Chapter 6
Report on China Smart Education Development Index 2022 (Basic Education)

A new round of accelerating technology revolution has important and far-reaching impacts on social development. As the Digital China continues to advance, the education sector has also rolled out China's Strategic Action Plan for Education Digitalization to leverage and incorporate existing and emerging information technologies such as the internet, big data, cloud computing and artificial intelligent. Basic education is also undergoing a transformation to smart education. Aiming at quality development, technologies can be applied in a wide range of scenarios in basic education: enhanced learning environment, teaching method renewals, campus governance and digital literacy for teachers /students, all contributing to goals of going smart. To reflect the level of smart education in China's basic education, this chapter constructs the Indicator System of Smart Education Development (Basic Education) as well as provides a set of recommendations based on a future vision of digital education.

6.1 Indicators

The Indicator System of Smart Education Development (Basic Education) has 4 dimensions (environment, teaching and learning, governance, and talent literacy). In total, 13 sub-dimensions (ICT infrastructure, digital educational resources, cyber learning space, digital literacy of teachers, utilization of resources, transformation in teaching and learning practices, transformation in assessments, pedagogical research, data accessibility, ICT-based management, cyber and data security, digital literacy of students, and digitalized learning experiences) with 35 indicators included in the indicator system (see Table 6.1).

The measured data of Index is mainly from the departments of Ministry of Education, such as Department of Development Planning, Department of Science,

China National Academy of Educational Sciences (CNAES), *Report on China Smart Education 2022*, SpringerBriefs in Education,
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Table 6.1 Indicator system of smart education development (basic education)

Dimension	Sub-dimension	Indicator
Environment	ICT infrastructure	Percentage of schools with a broadband connection, includes both fixed and mobile (%)
		Percentage of schools with WLANs network coverage (%)
		Percentage of classrooms with multimedia device(s) (%)
		Number of digital devices per 100 students (device / 100 people)
Environment	Digital educational resources	Number of open digital curricular resources for primary and secondary education (class hours)
		Number of open digital resources for pedagogical research for primary and secondary education (pieces)
	Cyber learning space	Percentage of teachers with cyber learning space (%)
		Percentage of students with cyber learning space (%)
Teaching and learning	Digital literacy of teachers	Number of ICT professionals in education per 100 students (people / 100 people)
		Number of ICT-related training per 100 teachers (times / 100 people)
		Proportion of teachers with sufficient digital literacy (%)
	Utilization of resources	Annual user activity indices of the Smart Education of China, Platform for Primary and Secondary Education (SEC-PPSE)
		Effective utilization rate of resources on the SEC-PPSE (%)
		Hit rate of resources recommended to users by the SEC-PPSE (%)
		Effective utilization of moral, physical, aesthetic, and labor education related resources on the SEC-PPSE (%)
	Transformation in teaching and learning practices	Coverage rate of hybrid education (%)
		Coverage rate of online personalized teaching (%)
		Coverage rate of ICT engaged classroom lessons (%)
		Coverage rate of ICT engaged homework assignments (%)
	Transformation in assessments	Number of ICT-based assessment patterns
		Coverage rate of ICT-based assessments (%)
	Pedagogical research	Average hours of teachers participating in online professional training per year (hours)
		Coverage rate of online pedagogical research (%)

(continued)

Table 6.1 (continued)

Dimension	Sub-dimension	Indicator
Governance	Data accessibility	Percentage of students, teachers, and schools in which the identity data was collected in (national) core database(s) (%)
		Percentage of region-level learning management systems join in 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 (%)
		Coverage rate of after-school service management system (%)
		Percentage of schools with ICT-related policy (%)
	ICT-based management	Percentage of schools with data driven decision-making process (%)
		Financial expenditure on ICT in education (%)
	Cyber and data security	Percentage of schools with cybersecurity policy (%)
Talent literacy	Digital literacy of students	percentage of students with satisfactory digital literacy (%)
		Indices of students' life-long learning ability among primary and secondary schools
	Digitalized learning experience	Indices of learning experience of users on SEC-PPSE

Note ★ indicates that data is temporarily unavailable

Technology and Informatization, Department of Basic Education, Department of Teacher Education. Data also comes from National Center for Educational Technology (National Resource Center for Basic Education, Ministry of Education), Educational Informatization Strategy Research Base (Central China), Ministry of Education and other relevant departments, bureaus, and units.

For indicator "Number of digital devices per 100 students", in view of common practices in China and internationally, the index opts for one device for every 7 students as the criterion, that is, 14.3 devices for every 100 students as the maximum value.[1] For indicator "Number of ICT professionals in education per 100 students", considering the average levels in developed countries, we decides to go with one

[1] Internationally, the average OECD countries for student-device ratio released in 2012 was 4.7:1, and it was 5.9:1 for South Korea in the same year. According to the UNESCO Institute for Statistics (UIS), in 2012, device-student ratio was 7:1 in Japan, 9:1 in Hong Kong, China. In the mainland of China, the ratio varied across regions between 30:1 and 6:1. Zhejiang Province in its 2011 "School Benchmarks for Compulsory Education Standardization" required a 7: 1. Jiangsu Provinces in its 2019 "Interim Indicators for Standardized Compulsory Education Schools" required 10:1 and 8:1 for primary and secondary schools respectively. After considering practices from various countries

ICT worker per 100 students as the maximum value. For indicators measured in standardized scores, we linearly transformed the original scores into a normalized value in the range of [0, 1] for further calculation.

In the data collection and calculation process of China Smart Education Development Index, the missing data is processed according to different situation. 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 neither its data nor alternative indicator data are available temporarily, they are not used in calculation. The indicators of which theoretical data range cannot be identified would not be normalized. These indicators 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, 26 out of the 35 indicators report available data, 20 of the 35 indicators engage in the calculation of China Smart Education Development Index (Basic Education).

6.2 Calculation Results

It is estimated that China Smart Education Development Index (basic education) is 0.74. As shown in Fig. 6.1, among the dimensions, the value of environment dimension is 0.72; the value of teaching and learning dimension is 0.62; the value of governance dimension is 0.81; and the value of talent literacy governance is 0.79. The results indicate teaching and learning is a weak link in the development of smart education in China, in the area of basic education.

6.2.1 Environment

The overall value of environment dimension is 0.72. For the sub-dimensions, the value of ICT Infrastructure is 0.82 and the value of cyber learning space is 0.62, showing the level of ICT infrastructure construction performs better than cyber learning space. As of September 2022, the Smart Education of China, Platform for Primary and Secondary Education (SEC-PPSE) offers 19,505 class hours of curricular resources; and the pedagogical research platform offers 10,507 class hours or entries.

For all provinces, the maximum value of environment dimension is 0.95. Fifteen provinces report values of environment dimension higher than 0.72. The results suggest the overall environment in most Chinese provinces are adequate for meeting the essential demands of smart education, and the material basis for educational transformation is already in place.

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and different regions in China and consulting domain experts, the index settled on 7:1 or 14.3 per hundred students as its standard value.

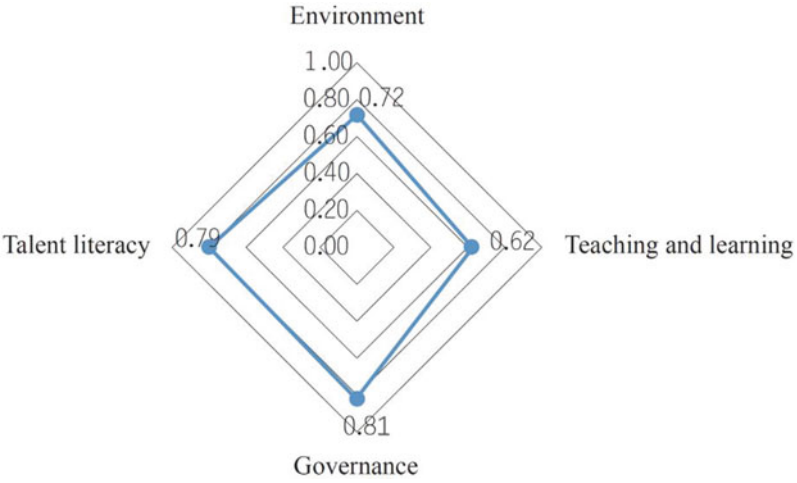

Fig. 6.1 China smart education development index (basic education) by dimension

ICT infrastructure. The average value of ICT infrastructure is 0.82. All provinces have 100% of their schools with a broadband connection. Nationwide, 75.59% of schools are covered by WLANs network, and 73.92% of all classrooms are equipped with multimedia device(s). The average number of digital teaching devices available for every 100 students is 11.29, or 0.79 in index. As shown in Fig. 6.2, for the value of ICT infrastructure for all provinces, the maximum value is 0.97. The values of most provinces locate in the range between 0.70 and 0.90. There are 14 provinces report values higher than the national average level. The standard deviation is 0.08, suggesting a narrow regional gap in ICT infrastructure.

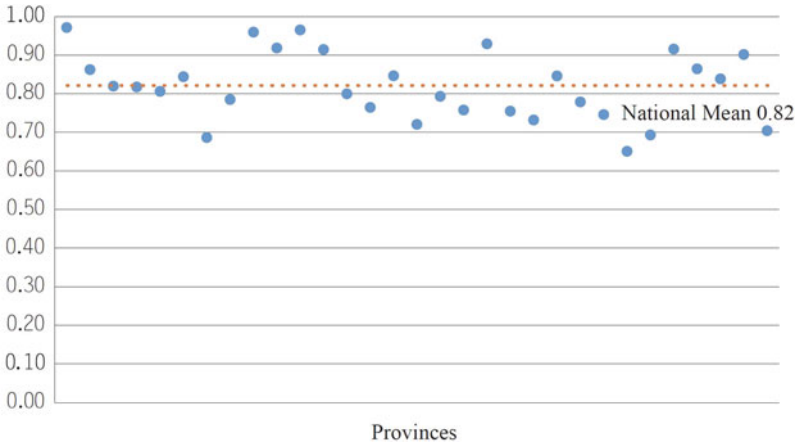

Fig. 6.2 Value of ICT infrastructure by province

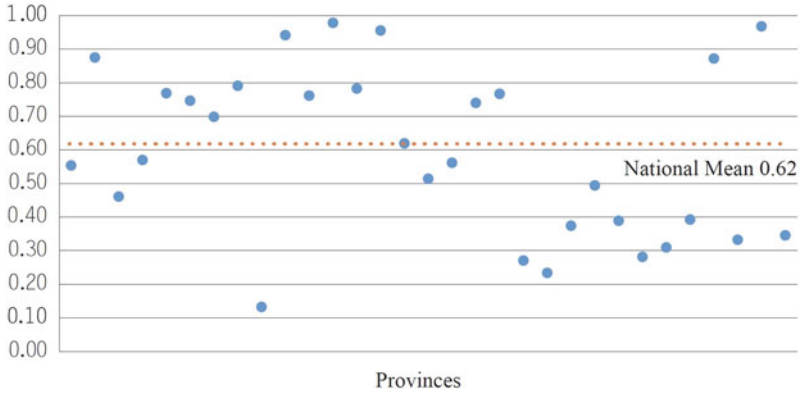

Fig. 6.3 Value of cyber learning space by province

Cyber learning space. The national average value of the sub-dimension cyber learning space is 0.62 with standard deviation of 0.25, suggesting significant regional disparity among the provinces. 69.35% of the students and 54.24% of teachers have registered personal accounts to access cyber learning space. As shown in Fig. 6.3, differences between provinces are quite large with 14 of them report values higher than 0.62, and 17 provinces report values lower than the national average level.

6.2.2 Teaching and Learning

The value of teaching and learning dimension is 0.62. For its sub-dimensions, the national average values are 0.53 for the digital literacy of teachers, 0.70 for the utilization of resources, 0.69 for transformation in teaching and learning practices, and 0.55 for pedagogical research.

Digital literacy of teachers. The national average of digital literacy of teachers is 0.53. There are 0.19 ICT professionals in education for every 100 students, and 86.50% of the teachers report sufficient digital literacy (passing the digital literacy test). As shown in Fig. 6.4, there are 16 provinces in which the number of ICT professionals in education per 100 students exceeds the national average. The number is between 0.15 and 0.19 for 12 provinces.

Utilization of resources. The national average for the utilization of resources is 0.70, with a high level of annual user annual activity on the SEC-PPSE.[2] Data show that the effective utilization rate of resources on the platform is 39.86%. It suggests

[2] The annual user activity of SEC-PPSE is calculated as the ratio of page view over the unique visitors of the platform. The national average value of this ratio is 65.67. Referring to related data from Baidu, Taobao, Amazon, and JD, we identify the user activity level of SEC-PPSE stay at high level. As a result, all provinces report full score at this indicator.

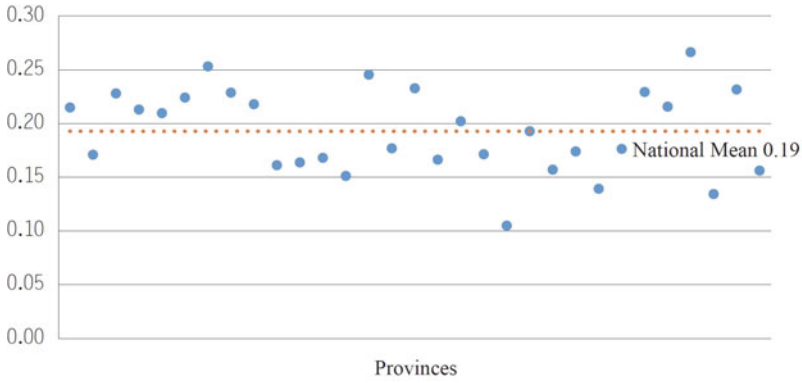

Fig. 6.4 Number of ICT professionals in education per 100 students by province

space for improving the utilization despite the large amount of available resources on the platform.

Under COVID-19, as an effort to keep teaching and learning amid class suspension, all primary and secondary schools register as users of the SEC-PPSE and begin the exploration of hybrid education. Surveys show 82.66% of offline courses nationwide are engaging with ICT technologies, and the coverage rate of online personalized teaching for teachers is 54.61%, indicating where improvement should be made.

Pedagogical research. The average value of pedagogical research is 0.55. The coverage rate of online teacher training is 55.49% with standard deviation of 0.22, suggesting the space for improvement for this indicator in some provinces. As shown in Fig. 6.5, teacher online training is above national average level in 14 provinces. The maximum value of this indicator is 91.98%.

6.2.3 Governance

The value of governance dimension is 0.81. For the sub-dimensions, data accessibility reaches 100% in all provinces; the national average of ICT-based management is 0.59; and the national average of cyber and data security is 0.85.

Data accessibility. Data accessibility reaches 100% in basic education, suggesting a solid foundation to roll out digital transformation on.

ICT-based management. The value of ICT-based management is 0.59. The "National after-school service management system" for primary and secondary schools covers more than 29,000 schools, suggesting ICT, as a "fast variable", is already beginning to empower policies such as "double reduction". As shown in Fig. 6.6, there are 82.78% of the schools conducting data driven decision-making

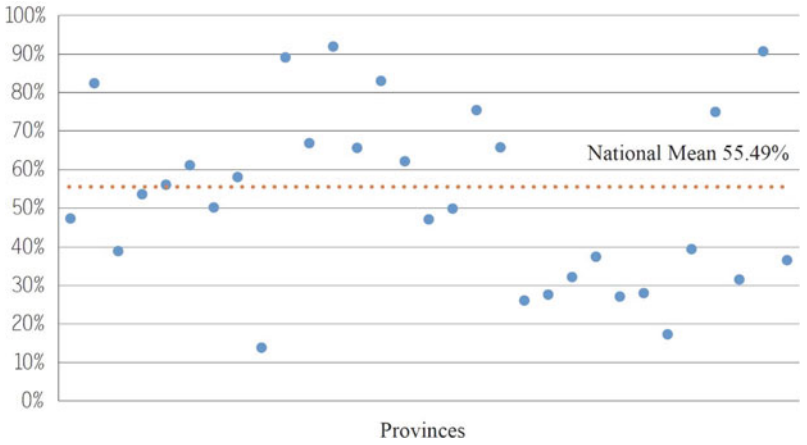

Fig. 6.5 Teacher online training by province

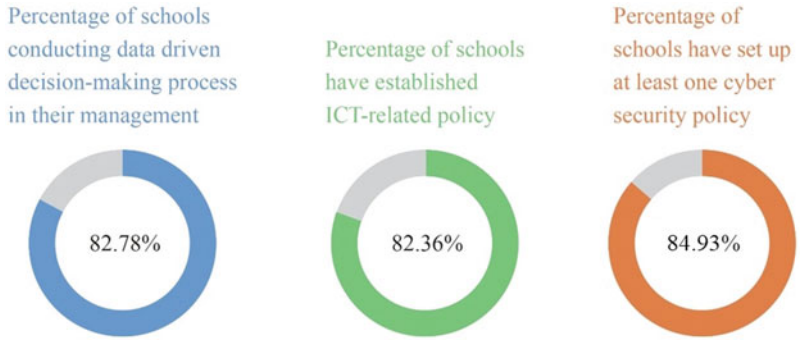

Fig. 6.6 Selected indicators from governance dimension

process in their management, showing a strong national consensus. In total, 82.36% of the schools have established ICT-related policy.

Cyber and data security. 84.93% of the schools have set up at least one cybersecurity policy. From the provincial perspective, 17 provinces report percentage more than the national average.

6.2.4 Talent Literacy

The value of talent literacy dimension is 0.79. There are 78.79% of student meeting the criterion of sufficient digital literacy, suggesting students in basic education have solid digital skills.

6.3 Achievements and Deficiencies

6.3.1 Achievements

Digital transformation of basic education in China is in good shape with well-developed infrastructure and strong policy and public service support. The teaching and learning process is enriched by extensive digital content and diverse applications with rapid improvement in digital management and teacher/student's digital literacy. A large set of experiences have been developed on digital transformation in education encompassing theories and practices with Chinese characteristics. Under China's Strategic Action Plan for Education Digitalization, primary and secondary schools have embarked on a new stage of the digital journey to embrace transformative changes in all educational aspects leading to a new ecosystem.

i. Fundamental improvement is achieved of digital environment across the country

Educational ICT infrastructure has improved rapidly, offering ubiquitous access to smart learning environment with complete network coverage and integrated multimedia for both offline and online settings. By the end of 2020, primary and secondary schools were 100% connected to the internet. By the end of 2021, the number of multimedia classrooms at primary and secondary schools exceeded 4 million, and 73.92% of classrooms were equipped with multimedia with internet access. 99.50% of the primary and secondary schools had multimedia classrooms. ICT infrastructural development is quite quality and fairly even across China.

ii. The national public service system of sharing digital content for basic education has made remarkable breakthrough

To ensure every child enjoy fair and quality education through rapid modernization and public accountability, the SEC-PPSE and other resource centers were developed as a public service to expand access to premium content. As of December 2022, the total number of digital resources on the platform reached 44,000 with 69.98 million registered users. The total number of visits of SEC-PPSE reached 19.6 billion, with daily visits reaching 64.32 million. During COVID-19, the platform keeping learning amid class suspension during the pandemic. It also expands equal access to education by supporting the national policy such as "double deduction" to prohibit overloading students with campus and extracurricular academic duties.

iii. ICT's deep integration with education paves the way for new teaching formats to emerge

ICT's role as an instrumental enabler to education reform is becoming evident through demonstration sites, case studies and hands-on training. By the end of 2021, more than 80% of offline teaching sessions were supported by ICT. Schools across the country are leveraging the SEC-PPSE and resources centers to carry out hybrid education. ICT is frequently and extensively used in the teaching process. Personalized learning,

adaptive learning and "courier class" enabled by ICT keep emerging, effectively promoting education quality and equity.

iv. The level of digital management in education has improved steadily

Digital public service platforms, such as the National Management Service Platform for Primary and Secondary Schools, have developed rapidly, with significant improvement in data-driven governance, e-government and coordinated oversight. The platform was put into operation in June 2022 with three modules: student management, school management; and special purpose management, and two services: the work desk and the "Learning Through Excellent Teaching" App. It meets the daily needs of regulators, school administrators, teachers, parents, and students. As of December 2022, the platform has been connected with 220,000 primary and secondary schools in various provinces, cities and counties together with their corresponding regulators. Data on basic education are shared 100%. The registration system of primary and secondary school students has collected 303 million pieces of information, and the coverage rate of basic education data reached 100%. The after-school service management system has carried out two rounds of piloting. Nearly 30 thousand schools across China use the national platform while about one thousand schools use their locally developed systems with interfaces connecting to the national platform for data transfer. Digital enablement and standardization are improving fast as well as the cybersecurity is becoming more robust.

v. The talent development system gearing towards the digital age has taken shape

China attaches great importance to improving the capacity of applying digital technologies in teaching for primary and secondary school teachers. Between 2013 and 2017, the Ministry of Education initiated educational technology capability training, and information technology application capability improvement project for primary and secondary school teachers, offering training sessions to more than 10 million teachers nationwide. In 2019, the Ministry of Education implemented an upgraded version of this project to ensure continuous improvement of teachers' digital literacy. A survey in 2021 showed 86.5% of teachers qualified sufficient digital literacy. Meanwhile, China was intensifying efforts to cultivate the digital literacy of students. The Ministry of Education formulated the *Information and Technology Curriculum Standards for General High Schools (2017 Edition Amended in 2020)* and *Information and Technology Curriculum Standards for Compulsory Education (2022 Edition)* to improve students' digital literacy. The survey in 2021 showed that more than three quarters of primary and secondary school students had qualified digital literacy.

6.3.2 Deficiencies

i. Infrastructure deficiency

There is still room for further improving the configuration of digital equipment and facilities. For example, most of the digital devices at schools are desktop computers, which are not portable. Some equipment is sitting idle with minimum usage. Bandwidth at some schools is too low to support the "pair-teacher class" and "courier class" formats. At the same time, data show the ratio of registering on network teaching space as users can be further raised. The integration of cloud and on-premise functions is not fully achieved to support online and offline hybrid teaching, so it needs to be updated with new iterations.

ii. Digital content is not learner specific

At present, digital content in basic education is not evenly distributed, and its presentation form lacks diversity. For example, content on the SEC-PPSE is mostly related to subject-centered curriculum, with very little available on moral, physical and artistic development, coordination between home and school, after-school services and interdisciplinary learning. Digital content is presented primarily as MOOC or video recordings of classroom sessions. E-textbooks, digital toolkit, virtual simulation are not commonly used.

iii. Use of digital technologies not yet routine

At present, teachers at primary and secondary schools are not fully harnessing the potential of ICT to flexibly implement teaching with innovate tools suited for different needs. Administrative staff and school management are not open-minded enough, and some of them are using new technologies to cement legacy education systems. Many schools don't have enough ICT expertise to back up digital teaching in a sustainable way. Full-time IT staff is less and not specialized. At most schools, the IT administrator is not an independent job position, and someone teaching ICT often assumes the role, leaving huge gaps in maintenance work.

iv. Insufficient public service support

There are still a number of shortcomings ranging from data integration, to service coordination and diversification. For example, various platforms and data sources are not fully integrated; data under different statistical measurements are not standardized and difficult to exchange; access to data still faces barriers; collaborative governance and decision-making based on full data flow is still hindered. Digital supervision, after-school services, home-school-society coordination and other diverse needs have not been met.

6.4 Development Recommendations

6.4.1 Make Utilization Routine and Improve the Digital Infrastructure

First, provide guidelines for schools on using their existing digital facilities to make utilization a daily routine. Second, update and renew mission critical equipment, add mobile digital devises, enhance the campus local area network, raise the bandwidth and build multimedia classrooms with internet access and interoperability. Third, strengthen the conditions at rural schools to deliver "pair-teacher class", improve their connectivity, equip them with interactive tools over long distances, support their effort to offer the national mandatory curriculum in its entirety. Fourth, require proper maintenance of digital assets with increased staffing to ensure availability, reliability, and sustainability.

6.4.2 Produce Quality Digital Content in Larger Volumes to Support the Basic Education Reform Agenda

First, improve the SEC-PPSE with constant generation of new and innovative content to enrich teaching and learning on academic subjects as well as morality development, acquisition of practical skills and home-school-community engagement. Second, diversify the forms of presenting digital content to support a wide range of scenarios such as "blended learning", "self-managed learning", "project-based learning" and "virtual simulation experiment resources". Third, increase the precision and relevance of digital content through intelligently filtering, automatic classification, semantic retrieval, information recommendation and other big data and AI technologies to ensure efficient resource use. Fourth, develop an ecosystem for digital content creation, maintenance, updating, audit and supervision with multiple stakeholders. Fifth, refine the standards for evaluating digital content for quality education, build a full-chain mechanism for efficient supervision of massive content.

6.4.3 Create Innovative Use Scenarios and Deepen the Integration Between Digital Technologies and Education

First, develop a greater understanding of education's digital transformation, systematically design and innovate new use scenarios of in all aspects and processes, and regularly publish the list of application settings. Second, study the inherent requirements of quality basic education and develop key use scenarios on the SEC-PPSE, reflecting

learners' cognitive characteristics, teaching patterns and teacher student dynamics. Third, implement pilot projects such as the "smart education demonstration zone" and the "new teaching and learning model experimental zone based on teaching reform and IT integration", and develop benchmark scenarios that can be replicated. Fourth, open up the educational setting to interface with a wide range of players for collaboratively developing scenarios while maintaining schools' leading role as education providers. Fifth, raise teachers' digital literacy through ongoing training them to incorporate digital technologies in their day-to-day teaching activities, and refine the evaluation standards in this regard.

6.4.4 Develop a Well Functioning Public Service System for Digital Education Aiming at Universality, Quality and Efficiency

First, improve data governance and standards, facilitate cross-platform and cross-regional data convergence, offer big data service with open access, encourage efficient data sharing under relevant laws, and fully release the value of data assets. Second, strengthen the National Primary and Secondary School Management Platform, broaden public services and their channels of access, provide schools with easy-to-use digital management tools and communication solutions with parents, and transform towards data driven education intelligent governance. Third, build a system for enhancing student digital literacy aiming at their all-round development, and bridge the digital skill divided between student groups. Fourth, deploy digital supervision and monitoring, and conduct real time collection, evaluation and diagnosis of smart education indicators.

6.4.5 Enhance Technology Governance to Safeguard Digital Security

First, implement the Cybersecurity Law of China and other relevant regulation and policies, improve the safeguards of data and cybersecurity, timely update the systems and ensure the integrity of critical assets. Second, strengthen technology ethics, step up monitoring, early warning and regulatory responses, improve oversight over data and algorithms, and ensure the standardized and orderly integration of digital technologies into the education ecosystem. Third, conduct studies before implementing new technologies and processes in a large scale, and establish an evaluation framework to assess the readiness and feasibility of digital technologies.