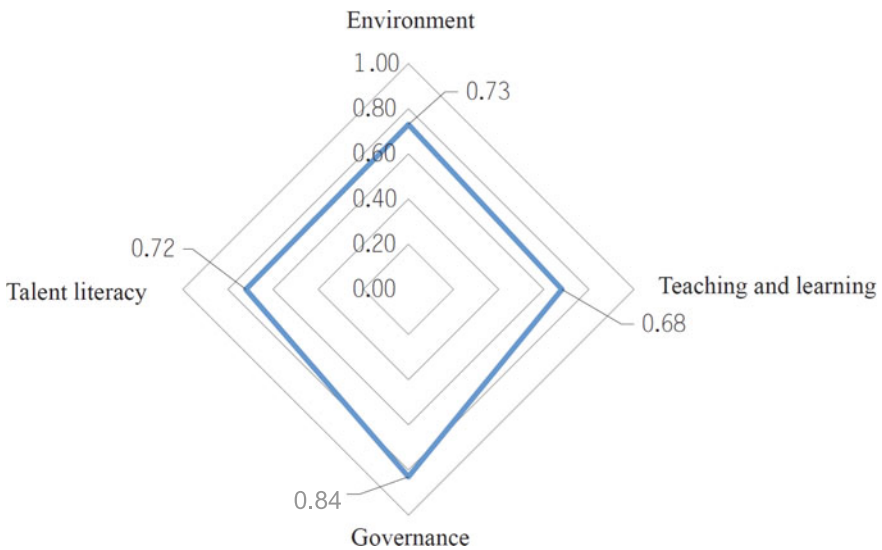| Dimension	Sub-dimension	Indicator
Environment	ICT infrastructure	Percentage of educational institutions with a broadband connection, including both fixed and mobile (%)
		Percentage of educational institutions with WLANs network coverage (%)
		Percentage of classrooms with multimedia device(s) (%)
		Number of digital devices per teacher (device/person)
	Digital educational resources	Average amount of digital educational resources by person (piece/person)
		Number of digital curricular resources per 100 students (class hours/100 people)
		Coverage rate of digital educational resources (%) ★
	Cyber learning space	Percentage of teachers with cyber learning space (%)
		Percentage of students with cyber learning space (%)
Teaching and learning	Digital literacy of teachers	Proportion of teachers with sufficient digital literacy (%)
	Utilization of resources	Effective utilization rate of public digital educational resources (%) ★
		Effective utilization rate of curricular resources on the Smart Education of China platform (%)
		User activity indices of the Smart Education of China platform (time/person)
		Hit rate of resources recommended to users by the Smart Education of China platform (%) ★
	Transformation in teaching and learning practices	Coverage rate of hybrid education (%)
		Coverage rate of online teacher training (%)
		Coverage rate of online personalized learning (%) ★
		Percentage of users learning with online videos (%)
	Transformation in assessments	Coverage rate of ICT-based formative assessments (%) ★
		Coverage rate of AI-based assessments (%) ★
Governance	Data accessibility	Percentage of students, teachers and institutions in which the identity data was collected in (national) core database(s) (%)
		Percentage of region-level educational management system in which data is available to national Education Data Exchange Network (%) ★
	ICT-based management	Coverage rate of one-stop online educational affairs and services (%)
		Coverage rate of ICT engaged educational supervision (%) ★
		Percentage of educational institutions with ICT-related policy (%)

Table 5.1 (continued)

Dimension	Sub-dimension	Indicator
		Percentage of educational institutions with data-driven decision-making process (%)
	Cyber and data security	Percentage of schools with cybersecurity policy (%)
Talent literacy	Digital literacy of students	Proportion of students with sufficient digital literacy (%)
		Percentage of graduates from ICT-related majors (%)
		Indices of students' lifelong learning ability ★
	Laborer digital skills	Indices of average digital skills of population between ages 16 and 74
		Indices of digital skills among active population

Note ★ indicates that data is temporarily unavailable, and the rest is the same

5.2 Calculation Results

5.2.1 General Description

The China Smart Education Development Index 2022 is 0.74. Among them, the Environment index is 0.73, the Teaching and learning index is 0.68, the Governance index is 0.84, and the Talent literacy index is 0.72 (see Fig. 5.1).

Fig. 5.1 The result of China smart education development index 2022

Table 5.2 Index values of environment dimension

Sub-dimension	Indicator	Value
ICT infrastructure	Percentage of educational institutions with a broadband connection, including both fixed and mobile (%)	98.85
	Percentage of educational institutions with WLANs network coverage (%)	75.52
	Percentage of classrooms with multimedia device(s) (%)	71.82
	Number of digital devices per teacher (device/person)	0.98
Digital educational resources	Average amount of digital educational resources by person (piece/person)[1]	—
	Number of digital curricular resources per 100 students (class hours/100 people)[2]	—
	Coverage rate of digital educational resources (%) ★	—
Cyber learning space	Percentage of teachers with cyber learning space (%)	65.21
	Percentage of students with cyber learning space (%)	53.08

Note If there is no specific description, "—" in the table indicates that there is no data for this indicator, and the rest is the same

5.2.2   Results of Each Dimension

i. Environment index

The Environment index is 0.73. Among them, the ICT infrastructure index is 0.86, and the Cyber learning space index is 0.59. See Table 5.2 for the index values.

ii. Teaching and learning index

The Teaching and learning index is 0.68. Among them, the Digital literacy of teachers index is 0.87, the Utilization of resources index is 0.60, and the Transformation in teaching and learning practices index is 0.58. See Table 5.3 for the index values.

iii. Governance index

The governance index is 0.84. Among them, the Data accessibility index is 1.00, the ICT-based management is 0.66, and the Cyber and data security index is 0.85. See Table 5.4 for the index values.

iv. Talent literacy index

The Talent literacy index is 0.72. Among them, Digital literacy of students index is 0.89, and Laborer digital skills index is 0.54. See Table 5.5 for the index values.

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[1] The theoretical maximum and minimum values of the index data cannot be determined temporarily, and will not be included in the index calculation in 2022.

[2] Same as above.

Table 5.3 Index values of teaching and learning dimension

Sub-dimension	Indicator	Value
Digital literacy of teachers	Proportion of teachers with sufficient digital literacy (%)	86.50
Utilization of resources	Effective utilization rate of public digital educational resources (%) ★	—
	Effective utilization rate of curricular resources on the Smart Education of China platform(%)	59.99
	User activity indices of the Smart Education of China platform (time/person)[3]	—
	Hit rate of resources recommended to users by the Smart Education of China platform (%) ★	—
Transformation in teaching and learning practices	Coverage rate of hybrid education (%)	78.97
	Coverage rate of online teacher training (%)	54.62
	Coverage rate of online personalized learning (%) ★	—
	Percentage of users learning with online videos (%)	40.90
Transformation in assessments	Coverage rate of ICT-based formative assessments (%) ★	—
	Coverage rate of AI-based assessments (%) ★	—

Table 5.4 Index values of governance dimension

Sub-dimension	Indicator	Value
Data accessibility	Percentage of students, teachers and institutions in which the identity data was collected in (national) core database(s) (%)	100.00
	Percentage of region-level educational management system in which data is available to national Education Data Exchange Network (%) ★	—
ICT-based management	Coverage rate of one-stop online educational affairs and services (%)	57.31
	Coverage rate of ICT engaged educational supervision (%) ★	—
	Percentage of educational institutions with ICT-related policy (%)	82.32
	Percentage of educational institutions with data-driven decision-making process (%)	58.74
Cyber and data security	Percentage of schools with cybersecurity policy (%)	84.90

[3] The theoretical maximum and minimum values of the index data cannot be determined temporarily, and will not be included in the index calculation in 2022.

Table 5.5 Index values of talent literacy dimension

Sub-dimension	Indicator	Value
Digital literacy of students	Proportion of students with sufficient digital literacy (%)	78.79
	Percentage of graduates from ICT-related majors (%)	40.77
	Indices of students' lifelong learning ability ★	—
Laborer digital skills	Indices of average digital skills of population between ages 16 and 74[4]	47.00
	Indices of digital skills among active population[5]	4.70

5.3 Achievements and Deficiencies

5.3.1 Achievements

i. Intelligent infrastructure, equipment and environment in education have been basically completed

Since the twenty-first century, especially since the 18th CPC National Congress in 2012, China has issued policies such as the *Ten Year Plan for the Development of Education Informatization (2011–2020), the 13th Five Year Plan for Education Informatization, and the 2.0 Action Plan for Education Informatization*, to implement China's Strategic Action Plan for Education Digitalization, promote the construction of new educational infrastructure, and increase financial investment in infrastructure equipment for Education Informatization. After years of development, the proportion of schools connected to the internet in China has reached nearly 100%, more than three quarters of schools have been fully covered by wireless networks, more than 70% of classrooms are network multimedia classrooms, and digital terminals for teachers' teaching are popularized. The digital facilities of school has been significantly improved. It has laid a solid foundation for smart education from the "network" and "equipment" aspects of the digital environment.

ii. Digital literacy of primary and secondary school teachers has been improved comprehensively

China has successively implemented training programs such as the National Training Program, educational technology capability training, and national information technology application capability improvement project for primary and secondary school teachers, and formulated relevant standards such as the Standards for Information Technology Application Competence of Primary and Secondary School Teachers (Trial), and the Curriculum Standards for Information Technology Application

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[4] The index data adopts the measurement results in the series of reports of the European Commission's Digital Economy and Society Index, and the numerical range is [0,100].

[5] The index data adopts the measurement results in the Global Competitiveness Report 2019 of the World Economic Forum, and the numerical range is [1,7].

Competence Training for Primary and Secondary School Teachers (Trial). At present, China has completed the training for more than 10 million primary and secondary school teachers, more than 100,000 primary and secondary school principals, and more than 200,000 vocational college teachers to improve their ICT application ability. In this process, China has gradually accumulated a teacher training practice model that combines the whole school promotion, application orientation, and regular evaluation. The survey of teachers' digital literacy conducted by the Educational Informatization Strategy Research Base (Central China), Ministry of Education shows that more than 86% of teachers have the ability to apply information technology, laying a good human resource foundation for the implementation and development of smart education.

iii. Hybrid teaching and learning is increasingly popular

China actively promotes "internet plus education", constantly optimizes the supply of high-quality education resources, and provides effective support for promoting education fairness, quality improvement, and bridge the digital divide. In the field of basic education, China has strengthened the construction and application of "courier class", "famous teacher class" and "famous school network class", and selected and promoted the application of national online quality courses in the field of higher education and vocational education. At present, the number of MOOCs launched in China has exceeded 64,500, with 402 million registered users, 1,088 million learners. Especially during the prevention and control of the COVID-19, China's smart education has rapidly accumulated and effectively integrated, supporting the world's largest online teaching. Hybrid teaching in higher education has been fully popularized, while hybrid teaching in basic education has been popularized.

iv. The data base of education governance is basically established

China pays attention to establishing and improving the standard system of education management informatization, strives to build an education public management service platform, issues the Notice on Strengthening the Education Informatization Management in the New Era and other specific documents, and promotes the modernization of education governance. At present, the basic data of China's smart education governance is well established. Three major education basic databases of schools, teachers and students have been built, and the basic data collection and management of schools, teachers and students nationwide have been completed. "One school, one code" and "one person, one number" have become a reality, which has established a data base for education governance.

v. The policy of schools' management informatization and cybersecurity is relatively complete

Driven by the Platform for Action to Promote the Development of Big Data, the Guiding Opinions on Strengthening the Construction of Digital Government, the Notice on Strengthening the Informatization of Education Management in the New Era, and the construction norms of various digital campuses at all levels, over 80% of schools have established policy of information-based operation and management,

which has made full institutional preparations for promoting the practice of digital governance. China has also successively promulgated the Cybersecurity Law of the People's Republic of China, the Data Security Law of the People's Republic of China, the Personal Information Protection Law of the People's Republic of China and other laws. China has been vigorously promoting the construction of school cybersecurity. Nearly 85% of schools have adopted cybersecurity management systems, which firmly established the system for schools to carry out safe digital governance "Fence".

vi. Nearly 80% of primary and secondary school students have sufficient digital literacy

In order to cultivate citizens who meet the requirements of the development of the digital era and enable students to have the necessary quality and ability to study, work and live in the digital society, the Ministry of Education has issued a number of policy documents in recent years, deployed and implemented the comprehensive improvement action of students' information literacy, formulated the curriculum standards related to information literacy training, incorporated the evaluation of students' information literacy into the comprehensive quality evaluation, and strengthened the cultivation of students' information literacy. The result of the students' information literacy survey in the Educational Informatization Strategy Research Base (Central China), Ministry of Education shows that nearly 80% of the primary and secondary school students' digital literacy has reached the qualified level or above.

vii. The proportion of ict related professionals is relatively high in the world

In order to cultivate digital professionals and ensure the innovative development of China's digital economy and science and technology, planning documents such as the New Generation Artificial Intelligence Development Plan, the Fourteenth Five Year Digital Economy Development Plan, and Several Opinions on Deeply Promoting the Construction of World-class Universities and Disciplines require strengthening the training of digital technology skilled talents, and strengthening the training of science, industry, agriculture, medicine and interdisciplinary talents. The proportion of graduates in ICT-related disciplines in China is more than 40%. The professional structure is stable and at a high level internationally, which provides intellectual support for the development of economic industries in the digital era.

5.3.2 Deficiencies

i. The supply and service capacity of digital educational resources still needs to be improved

In March 2022, the Smart Education of China platform was put into operation, the supply of various high-quality digital resources continued to expand, and the number of registered users of the platform grew rapidly.

However, from the perspective of the coverage of registered users of the public digital education resource platform in the population, and the amount of digital education resources per capita and per student, as a comprehensive integrated platform of national education public services, the Smart Education of China platform still needs to continue to gather more diverse types, more complete subjects and better quality education resources, and strive to expand the coverage among teachers, students, parents and the public to benefit more people.

ii. The cyber learning spaces are not coverage to all student and teachers

In order to accelerate the construction of a learning society that "everyone can learn, everywhere can learn, and always can learn", and realize the normalized applications of space-based teaching and learning, teaching management, and education governance, China has strengthened the construction and application of cyber learning spaces, and carried out the popularization of cyber learning space applications for many years in a row. At present, the number of teachers' cyber learning spaces and students' cyber learning spaces are 9,737,600 and 115,388,000, respectively. The development goal of "one person, one space, and everyone uses space" has not been achieved. The awareness of teachers and students to open and use cyber learning spaces needs further improvement. The construction and application of "cloud" space in the basic environment of smart education still need to be continued.

iii. Smart teaching has not yet formed deep-level, regular and full-process application and reform

China's smart education is still lacking in reform and innovation at the teaching level, which is mainly reflected in the following aspects: the application level of smart teaching is not deep, only about half of primary and secondary school teachers and vocational school teachers carry out online research with the advantage of information technology such as the internet, and the popularity of students' online personalized learning needs to be improved; the interactive application of educational resources is not enough, especially the accuracy of interactive services is not high; the personalized, intelligent and accurate push services for users need to be improved and deepened; the reform of intelligent evaluation has not achieved obvious results. It is urgent to strengthen the popularization and application of digital teaching process evaluation and intelligent evaluation.

iv. The popularity of school data application needs to be improved

The construction of basic education data is to serve digital education governance. In order to effectively solve the prominent problems such as insufficient integration of educational management information system, poor data sharing, poor service experience, and repeated construction of facilities, the Ministry of Education requires the use of new generation information technology to improve the digital, networked, and intelligent level of educational management, and to promote the transformation of educational decision-making from experience-driven to data-driven. At present, less than 60% of schools apply all kinds of educational management information

system data to daily decision-making and management services, and the application rate of educational management data needs to be improved.

v. There is much room to improve the development of digital literacy of the whole nation

It is a necessary measure to promote workers to better adapt to digital production and lifestyle by focusing on the training of digital literacy for workers and improving their digital literacy and skills. The Fourteenth Five Year Plan for National Economic and Social Development of the People's Republic of China and the Outline of the Long term Goals for 2035 emphasized "strengthening digital skills education and training for all, and popularizing and improving citizens' digital literacy". In 2022, the Cyberspace Administration of China (CAC) issued the Action Outline for Upgrading Digital Literacy and Skills of the General Public, proposing the goal of "By 2025, the digital adaptability, competence and creativity of the general public …are expected to be on par with that of developed countries". Due to the short starting time of this action, China has not yet fully established a lifelong digital literacy learning system for all, especially for workers. The improvement of workers' digital literacy requires a long period of time.

The positive role of school education, continuing education and lifelong learning in improving workers' digital literacy needs to be accumulated in the later period.

5.4   Development Recommendations

5.4.1   Enhancing the Level of Data Connection Through Platform Optimization

i. Build a high-quality, fair and efficient public service platform for smart education

We are supposed to give priority to application and services, upgrade and improve the Smart Education of China platform. A learner-centered personalized learning and lifelong learning environment can be built based on extensively gathering high-quality educational resources, seamlessly integrating efficient learning tools, comprehensively tracking the learning process, proactively offering customized services. Dedicated to education equity, we will provide everyone with higher quality education resources and more convenient and reliable public services.

ii. Create a smart education ecosystem integrating the Internet of Things, big data and intelligent technology

We suggest to revitalize the existing resources of digital education and optimize the new resources, give full play to the role of data as a new factor of production, build an integrated infrastructure of "cloud-network-edge-device" based on the new

generation of information technology, speed up the deployment of IoT perception infrastructure in universities, promote the construction of smart campuses and smart laboratories, and build a new education ecosystem that integrates virtual and real scenes online and offline, and bridges activities on and off campus.

5.4.2   Transforming to a New Teaching and Learning Paradigm Around Deep Application of Technologies

i. Actively explore the innovative application of the new generation of information technology in education

We suggest to actively promote immersive and experiential teaching based on augmented reality and virtual reality, remote multi-location collaborative teaching based on 5G technology, inquiry and personalized learning based on artificial intelligence, to promote inter-disciplinary teaching, and remodel teaching processes and teaching modes. We supposed to encourage education institutions of all kinds at all levels to innovate management models and education methods based on the new generation of information technology, improve teachers' digital literacy, and promote deep changes in teaching and learning through collaboration between schools, families and society.

ii. Building a smart education evaluation system driven by big data

We recommend to innovate education evaluation methods by employing smart evaluation and big data analysis, and reform the evaluation methods and mechanisms in education development, talent training and selection through data collection, mining and analysis that cover all elements, the whole process and all dimensions. Blockchain and other technologies should be used to accelerate the construction of a credit certification and skills certification system for lifelong learning, and explore a common mechanism for recognizing different types of learning achievements and online and offline learning qualifications.

5.4.3   Developing Intelligent Governance in Education Powered by Big Data

i. Build a new mechanism of data-empowered collaborative education governance

We suggest to improve the functions of the government service platform for education integration, accelerate the data flow and collaborative application across departments, regions and government levels, and improve the overall effectiveness of digital education governance. A decision-making support platform for educational development

can be built to optimize the allocation of educational resources and factors, enable scientific management and trend prediction through comprehensive collection and analysis of educational, economic, social, and demographic data, so as to provide scientific and reliable evidence for educational decision-making.

ii. Improve standards for smart education development

We are supposed to improve governance systems such as information networks, platform systems, digital resources, smart campuses, innovative applications, and digital certification, establish and improve education platforms and data security assurance networks, and harmonize processes and standards for the collection, transmission and use of teacher and student information, as well as ethical codes on the application of artificial intelligence in education, so as to build an institutionalized, scientific, and standardized governance system for smart education.

5.4.4   Establishing an Innovative Pattern of Talent Cultivating Aiming at Nationwide Digital Literacy Improvement

i. Accelerate enhancing digital literacy of students

We recommend establishing digital literacy standards for teachers and students, incorporate digital literacy cultivation into the integrated education program for universities, middle schools and primary schools, and evaluate the progress of digital talent training system on a regular basis. According to the needs of social development, we suggest to promptly optimize the discipline design of vocational education and higher education, dynamically adjust the programs offered, and enhance the training of digital related professionals. With a focus on lifelong learning awareness, self-management, quality of thinking and adaptability, we suggest to innovate the training model for students' lifelong learning ability under the smart education environment, and cultivate talents capable of sustained learning and self-development.

ii. Improve nationwide digital literacy

We suppose to integrate resources in community education, elderly education network and various public learning service platforms, and expand the supply channels of high-quality resources for lifelong learning for all. Whole-life-cycle learning support should be provided for all people through digital means, so that everyone has access to learning resources anywhere and anytime. We also suggest to establish digital literacy standards for all people, regularly monitor lifelong learning needs and capabilities of the whole population, accelerate lifelong learning for all through digital education, and lay a solid foundation for building a learning society and a learning country.