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Constructing Regional Smart Education Ecosystems in China

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Preface

Since the beginning of the 21st century, a new round of technological revolution and industrial reform is reshaping the global structure of innovation and economy. The new-generation Information Technology (IT) industry has exerted a revolutionary effect on the development of education, as it has largely promoted the development of educational reform and the establishment of a high-quality education system. The report to the 20th National Congress of the Communist Party of China stresses that China will move faster to build a high-quality educational system. Indeed, smart education construction itself is a powerful engine of the high-quality development of education in China. In recent years, China has issued a series of policy documents to vigorously promote the construction and development of smart education. In 2018, the Ministry of Education released the *Education Informatization 2.0 Action Plan*, which proposes to carry out the Smart Education Innovation and Development Action. Soon after, in 2019, the CPC Central Committee and the State Council issued the *China's Education Modernization 2035*, which highlights the reform of education in the information age. The *Outline of the Fourteenth Five-Year Plan for National Economic and Social Development of the People's Republic of China and Vision 2035* points out the need to accelerate digital development and build a digital China, and lists smart education as one of the ten digital application scenarios. *The 14th Five-Year Plan for National Informatization* proposes to carry out lifelong digital education as well as *The 14th Five-Year Plan for the Development of Digital Economy* emphasizes the need to further promote smart education. As an advanced form of education informatization, smart education relies on the cross-integration and two-way empowerment of technology and education to promote the high-quality and high-level development of education in China.

In the era of facing new opportunity, the driving force of digital transformation as a whole in production, lifestyle and governance is of great significance. It fosters China to achieve the development goals, including becoming a leader of quality digitalization, education and workforce. The *Highlights of the Work of the Ministry of Education 2022* points out that it is necessary to implement the strategic actions of education digitization and accelerate the digital transformation and intelligent

upgrading of education. Minister Huai Jinpeng emphasized at the launching ceremony of the National Smart Education Platform that it is necessary to "seize strategic opportunities for the development of digital education and lead education modernization with high-level education informatization" and "strive to become an international leader in smart education, to provide Chinese solutions and to contribute Chinese wisdom to the world". Smart education is the target form of digital transformation of education, aiming at building a smart learning environment. Thus, traditional teaching and learning methods would be reformed, and a new education system would be accordingly created in the intelligent age. Eventually, a highly experience-based, a highly content-adapted, and a highly efficiency-driven education system provided by countries, regions, and schools shall be built.

Until now, the Ministry of Education has selected two batches of 18 enthusiastic regions with suitable local conditions to carry out the construction of the "Smart Education Demonstration Zone". There are 6 main aspects of the construction:

1. Taking curriculum and practice as the core to construct ways and mechanisms to comprehensively improve teachers and students' information literacy;
2. Exploring a new teaching mode to promote the deep integration of information technology and education and teaching practice;
3. Improving the accuracy of students' comprehensive quality evaluation based on learning process data;
4. Constructing personalized teaching support service environment of data interconnection and integration;
5. Promoting the ability of regional education resources supply and service by adopting collaboratively innovative mechanism;
6. Using artificial intelligence, big data and other new technologies to improve modern education governance ability.

Through applying this construction, we aim to promote the integration and innovation of educational informatization, realizing the reform and innovation of the concepts and modes as well as the teaching contents and methods in education. It is a thinkable way to improve regional education level, explore and accumulate advanced experiences and excellent cases that can be popularized, and form new ways and modes to support and lead educational modernization. Since the establishment of the "Smart Education Demonstration Zone" project, a large number of regional smart education practical experiences and construction programs with local characteristics and highlights have emerged across the country. After 2–3 years of development and construction, many regions have taken measures according to local conditions. They have gained several achievements, which also led to the construction and development of national smart education.

In order to implement the strategic actions of education digitalization, further promote the development of smart education, and strengthen the spread and experience sharing of excellent cases of smart education, the secretariat of the expert group of the project "Smart Education Demonstration Zone" and the strategic research base of educational informatization of the Ministry of Education (Beijing, Central

China, Northwest China) launched the collection of excellent cases of smart education. According to the *Collection of Excellent Cases of Smart Education*, a total of 644 cases were collected. After application or recommendation, writing training program, revision and expert evaluation, we finally selected 30 cases of regional construction, 8 cases of solutions, and 8 cases of research findings.

The regional construction cases mainly focus on the sustainable development mechanism of regional smart education, improving the ability of regional education resources supply and service, data-driven education governance, constructing personalized teaching support service environment, improving teachers and students' digital literacy and skills, deepening the reform of students' comprehensive quality evaluation, the application of smart education platform, the experience of large-scale online education under epidemic prevention and control, the 'double reduction" of efficiency and empowerment of smart technology, and the promotion of rural education by smart education. Evaluation dimensions mainly include concepts and implementation, effectiveness and characteristics, innovation and demonstration, expression and structure, etc.

The solution cases are mainly technical solutions provided by enterprises for the development of smart education, and present their application scenarios, methods, and effects in regions or schools around smart educational equipment, platforms, networks, tools, resources, or integrated solutions. The evaluation dimensions of solution cases include values, application and innovation, content presentation, expression and structure, etc.

The research findings cases are mainly research results produced by research teams and individuals mainly focusing on theories, models, technologies, practical investigations, or international comparisons related to smart education. The evaluation dimensions of research results cases include values, innovation and practice, expression and structure, etc.

In this book, we would like to especially appreciate the guidance of the Department of Science, Technology and Informatization in the Ministry of Education, all the experts of the expert group for Demonstration Zone of Smart Education, all the members of the secretariat of the Project Expert Group for the Construction of the Demonstration Zone of Smart Education, the Educational Informatization Strategy Research Base (Beijing, Central China, Northwest), and all the teams that provided case studies.

Beijing, China Haijun Zeng
March 2023

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Part I
Overview

Chapter 1
Constructing Regional Smart Education Ecosystem: Policy, Technology, and Practices

Zhisheng Li, Jiahao Liu, and Haijun Zeng

At present, the Internet, big data, cloud computing, artificial intelligence, blockchain, and other new generation of information technologies are having a significant and far-reaching impact on economic development and social progress, and pushing human society into an intelligent era of human–machine cooperation, cross-border integration, co-creation and sharing of knowledge. At the 2015 International Conference on Education Informatization, Chinese President Xi stressed that the development of information technology, the promotion of educational reform and innovation, and the construction of a networked, digital, personalized, and lifelong education system are major issues faced by mankind. Also, a learning society where "everyone can learn anywhere at any time", and the training of a large number of innovative talents are needed urgently as well. In the era of intelligence, intelligent technology is redefining human beings' modes of thinking, knowledge, and the value of ability. New requirements for education and teaching, especially for talent training have been put forward to conform to the trend.

Comprehensively promoting the digital transformation of education is of great strategic significance for implementing the Digital China strategy, which plays a vital role in supporting the construction of a powerful nation of education, and promoting Chinese educational modernization. It is the necessary way to adapt to the requirements of the cultivation of top-notch innovative talents in the new era and the inevitable choice to comply with the trend of global education reform. The construction of Digital China has made decisive progress and remarkable achievements. During the process, it can be seen clearly that the development process of China's

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education informatization has been accelerating, which lays a solid foundation for the transformation of digital education and the development of smart education.

1.1 Promote the Digital Transformation of Education and Build a Smart Education Ecosystem

As a high-end form of education informatization, smart education represents the future development direction of transforming education through using intelligent technology. How to promote the digital transformation of education and how to build a smart education ecosystem are common challenges and important opportunities faced by all countries in the world.

1.1.1 Development Trend of Digital Education Transformation

The "Action on Assuring and Improving Quality Digital Public Learning for All" issued during The UN Transforming Education Summit reaffirmed the need to fully explore the power of the digital revolution, which ensures that quality education and lifelong learning are provided to all as a common interest and human rights, especially to the most marginalized groups. UNESCO has released a series of reports to lead the digital transformation of education, such as "Reimagining our Futures Together: A New Social Contract for education", "The Beijing Consensus", "AI and Education Guidance for Policymakers", and "Recommendation on the Ethics of Artificial Intelligence". What's more, the "World Digital Education Conference", "International Conference on Artificial Intelligence and Education" and "Global Smart Education Conference" have released a series of initiatives related to global digital education and smart education cooperation.

In the face of the new round of scientific and technological revolution and industrial revolution, the pace of digital transformation of education worldwide has been accelerating, which shows ten major international development trends, namely, releasing sustainable digital education strategy, leading the reform of the education system, optimizing the infrastructure of education information network to build an education environment of intelligent interconnection and intercommunication, building a public service platform for smart education to share high-quality education resources to the public, using information technology to support teaching mode so as to innovate learning support services, breaking the boundary of traditional school running mode to reshape the future school form, deepening the data-driven reform of teaching evaluation to improve the quality of education, developing standards and specifications in the field of digital education to promote education interconnection, defining and cultivating the digital literacy of teachers and students to improve their

digital competence, perfecting the ethical rules for the application of digital technology to consolidate the foundation of reform security, and building a cross-regional digital education community to promote international cooperation and exchange.

From the perspective of international experience, digital transformation is a process of systematic planning at the strategic level on the basis of digital transformation and upgrading, which promotes digital awareness, digital thinking, and digital ability in all elements, processes, businesses, and fields.

1.1.2 Digital Transformation Toward Smart Education

The history of human civilization is not only a history of technological innovation but also a history of educational progress. The modern education system was created by human beings in the process of industrialization, with obvious characteristics of standardization on a gigantic scale. With the advent of the digital era, the class teaching model built since the industrial revolution is facing challenges. Actively promoting the digital transformation of education is a strategic choice to cope with the changes of the times and an important part of promoting the modernization of Chinese education. Smart education is the target form of education digital transformation. Also, it can be understood as a kind of system, which is an educational behavior (system) with learning experience with a good learning experience, strong content adaptability, and high teaching efficiency provided by schools, regions, or countries. It can provide a series of differentiated support and on-demand services for students, teachers, and parents by using modern technology and can comprehensively collect and use the status data and teaching process data of participant groups to promote fairness, continuously improve performance and nurture excellence in education.

From the perspective of the constituent elements of the modern education system, the smart education system includes five major elements: the modern education system, the modern teacher system, the digital generation of students, the smart learning environment, and the teaching mode, among which the teaching mode is the core element of the smart education system. If the teaching mode, modern teacher system, and digital generation students are combined into a new teaching mode, the intelligent education system can be transformed into three levels (three layers), namely, Smart Learning Environments, Technology- Enhanced Learning And Teaching, and Evidence-Based Governance (Fig. 1.1).

Smart education is a new form of education that adapts to the new round of scientific and technological revolution which fits in with the development of the smart society in the future. With information technology as the means and digitalization as the basis, it is necessary to integrate the essence of education, and promote the deep reform and overall reconstruction of education concepts, models, and systems, so as to form a new paradigm of education.

The essential characteristics of smart education mainly include perception, adaptation, care, fairness, and harmony. Specifically, they are: (1) the perception of the learning environment, which is using various technologies, sensors, and scales to

Fig. 1.1 Three layers of smart education

perceive the external learning environment and people's internal learning state, so as to provide the basis for "push on demand" and "learn on demand". (2) The adaptability of learning content, which allows education resources to be acquired and used according to the personalized needs of students, and teaching and learning can be carried out as needed to achieve the good wish of "teaching students according to their aptitude". (3) To respect and care for students, which asks teachers to establish and maintain trust and support relationships with students through empathy, attention, dependability, respect, affirmation, and other behaviors in the process of interaction with students. (4) Educational fairness among the educated groups, which means that equal rights in terms of educational rights, educational opportunities, educational resources, and educational quality should be equally offered to students in the process of their education. (5) The organic integration of the elements of the education system and its harmonious relationship, which are people's subjective pursuit and beautiful ideal of education, as well as the profound driving force of building a harmonious society. A smart learning environment transmits educational wisdom, a new teaching mode enlightens students' wisdom, and a modern education system breeds human wisdom.

1.2 The Construction Effect of Smart Education Demonstration Zone: Innovative Actions for the Development of Regional Education Informatization

"Smart Education Demonstration Zone" gained the support of the local governments. Also, to promote it, the education administration department will coordinate relevant institutions, give full play to the role of the market mechanism, and use the new generation of information technology to provide personalized support and accurate services for students, teachers, and parents. Also, it will collect and use the status data of the participants and the education process, and promote learners at any time, in any place, in any way learning at any pace. What's more, it will provide teachers and students in the region with a good learning experience, strong content adaptation, and high teaching efficiency, so as to promote education fairness and improve education quality. The Ministry of Education carries out the construction and practical exploration of the "Smart Education Demonstration Zone" in order to promote digital transformation, intelligent upgrading, integrated innovation, and development of regional education, as well as to realize the reform and innovation of education concepts and models, teaching content and methods. Also, it is aimed to improve the level of regional education, explore and accumulate advanced experience and excellent cases that can be promoted, and form new ways and models to support and lead the modernization of education (Table 1.1).

The focus of the construction of the smart education demonstration zone mainly includes:

It is necessary to promote the reform and innovation of talent training mode. Using intelligent technology to transform classroom teaching from a simple "stage play" to a "blockbuster" in the past matters a lot, which not only really can help students improve their interest in learning, their initiative in learning, and learning efficiency, and but also cultivate more innovative talents with "from 0 to 1" innovative thinking and integrity and ability.

It is necessary to highlight the innovative application practice of AI. The construction needs to adhere to the combination of demonstration zone construction and artificial intelligence social governance experiment. Taking the school as the unit, it should explore the school-based practice curriculum of AI, and construct the school-based curriculum system of AI education. With intelligent terminals as the carrier, it should explore the combination of science, technology, engineering, arts, mathematics (hereinafter referred to as STEAM), and artificial intelligence, namely the new teaching mode of "STEAM and artificial intelligence education". In the form of an online research community, it needs to explore the precise teaching and research model based on big data evaluation and promote the high-quality and balanced development of education.

It is necessary to adhere to the combination of designed development and regional coordination. Each region should be based on its own standard, find its own characteristics, give full play to its own advantages, and form its own distinctive development

Table 1.1 List of "smart education demonstration zone"

City/province	2019	2020
Beijing	**Dongcheng District**	**Haidian District**
Shanghai	**Minhang District**	
Hebei	**Xiongan**	
Shanxi	**Yuncheng**	
Sichuan	**Wuhou District, Chendu**	**Chenghua District, Chendu**
Hubei	**Wuhan**	
Hunan	**Changsha**	
Guangdong	**Guangzhou**	**Shenzhen**
Tianjin		**Hexi District**
Jiangsu		**Suzhou**
Zhejiang		**Wenzhou**
Anhui		**Bengbu**
Fujian		**Fuzhou**
Jiangxi		**Nanchang**
Shandong		**Qingdao**
Chongqing		**Bishan District**
Gansu		**Lanzhou**

path of smart education. At the same time, it should actively build a new mechanism for coordinated development among regions and create an ecosystem for the development of smart education.

It is necessary to vigorously develop new infrastructure of education and continuously improve the supporting capacity of education informatization. It needs to use the new generation of information technology so as to build a new infrastructure system facing education and serve the development of educational modernization.

As a new project, it shoulders an important mission. Since the establishment of the project, various "smart education demonstration zones" have carried out bold exploration and beneficial attempts in line with local conditions around six key tasks, and have formed some highlights in terms of environment, mode, service, and governance.

1.2.1 Focus on Improving the Digital Ability of Teachers and Students, and Promote the Innovative Application of Intelligent Technology

The intelligence era has put forward higher requirements for talent training objectives and specifications, which emphasize the improvement of digital literacy in curriculum

and practical teaching. The demonstration area fully implements the information technology and information technology curriculum standards and improves students' core qualities, such as information awareness, computing thinking, digital learning and innovation, and information social responsibility. It creates excellent online courses, applies information technology innovation to solve the pain points and difficulties of teaching, and improves teachers' information-based teaching ability. It extensively carries out comprehensive practical courses in information technology, offers artificial intelligence education courses and experimental projects, and effectively improves students' ability to apply and innovate information technology. Also, it carries out innovative education in various forms such as maker education and STEM education to cultivate learners' abilities related to interdisciplinary problem-solving and innovation.

Dongcheng District of Beijing has established a district-level "1 + N + 8 + X" "college system" curriculum system. Also, it has paid great attention to practicing base for teenagers, established the Dongcheng District Youth Information Literacy Education College, trained students' innovative awareness and innovative thinking, built a platform for students' innovative works display, and led teenagers to explore the field of artificial intelligence technology. What's more, it has improved teachers' professional skills and information literacy and promoted teachers to actively adapt to new technological changes such as information technology and artificial intelligence through such measures as teachers' intelligent training system, evaluation, and reward mechanism.

Haidian District of Beijing has vigorously promoted the digital literacy of subject teachers and explored the development of expert-led online teaching and research. In addition, it has developed a student digital literacy indicator system, incorporated student digital literacy into the student comprehensive quality evaluation system, and actively carried out school programming, STEM, and other kinds of education.

Changsha has set up a collaborative innovation center for smart education, an innovative talent training research institute, a group of future education lecturers, and a future school research community to comprehensively promote the practice and research of smart education.

Yuncheng launched a 3-year "Information literacy enhancement legacy for teachers" to build a maker education curriculum system and explore a 5E teaching model based on student inquiry.

The information literacy improvement project for teachers in Wenzhou has created an "AI education five-in-one" ecosystem, which means "every school with one AI curriculum, every school with one AI team, every school with one innovation project, every school with one intelligent space and every school one brand activity".

Qingdao has put forward the new goal of popularizing AI education in the whole region, issued the *Guiding Outline of AI Educational System for Primary and Secondary Schools,* created a professional teaching team, built an education and teaching environment combining software and hardware, comprehensively carried out the popularization of AI education courses, and conducted AI literacy assessment.

Chenghua District of Chengdu implements the school CIO system to improve the "leadership" and "guidance" of school informatization applications and carries out all-staff training to improve the "application" of teachers' informatization.

1.2.2 Deeply Promote the Reform of Classroom Teaching and Construct a New Teaching Model

The cultivation of innovative talents needs to rely on school education, so promoting "classroom revolution" is one of the key issues in the establishment of the demonstration zone. Classrooms are the main battlefield of educational reform. Only by building a new teaching model that conforms to the cognitive characteristics of "digital indigenous" can learners actively learn, release their potential, and develop in an all-around way. Since informatization teaching helps to realize the organic combination of large-scale education and personalized training, the demonstration area deepens the innovative integration of information technology and classroom teaching, advocates the innovative application of information technology by teachers to improve teaching, strengthens the student-oriented teaching practice, and promotes the realization of classroom teaching reform. It encourages the application of new teaching methods such as collaborative and constructive learning, capacity-guided learning, and design-based learning to promote the overall improvement of students' comprehensive quality and abilities such as cooperation, practice, and innovation. Also, it digs out typical cases of applying information technology to solve the "pain points" in teaching, and gives play to the leading and exemplary role of excellent teachers.

Dongcheng District of Beijing has implemented the "Reform and Innovation Project of Teaching and Learning". With the help of big data, artificial intelligence, and other information technologies, it reorganizes teaching content, changes classroom form, reconstructs the teaching process, and optimizes academic evaluation. Also, it promotes the "double classroom" teaching mode of deep integration of traditional classroom and virtual classroom, expands the full space, full dimension, and full field of "teaching, learning, management, evaluation and testing", and improves the teaching quality, reduces the burden and increases efficiency.

Haidian District of Beijing uses AI, big data, blockchain, and other emerging technologies to create an intelligent teaching environment of "Internet + Education" with a full-time domain, full airspace, and full audience. Also, it applies personalized learning platforms, intelligent learning terminals, intelligent education assistants, and intelligent knowledge maps to promote classroom information teaching.

Changsha City plans to comprehensively promote the application of online learning space and promote the "classroom revolution". It greatly promotes the application of AI teaching and widely applies new technologies such as intelligent teaching assistants, intelligent learning companions, simulation experiments, intelligent paper, and pens in classroom teaching to comprehensively promote the popularization of

AI education. It uses 5G and high-definition distance interactive teaching techniques to promote the construction of "thousands of classes" rural network joint schools.

Guangzhou has firmly promoted the reform of classroom teaching, reconstructed and defined the basic environment configuration, teaching strategy, experimental process, and organization management of the smart classroom, and explored a set of smart classroom organization paradigms, that is, to explore and grasp the key points before class, to pay attention to class presentation and group inquiry, accurate teaching and individualized teaching during the class, and to focus on classroom consolidation and mutual improvement after the class. More than 100,000 students in the city carried out smart classroom experiments.

Wuhou District of Chengdu has built a "new teaching ecology", explored a "new service pattern" and promoted a "new governance pattern". The district actively explores the new online and offline three-stage teaching modes combining preset, face-to-face teaching, and expansion, and pays attention to the in-depth application of blended learning in the post-epidemic era.

Suzhou strongly advocates the innovative in-class teaching mode with a smart classroom, based on the construction of a future classroom, flipped classroom, synchronous classroom, and other mobile and interconnected personalized learning fields, creating interactive, exploratory, and collaborative classroom, achieving accurate and effective teaching, so that learning really happens to students.

Shenzhen Cloud School, as an innovative school that uses physical schools to run Internet education, has explored the two-teacher teaching mode of "a main lecture plus auxiliary lecture, online plus offline", realizing the cross-school sharing of high-quality classes and the rapid growth of young teachers. According to the questionnaire, 95% of students in the cloud class like the teaching mode of Shenzhen Cloud School, and their satisfaction with the three subjects of language, mathematics, and English is more than 92%.

Fuzhou has promoted virtual experiment classes. School teaching has changed from a three-foot platform with chalk, a blackboard, a mouth, and a book to a virtual experiment, a VR view of the underwater world, and a virtual teaching assistant.

1.2.3 Data-Driven Educational Evaluation Reform to Support the Comprehensive Quality Evaluation of Students

In the era of intelligence, the application of new technology has changed the single, score-based evaluation standard in traditional teaching. Instead, it emphasizes the multidimensional evaluation of students' comprehensive quality. The demonstration zone innovates evaluation tools, deepens the application of education big data, analyzes the learning process, improves the matching degree of teaching service supply and learning demand, optimizes the quality and efficiency of teaching services, and realizes the effective and high-quality supply of education services. At the same

time, it actively participates in the pilot work of the comprehensive quality evaluation of students supported by information technology, explores and carries out the longitudinal evaluation of the whole process of students' learning and growth in each grade, and the horizontal evaluation of all elements of morality, intelligence, physique, beauty, and labor by using the data-driven comprehensive quality evaluation solution of students.

Minhang District of Shanghai has carried out the incidental collection of students' learning process data with e-books as the carrier and completed the comprehensive quality evaluation of students in more than 80 schools with the help of the comprehensive quality evaluation system.

The "Evaluation and Evaluation Demonstration Development Project" in Dongcheng District of Beijing has established a regional education big data cockpit to support comprehensive quality evaluation.

The practical innovation of education evaluation based on big data in Wuhan has made it possible to "Internet + moral education". By building the evaluation index system and evaluation model of students' comprehensive quality, the Wuhan Education Big Data Center has been built to collect the data of students' learning process, realize the large-scale and accurate evaluation, eliminate the barriers of the evaluation system, and guide students' growth and development in a long-term way.

Changsha pays attention to the result evaluation, process evaluation, value-added evaluation, and comprehensive evaluation, breaks the only score, and uses intelligent methods to evaluate. The evaluation methods are diverse, and the monitoring and evaluation are oriented to all people.

Guangzhou has vigorously carried out smart reading projects to improve learners' reading interest and ability through collecting and analyzing reading data to promote their personalized growth.

Based on the smart homework platform, Nanchang uses big data, cloud computing, artificial intelligence, and other information technologies to build a large-scale cloud computing infrastructure, and provides dynamic collection support for students' homework information for the upper application of smart homework through three forms: dot-matrix pen, altimeter, and fast scanner.

1.2.4 Consolidate the Smart Interconnectivity of the Learning Environment, and Break the Barriers of Collaborative Education Between Family, School, and Community

The behavior and interaction between teachers and students are the main factors that affect the effect of education and teaching. The intelligent learning environment can shape the behavior habits of teachers and students. With the development of artificial intelligence, the Internet of Things, and other technologies, the learning environment has changed from a closed physical space to an open, virtual, and real

space. Driven by data intelligence, the demonstration zone integrates smart education into the construction of smart cities, smart villages, and smart societies. It also breaks the data and information barriers between schools, families, and society, and promotes the all-around mining and integration of education data. Also, it formulates rules and regulations for the confirmation, opening, connection, and protection of education big data, and promotes data integration between various digital platforms at all levels. What's more, it uses learning analysis, education data mining, and other means to improve the matching of teaching service supply and learning demand, achieve accurate push, and optimize the quality and efficiency of teaching service.

Dongcheng District of Beijing has implemented the "Future Learning Space Construction Project", which is based on the unified certification of Dongcheng District's education cloud service platform, docking with various application systems such as education management, teaching, learning, research, evaluation, and supervision, and comprehensively popularizing the "one person, one space" for teaching and learning under the network environment of teachers and students in the whole district.

Haidian District of Beijing has established an intelligent learning experience center, which uses virtual reality, augmented reality technology, and other modern information technologies to promote scenario-based, experiential, and immersive learning and stimulate endogenous learning vitality.

Wuhan has built 135 four-star smart campuses, 120 smart classrooms, 120 artificial intelligence laboratories, 30 standardized examination schools for physical and chemical experiments, and 30 smart libraries.

Changsha has promoted the construction of smart campus demonstration schools in batches, which advocates the empowerment of online learning space, and the convergence of intelligent teaching assistants, teaching tools, teaching resources, etc. in the space. Teachers use the space to carry out education, teaching, research, and evaluation, and students use the space to carry out growth records, independent learning, inquiry learning, and personalized learning.

Minhang District of Shanghai has broken the boundaries between departments and homes by increasing investment in funds, optimizing the layout of sites, building a smart education system, and developing and applying a health platform. It has established a real-time and coordinated hierarchical management and early warning mechanism, which is convenient to gather all forces to protect the health and safety of children.

Wuhou District, Chengdu City pilot "One Network for All", which integrates all education and teaching businesses of the school with one 5G-based Internet of Things and one software business network, extends the construction of multiple personalized application scenarios and explores the "1 + 1 + N" smart campus construction model in four school stages.

Suzhou Education Metropolitan Area Network has achieved 10,000 megabytes to campus, 1000 megabytes to class, and 100 megabytes to desktop. The wireless campus coverage rate has exceeded 90%, and 90% of schools have reached the provincial smart campus standard.

Qingdao has built an infrastructure that combines software and hardware. Through the construction and operation of a supercomputing center, teaching platform, and artificial intelligence laboratory, it really solves the problem of "how to teach well" AI courses.

The Public Service Bureau of Xiong'an New Area has selected 7 "smart campus" and 16 "smart classroom" experimental schools in Xiongxian, Rongcheng, and Anxin counties, and provided financial support.

1.2.5 Promote the Application of Smart Education Platform and Optimize the Regional Public Service Capacity

The key to the development of regional smart education is to establish a collaborative innovation mechanism with the participation of government, scientific research institutions, enterprises, and other parties, and carry out the reform of the organized education system. Relying on the public service system of digital education resources, especially the national smart education platform, the demonstration zone brings together schools, scientific research institutions and enterprises, and other forces to vigorously promote the digital construction of education resources. It explores new mechanisms for resource sharing and service supply, uses intelligent technology to gather high-quality education and teaching resources, expands the coverage of high-quality education resources, and effectively supports schools and teachers, and students to carry out information teaching and learning applications so as to comprehensively improve the digital public service capacity of regional education.

The idea for the establishment of the Smart Education Demonstration Zone in the Dongcheng District of Beijing is to build an intelligent, flexible, and ubiquitous new education and teaching environment and create a regional "1 + 7 + N" smart education system. "1" is the "data brain" of education in Dongcheng District. "7" refers to seven demonstration projects, including the in-depth focus on teaching and learning reform and innovation project, the open innovation project of educational resources, the innovative talent training and leading project, the education management and service improvement project, the evaluation and evaluation empirical development project, the basic environment intelligent improvement project, and the future learning space construction project. A new education and teaching environment with full data support and deep application breakthrough has been formed in N "future schools", and the "Internet+" teaching and learning model and data service school management model have been popularized.

The Internet Education Research Institute was established in Haidian, Beijing, to jointly research the application of intelligent technology education with high-tech enterprises and experts, scholars, front-line teachers, etc. in various fields.

The "1258 Project" of large-scale individualized education driven by data is comprehensively deployed in the Minhang District of Shanghai, which builds a

vertical service education cloud platform and relies on intelligent teaching and intelligent learning partners to carry out personalized teaching. As a result, it provides accurate services for students, parents, teachers, managers, and citizens, and focuses on the 8 business scenarios of classroom teaching, adaptive learning, course selection, campus activities, community participation, social practice, home-school interaction, and subject experiment to enrich the application requirements.

Around the construction of the "digital brain" intelligent service system for education, Wenzhou has built an education data center, three digital service centers for education governance, ubiquitous resources, and school applications, and created X application scenarios.

The construction and application of Bengbu's "smart school" have adopted a new mechanism of "total integration and total service", expanding the "turn-key project" into a "resident service project", which requires not only "good construction", but also "good use". "Changing the 'one-off sale' is related to the 'long-term sustainable' development relationship, which promotes the operation upgrading from the 'product level' to the 'standard level' within the enterprise, as well as the transformation of the enterprise's operation mode. Also, it encourages the enterprise to improve the use efficiency of the educational information products on the supply side".

Bishan District of Chongqing focuses on "double reduction", which aims to improve its quality and efficiency. Also, it implements 10 major action systems to promote by focusing on the three tasks of "smart classroom, smart evaluation, and smart governance".

Relying on "Lanzhou Smart Education · Famous Teachers Online", Lanzhou adopts the distance education mode of the webcast, centralizes the resources of famous teachers in the city, and carries out remote real-time after-school tutoring for urban and rural students in the city through the Internet in the spare time, weekends and winter and summer holidays, helping students choose high-quality famous teachers' courses independently, listening to famous teachers' lectures, and realizing the seamless connection, supplement, and expansion with the current school curriculum.

1.2.6 Intelligent Technology Empowers Educational Governance and Promotes the Transformation of the Educational Organization

Forming a new pattern of educational governance with the participation of the whole society, and promoting the modernization of the educational governance system and governance capacity has become the key to comprehensively deepening educational reform. Intelligent technology empowers education governance, which will promote the reform and innovation of education organization form and management mode, and promote the scientificity of education decision-making and the accuracy

of resource allocation. The demonstration zone establishes and improves the scientific decision-making and educational governance mechanism assisted by big data, which reasonably uses the national basic education database and urban development data, effectively supports the various decisions of education, and improves the digital governance level and serviceability of education. It carries out the research of dynamic simulation of education and uses machine learning, fuzzy mathematics, and other methods to establish models. Also, it can dynamically simulate the results of the implementation of educational decision-making and provides a scientific basis for educational decision-making. It makes full use of intelligent technology to perceive, predict, and warn the campus infrastructure and safe operation, timely grasp the cognition and physical and mental changes of teachers and students and make active, timely, and accurate decisions. During the epidemic period, the demonstration areas have made full use of the advantages of the regional information public service support system, made overall planning, deployed the relevant teaching activities arrangement of "Disrupted Class, Undisrupted Learning", and taken the lead in this unprecedented educational social experiment. At the same time, the experimental project of educational social governance under AI conditions in relevant regions has also achieved positive results in the construction of a smart education environment, and promotion of the combination of large-scale education and personalized training.

Dongcheng District of Beijing has built a "data brain" to grasp the development trend of regions, schools, teachers, and students in real time, and support the full scene application in education quality monitoring, comprehensive literacy evaluation, enrollment and degree management, information security control, campus security early warning, etc.

Haidian District, Beijing, has implemented the "double reduction" policy of science and technology empowerment and has made full use of big data and artificial intelligence technology to build education behavior portraits for different objects, improve the collaborative education and management mechanism of schools, families, and society, and promote the efficiency of regional education management through data governance.

Minhang District of Shanghai realizes a unified platform, access, authentication, data, and protection, and the One-Network Office provides services for personalized teaching management and big data applications.

Wuhan has established a full coverage system of city, district, and university CIOs, formed a linkage mechanism of collaborative innovation among the government, universities, scientific research institutions, primary and secondary schools, and enterprises, and strengthened the supervision and evaluation of the third party.

Xiong'an New Area of Hebei Province has prepared the "Five-year Action Plan for Smart Education" according to its actual development situation and clearly put forward 18 action plans so as to lay a foundation for better implementation.

Based on the big data of space, Changsha has collected the data of the management, teachers and students, teaching, enrollment, evaluation, relationship, and safety of primary and secondary schools in the city, and analyzed, compared, and excavated them to reflect the current situation and development level of education in Changsha in a multi-dimensional way, and improve the level of modern education governance.

It carries out artificial intelligence education and social governance experiment, and guides and standardizes the "campus" of digital learning products for teenagers.

Wuhou District of Chengdu City, using the preliminarily built Wuhou Education Data Center, integrates the data of four application platforms, including the national student registration system, the comprehensive quality evaluation data of students in Chengdu, the data portrait of teachers in Wuhou District, the prevention and control of myopia in primary and secondary schools and kindergartens in Wuhou District, and initially realizes multiple application scenarios such as "development monitoring, remote supervision, teaching analysis, equipment management, myopia prevention and control, supervision and evaluation, and career statistics".

Wenzhou has established a "big community" platform promotion mechanism, and the government has led the establishment of a regional inter-school community, political research cooperation community, and industry-education integration community to promote the high-quality and balanced development of regional education.

Bengbu has established a collaborative innovation mechanism of "government, enterprise, school and research", and implemented the smart school construction project and the individualized education promotion project through the way of government coordination, enterprise service, school practice, and teaching and research guidance.

Qingdao, Shandong Province, established the International Alliance for Artificial Intelligence in Education to form a comprehensive solution for AI education.

Hexi District of Tianjin has built a data center to carry out digital governance of education. It gathers data and uses the data decision visualization system for modeling and analysis. In view of the weakness of teachers in new schools, a database of teachers' district management and school recruitment is established. In order to improve the "double reduction" policy, it establishes a private education operation supervision database which includes all institutions outside the school, kindergartens, and art and sports training schools in the area into the scope of data governance.

1.3 Suggestions for Building a New Ecosystem of Regional Smart Education

The development of regional smart education still faces some challenges. For example, there is a widespread phenomenon of paying attention to everything concerned, and the characteristics are not clear. Most regions develop smart education in the way of "feeling the stones to cross the river", with insufficient scientific and technological support. The publicity and promotion of new models and new ways that have been relatively mature and have achieved good results are not enough, and the radiation and driving effect of "from points to lines to areas" has not been formed, and the social awareness of smart education is not high enough. The "Smart Education Demonstration Zone" is a pioneering exploration of China's smart education. Under the overall arrangement of the Ministry of Education, the efforts of all regions,

and the collective efforts of experts, the establishment of the demonstration zone has promoted the renewal of education concepts, the reform of teaching models, and the reconstruction of the education system, promoted the education informatization work to a new level, and contributed to the realization of China's education modernization. It plays a leading and exemplary role in the development of digital education and contributes to the development of international smart education with Chinese programs and Chinese wisdom.

1.3.1 Strengthen Evidence-Based Research and Guidance, and Further Promote the Project of the "Smart Education Demonstration Zone"

The demonstration area is the "fertile ground" for research and practice of smart education. For practical results, it can take "application data" as the core to build smart education development index and evaluation tools, carry out performance evaluation on the demonstration area, give full play to the guidance and consultation role of experts, conduct evidence-based research in the front line, and carry out targeted practical guidance and effectiveness analysis. It can expand the scope of the demonstration zone, adhere to the combination of special development and regional coordination, problem-oriented and innovative guidance, and take the cultivation of top innovative talents as the core goal and breakthrough. Also, it can give full play to the role of scientific research institutions and think tanks, study the development path of regional smart education suitable for the world, national conditions, and people's conditions, and provide theoretical guidance and solutions for the development of regional smart education.

1.3.2 Promote the Demonstration Application of the National Smart Education Platform in the Region and Expand the Coverage of High-Quality Education Resources

The national smart education platform is a major project to promote the strategic action of digital education. Strengthening the promotion, popularization, and application of the national smart education platform in the region has become an important measure to promote the development of regional smart education. For the demonstration area, it is necessary to interconnect the decentralized digital platform with the national smart education platform and create a digital base of education public service that connects the country and the region. Also, it needs to build a two-way collaborative mechanism for the mass creation and sharing of high-quality education resources, and encourage schools and teachers, and students to deliver high-quality education resources to the national smart education platform. In addition, it should

carry out training around the educational resources, application scenarios, main functions, and operation methods of the national smart education platform, and promote students, teachers, schools, and parents to use the national smart education platform in a normal way.

1.3.3 Optimize the Planning and Layout of Educational Science and Technology Innovation Projects, and Promote the Two-Way Empowerment of Science and Technology and Education

Smart education is a digital transformation and intelligent upgrading that uses intelligent technology to support education in all fields, elements, businesses, and processes. In view of the scientific problems and technical weaknesses of smart education, it is necessary to set up guiding projects, adopt the method of "unveiling and leading", determine the dominant research, practice, and technology main units, and carry out organized scientific research. It gives key support to places, units, schools, and platforms that have made remarkable achievements in promoting digital education and smart education, and creating "model projects". Also, it makes full use of the theory, model, technology, platform, equipment, and other research and development achievements of the national key research and development plan projects such as "social governance and smart society technology support", "technological innovation 2030—new generation artificial intelligence", and takes the lead in carrying out pilot demonstration applications in the region.

1.3.4 Deepen the Innovation of Regional Smart Education Development Mechanisms and Serve the High-Quality Development of the Economy and Society

The development of smart education is a systematic reform project, which requires the government, schools, scientific research institutions, enterprises, etc. to form a working mechanism that connects up and down and promotes in one, so as to improve the ability of education to serve economic and social development. The government supports regions and schools to make bold attempts in terms of policies and funds to establish a long-term tracking research mechanism. Enterprises carry out technological innovation and service innovation and develop regional smart education development solutions. Scientific research institutions and think tanks actively carry out educational social experiments under the conditions of artificial intelligence, provide a theoretical basis for practical exploration, and transform and apply educational scientific and technological achievements in the region.

1.3.5 Build a Regional Smart Education Brand and Disseminate Advanced Experience and Practices

Based on China's national conditions and education "confidence", it is necessary to strengthen the international dissemination of domestic smart education research and practice. Also, it needs to collect and compile excellent cases of smart education, and promote typical experiences and solutions through TV programs, newspapers, new media, seminars, etc. It should establish a regional smart education development cooperation alliance to build a regional smart education development ecosystem and community through flagship projects, special training, and resource sharing. What's more, it can make contributions to strengthen international exchange and cooperation, learn from each other, contribute to China's wisdom and China's plan for the development of smart education in the world, and strive to become an international leader in smart education.

Part II
Regional Construction

Chapter 2
Data Empowerment and System Remodeling Application

Lin Zhou, Lei Li, Shumin Zhang, and Yushun Li

2.1 Background

Dongcheng District of Beijing is the functional core area of the capital, which pays special attention to promoting the high-quality development of education. In 2019, Dongcheng District was awarded the first batch of the "Smart Education Demonstration Zone" by the Ministry of Education. In the same year, the overall framework of "1 + 7 + N" smart education construction was put forward. In 2021, Dongcheng District was awarded the educational characteristic base of the "National Intelligent Social Governance Experimental Base" jointly selected by the Office of the Central Cyberspace Affairs Commission, the Ministry of Education, and other eight ministries. It soon proposed to build the "1314" intelligent governance system of Dongcheng Education, which further promotes the advanced exploration and practice of artificial intelligence technology in the field of education.

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2.2 Measures and Results

2.2.1 Regional Systematic Digital Transformation Empowered by "Data Brain"

Formulating data standards and specifications. According to the educational data standards of the country, the Ministry of Education and Beijing, a series of measures for the management of educational data in Dongcheng District have been formulated, which unify the data collection standards, usage specifications and return requirements. Dongcheng District Smart Education Research Center takes the responsibility to co-ordinate, set up the governance work group, and establish the "internet+" data aggregation mechanism. It has also built a smart education cloud service platform in the district (hereinafter referred to as "cloud platform"), which can be used to vertically connect the national and Beijing's platforms, and to horizontally integrate regional applications, by realizing a unified login process. Until now, the database of Dongcheng District has been formed, covering 73 types of data materials, 11 business and application systems, 12 primary data subjects, 42 secondary data subjects, and 1517 data reports.

Optimizing service-oriented products by using data. Using the multidimensional data system, a holographic portrait combined with "one school with one file" for school, "one teacher with one file" for teachers, and "one file for students' life" for students is established. Dongcheng District has established a comprehensive data management platform to realize the unified "directory tree" management of educational data resources. Up to now, the cleaning, sharing, and quality inspection of 324 duty directories, 95 data tables, and 71.51 million data records in 46 departments have been completed. Moreover, it has built a smart screen for dynamic monitoring and analysis of functions such as data convergence, smart classroom, and smart office, and explored the use of data to support educational science decision-making. After opening the data interface, the Municipal Education Commission and subordinate educational units received the modular data in the "data brain" from Dongcheng District. Thus, Dongcheng has greatly promoted the ordered and well-organized sharing of regional data resources.

2.2.2 Artificial Intelligence Boosts the Remodeling of the Education System

2.2.2.1 Double-Teacher Class Breaks the Time and Space Boundary of Education

In 2021, Dongcheng promoted the online teaching platform in the whole district, and planned to carry out the transformation and exploration of double-teacher classrooms

in the schools. Shijia Primary School and Gexinli Primary School are one of the first pilot twinning schools in double-teacher classes. The faculty forces in Gexinli Primary School are relatively weak. What's more, there is a big gap between teachers' different understandings of the textbook and those of famous teachers. Through preparing a class with famous teachers in Shijia Primary School, and conducting immersion observation and lectures, the professional ability of young teachers in the Gexinli Primary School has been rapidly cultivated and improved. Up to June 2022, 184 smart classrooms for double teachers have been put into use in Dongcheng District.

2.2.2.2 Integrating Classrooms to Improve the Quality of Education

The intelligent assistants and virtual experiment resources embedded in the cloud platform optimize the design of teaching content, which makes classroom teaching more vivid and scientific. The modern art classroom based on VR technology allows students to be immersive in the virtual art museum, in that way, students are able to be more focused on studying paintings. Smart PE classroom equipped with smart bands makes it possible to formulate exercise plans for students by using real-time monitoring data. Meanwhile, the accompanying data acquisition system and interactive feedback system supported by big data can solve students' problems in class to avoid leaving any loopholes. Some statistical tools, which can be used in the individual learning process, monitor students' independent practice in time, and accomplish accurate analysis and personalized evaluation.

After being affected by the epidemic, the whole district has entered an arena of online teaching, in which teachers need to fully tap the advantages of online teaching tools. For example, the teachers of No. 2 Middle School can guide their students and achieve the exercise effect through live interaction, roll call, online PK, etc., and the atmosphere of online PE class is very lively and relaxing. During the online teaching period, teachers have also made full use of the function of "family" and carried out work in other education fields except for academics. For example, the online Young Pioneers activity class of Jingshan School Primary School not only achieved 100% coverage and completion rate, but also completed one district-level open class, 12 school-level exhibition classes, and 31 grade observation classes.

2.2.2.3 AI Teaching Assistants Can Improve the Quality of the Homework and Reduce the Burden of Teachers and Students

Using the units of "Accurate Management of Homework" and "English Listening and Speaking Teaching" in the cloud platform, teachers can set flexible questions and test papers. They are able to collect the learning situation of students, accurately comment and push personalized homework, etc. At the same time, the synchronous test questions of "formative exercises" compiled by a unified proposition are provided. The

local resource library in this area takes the new curriculum and new curriculum standards as the core, and marks the labels of knowledge points, subject core literacy, academic level, etc., so as to improve the quality of homework from the source.

The AI-based homework analysis system automatically generates an analysis report from students' online answers, reducing the burden of teachers' manual correction and academic situation analysis. The homework answered offline can also be integrated into the collection of academic data by means of a scanner or photo collection, etc., to meet the students' needs of individual counseling and personalized feedback. Every student's shortages of learning are recorded systematically, and teachers can put forward strategies according to the knowledge map, so that every student can get high-quality customized layered homework quickly and accurately. Through this effort, the system help students consolidate knowledge pertinently, and reduce the burden on teachers and student. Up to June 2022, Dongcheng has introduced a number of AI-based job analysis systems in its whole district, covering all the subjects of the college entrance examination, with a total of over 500,000 learners.

2.2.2.4 Regional Based "Teaching and Research" Supported by Technology

Dongcheng District has established a platform centered on teaching and research based on big data. The platform provides an online and offline integrated environment, and realizes the collection and analysis of the whole teaching process for teachers. Managers and researchers can focus on teachers' real needs through those analysis reports, and realize thorough consideration from lesson preparation, teaching, listening and evaluating to teacher training and evaluation, thus forming a relatively systematic and completely new form of teaching and research in disciplines. Accordingly, teachers can intuitively get to know their performances in teaching and research activities through reports, and benchmarks with excellent teachers to achieve accurate improvement of teaching and research quality.

It has also established an intelligent "teaching and research" system. Taking the Hepingli School District in Dongcheng as a pilot school, the district has set up the demonstration base of the Big Data Precision Teaching and Research Center of No.171 Middle School Education Group. This project has also set up the "Inter-school Collaborative Precision Teaching and Research and Resource Creation Alliance" which includes several other schools, aiming to spread high-quality teaching and research experience, models, and achievements to each other. In that case, the overall improvement of regional teaching and research ability could be improved rapidly. Relying on famous school bases and famous teaching and research staff bases in Dongcheng District, it has built to build a regional research community and an online teaching and research demonstration model school, which have promoted excellent teaching experience and methods in the form of "spreading, helping and bringing". Depending on the double-teacher classroom, a "1 + 1 + x teaching and research community" has been formed, which is led by teaching and research staff. Teachers from leading schools perform as the main lecturers, and X teachers from member

schools participate remotely, so as to realize effective interaction among teaching and research staff, experts and teachers, and teachers in the whole region and even across the country.

2.2.2.5 Integration of Teaching, Learning, and Research Under the Guidance of Scientific Research

Dongcheng undertakes the national project of "Integration of Intelligent Technology and Teaching", and continues to make efforts to carry out the integration process of teaching, learning, and research led by scientific research. Taking the English subject as a pilot, the District Education Committee has carried out various listening and speaking activities in the form of conducting a research, and has launched nearly 20 AI classes related to this form. Based on the software and hardware equipment, teachers carry out teaching on those platforms, extract all kinds of data generated in students' daily practice, and deeply mine them to form an analysis report of districts, schools, classes, and individual students. Thus, a unique "Dongcheng's mode: data empowers the quality education" has formed completely. Up to now, Dongcheng has built 75 standardized examination rooms in 44 schools, 105 listening and speaking training classrooms in 48 campuses, and 130 sets of listening and speaking resources suitable for students in different regions, with a total of over 430,000 people being served.

2.2.3 Smart Campus Innovation Based on the "Future School"

Beijing Huiwen Middle School has embraced the application of "Smart Huiwen", providing the school with better working instruments for improvement, and providing teachers with tools for daily management and micro-class. The application also provides students with personalized online learning resources and a platform for class interaction, and offers parents personalized students' learning data as well as an efficient home-school collaboration platform.

At the end of 2021, Dongcheng launched a project to popularize digital management within schools, focusing on promoting the landing of WeCom. By June 2022, the education systems of the whole district have logged in WeCom, with a 70% coverage rate of "Education and Teaching", "Home-school Communication", and "Health Report" units. There are 36 online office processes, and more than 12,000 teachers and 150,000 parents access it. There are nearly 190,000 online teachers and parents every day, and more than 1,200 active home-school communication groups, which greatly improve the efficiency of management, and ensure the security of notification and data collection.

2.3 Promotion Mechanism

Actively carry out the construction of various universal communities. Relying on the Modern Educational Technology Department of the Chinese Institute of Electronics (CIE), Dongcheng has set up an excellent community of "data-driven precision teaching", and trained a group of superior discipline teams and teachers with outstanding teaching performance and strong data application ability. It cooperates with Beijing Normal University, Capital Normal University, Beijing Institute of Technology, Peking University, and other scientific research institutions and professional colleges to carry out research projects. They have formed an action research community, and try to promote theoretical innovation with the guidance of experts. Dongcheng unites the teacher training system of the Academy of Education and the "Information Leadership Improvement Project of Principal" of the Education Central Party School to build a community for improving teachers' information literacy. Relying on the Dongcheng District Youth College and School Innovation Association, they cultivate a regional talents training community and cultivate students' innovative consciousness and ability.

Pilot goes first, then multi-type pilot follows. Taking the Lama Temple Primary School as a pilot, Dongcheng has built a dedicated online teaching system for mathematics, and explored the transformation path with discipline characteristics. Moreover, being led by Beijing No.5 Middle School, six primary and secondary schools have carried out the "double classroom" research together, discussing the mechanism and method of cultivating reading and writing ability across long chains of Chinese disciplines, and improving the quality of regional education through training. Gexinli Primary School-Shijia Education Group and Qianmen Foreign Languages School-Jingshan School took the lead in the demonstration. Both of them have comprehensively pushed forward the double-teacher class of teacher rotation and twinning schools in the school district. Cooperated with Peking University in the "Winter Training Camp for Innovative Music Lessons", Dongcheng District not only speeds up the construction of innovative classroom forms, but also achieves its goal to assist teachers in the whole region with the mobile application.

Build a platform to optimize the supply service of educational resources. By building an intelligent self-learning platform, Dongcheng has set up a distance learning model of "self-access + guided tour + interactive Q&A". Dongcheng also explores self-learning scenarios based on learning resource supply, intelligent resource recommendation, and teacher-student Q&A interaction. It has promoted quality courses in the "college system", and carried out the training of artificial intelligence courses in primary and secondary schools. It tries to develop literacy-oriented subject courses and interdisciplinary courses. Therefore, it makes efforts to support interactive class in different schools, districts, and cities. Based on the cloud service platform of smart education in Dongcheng District, Dongcheng has also fully popularized the "one person and one space" model for online teaching and learning between teachers and students in the whole district, realizing that

teaching applications cover all teachers and learning applications cover all school-age students, and striving to form a new normal of talent cultivation and resource supply in the "internet+" circumstance. Until now, 106,247 students' spaces, 21,576 teachers' spaces and 193 schools' spaces have been set up, integrating 41 national educational resources public service platforms, national primary and secondary school network cloud platforms, Beijing education public resources platforms, and third-party education and teaching applications.

2.4 Experiences and Expectations

Sustainable development. Dongcheng has broken through the traditional mode of educational informatization construction, embraced the Internet application positively, and absorbed the superior business services of various Internet companies actively. Combining with the "data brain" in Dongcheng, the District Education Commission has also actively created an integrated ecology of Internet applications and regional smart education applications, "leaving" the educational data generated by Internet applications in Dongcheng. During the process, Dongcheng has helped the sustainable development of regional smart education with the accumulated educational big data.

Application. In the process of digital transformation in Dongcheng District, the faculties resolutely implement the two-way promotion of technological innovation and business promotion. They have adhered to improve educational informatization from a scientific perspective, and insisted on giving priority to business applications. After fully implementing the three links of pilot exploration, highlighting demonstration and experiencing promotion in all work, Dongcheng has promoted the branding of smart education achievements.

Data brain. Dongcheng District's "data brain" grasps the development trend of regions, schools, teachers, and students in real time. It contributes to exploring the full application of educational data in monitoring, campus security warning, management, information control, inter-school collaboration, smart teaching comprehensive literacy evaluation, etc. To form a new mechanism of "using data to assist decision-making", it has constructed a new model of "one picture" education governance based on data visualization.

In the future, Dongcheng will continue to promote the systematic construction of "data brain", cooperate with technology companies to optimize algorithms and develop technologies, and cooperate with university think tanks to construct educational data models. Ad hoc, it will provide support for accurately evaluating the present situation of education and teaching, accurately predicting the development of education as well as refining education decisions. Dongcheng will explore the establishment of a smart decision-making system based on the comprehensive level of students' ability, knowledge, psychology, etc. and rules suitable for educational applications. It will be dedicated to exploring education equity under technological empowerment, and studying the smart educational application and service system,

providing support and basic guidance for the access and evaluation of smart education and artificial intelligence products, so as to effectively enhance educational quality and promote education equality.

Chapter 3
Group Intelligence Sharing Promotes Professional Development of Regional Teachers

Ping Xie, Guodong Gu, Yanqing Duan, and Yushun Li

3.1 Group Intelligence Sharing Promotes Professional Development of Regional Teachers

Yuncheng, as a central and western city with a large population base, relatively lacks educational resources, and teachers' information literacy needs to be improved. The key to completing the task of creating a smart education demonstration zone with high quality lies in "bringing in and going out". The very first step is to bring in expert teams and advanced educational resources, and build a team of local professionals under the guidance of those experts. After a full investigation, literature research, and comparative analysis, it is decided to start with the construction of the education system, and explore new and effective ways for smart education to empower the development of the regional education era.

Task 1: Promote the cultivation of students' innovative ability and practical ability.

Yuncheng integrates the faculty of information technology, science, comprehensive practice, and other disciplines in the city. Based on the educational concept of Maker, it has formed a school-based Maker curriculum practice combining with the characteristics of schools. With the cultivation of students' core literacy as the fundamental purpose, the curriculum content reflects the overall understanding of interdisciplinary concepts.

Task 2: Explore a new teaching model.

Yuncheng has initially constructed a school-based Maker course system that meets students' psychology, cognition and creativity. Taking the Maker course: Foundation of Open Source Hardware as an example, three teaching modes have been formed:

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a. Basically, there is a teaching mode based on lectures (1 class hour: for a single knowledge content), such as plan sharing, process analysis, which conforms to the characteristics of students' cognitivity.
b. Then, there is a "5E" teaching mode (3–4 class hours, subject-oriented knowledge content), which contains engagement, exploration, explanation, elaboration and evaluation. By creating real-life situations, teachers can stimulate students' interest in learning, arise students' cognitive conflict as well as motivate students to actively explore new knowledge.
c. Lastly, there is a project-based learning teaching mode (12–16 class hours, focusing on the completion of problems and tasks), including defining problems, designing schemes, working together, displaying works, evaluating and revising. Teachers ought to encourage students to conduct in-depth inquiry into problems related to disciplines or interdisciplinary subjects, and mobilizing students' knowledge, ability and quality to solve problems creatively.

Task 3: Improve the supply capacity of educational resources and services in the region.

To face the practical problems of teacher education and teaching, Yuncheng has established inter-school teacher training workshops, and formed local Maker education resources through expert guidance and peer teaching and research, so as to promote teachers' professional development.

At present, the infrastructure conditions of smart education in Yuncheng basically meet the needs of schools in various regions to set up Maker courses. The construction of professional teachers has been basically completed. 54 Maker base schools have been selected and 146 maker education backbone teachers have been trained accordingly.

3.2 Innovate the "Group Intelligence" Mechanism

3.2.1 Innovate the Guarantee of Regional Maker Curriculum Mechanism.

The first one mechanism is the management mechanism. By the end of 2021, all primary and secondary schools in the city, especially the leading schools and demonstration schools of the second phase of smart education, have realized the "six projects" of Maker education. The "six projects" are namely: setting up a Maker course, building a Maker space, allocating a Maker teacher, guaranteeing one Maker class per week, organizing a Maker education carnival every year, and completing one Maker work every year.

The second one is the incentive mechanism. Each county, city and district is expected to strictly implement the specific requirements of the Bureau of Education. The target schools set up full-time positions for Maker teachers and formulate relevant

incentive measures. They have also provided the curriculum research and development and creative design for backbone teachers, and incorporated the evaluation of Maker teachers into the evaluation of teachers' professional titles.

3.2.2 Form a Curriculum System with Characteristics of Yuncheng

Through visiting and studying in the schools embedded in Maker education, a systematic combination and analysis of the field research was conducted. After studying the related literature with the theme of Maker education, a localized Maker curriculum system is formed in combination with the regional development characteristics of Yuncheng.

The course content of Maker is planned by the Bureau of Education, including *Foundation of Open Source Hardware, 3D Creative Design, Electronics and Control, Structure and Machinery*, etc. The course mainly involves three categories: inclusive courses, inquiry courses and extended courses. There are more than 20 courses in total, which are offered to students from grade three to grade two in Yuncheng primary school. Combining the school-running ideal, characteristics, conditions, teacher allocation, and academic situation analysis, the school selects the content and theme independently and constructs a school-based curriculum system initially. The school conducts inter-school workshop discussions and activities regularly to promote the co-construction, sharing, optimization, iteration and promotion of high-quality school-based Maker courses. The followings are the explanation of the specific parts of the curriculum system.

Nature of the course: Maker Course in Yuncheng is a comprehensive course or in other words, interdisciplinary course. It aims at promoting the consciousness of accountability, innovative thinking and practical ability of students, and it tries to cultivate students' confidence in Chinese culture and nation in all primary and secondary schools. It has the characteristics of openness, locality and inheritance, and focuses on creating Maker culture.

Objectives of the course: It focuses on the development of responsibility, innovative thinking and practical ability of students, combining different regional characteristics and learning circumstances. It clarifies specific requirements, and provides a reference framework for teachers to develop Maker curriculum design.

Construction of the curriculum: Maker course construction involves theme selection, learning activity design and process teaching evaluation, etc., which cultivates the higher cognitive ability of students and emphasizes the materialization of creative works. Take the Maker course of Yuncheng Middle School in Yanhu District as an excellent example. With the theme of "Guan Gong Shadow Puppetry Based on Neural Network", the school combines Guan Gong culture, Pu Opera and non-material culture—Chinese shadow puppetry with modern AI technology. Eventually,

the course realizes intelligent shadow play, and enables students to appreciate the charm of thousand-year-old shadow puppetry and the non-material culture.

Implementation of curriculum: Referring to the basic principles and effective strategies of project-based learning design, Yuncheng makes students experience meaningful learning practices, such as inquiry practice, social practice, aesthetic practice, technical practice and regulatory practice.

Evaluation of curriculum: Yuncheng has formulated *Guidelines for Curriculum Construction and Implementation of Maker Education in Yuncheng Primary and Secondary Schools*, and provided a reference framework for relevant curriculum evaluation. It has highlighted the evaluation method which is combined with the process, summary and multi-subject participation, with the purpose of promoting deep participation of students in the learning process. The evaluation subjects are more diverse compared with the past, including self-evaluation, peer editing, teacher comment or suggestions from the public and professionals outside the school. Project schools are encouraged to formulate appropriate evaluation gauges according to their authentic situation. The design of evaluation gauges is not aimed at diagnosis, but to achieve the key evaluation dimensions, triggering students' self-monitoring and reflection, and motivating students to explore, create and cooperate in a deeper level.

3.3 Build an Ecological Mechanism of "Group Intelligence"

3.3.1 Regularly Organize the Cultural Maker Activities.

It is a good idea to regularly organize the cultural Maker activities. Every year in the first ten days of March, municipal competitions, such as information literacy improvement activities, for teachers and students in primary and secondary schools in the city are organized. Counties (cities/districts) are selected and awarded from bottom to top according to local conditions. Excellent students and their works are selected to participate in national and provincial competitions and all of them have achieved outstanding results.

3.3.2 Create a Maker Platform for Teachers to Communicate and Share.

3.3.2.1 Maker Education Cloud Space Realizes the Normalization of Cross-Regional Teacher Training

In order to realize the sharing of wisdom among 13 counties (cities/districts) and 9 municipal schools across districts and counties in Yuncheng, the Maker education cloud space was created based on the Yuncheng Smart Education Cloud Platform. The Maker courses, teacher training programmes, Maker education workshops, Maker activities, online communication, Maker display, survey questionnaire and other modules were set up to help Maker teachers improve their professional ability and provide a platform for display and communication.

It has set up teacher training workshop activities. The Maker Workshop organizes teaching and research activities on a weekly basis, and the participants include the training objects and expert teams of key teachers of Maker Education in Yuncheng. The team consists of "group intelligence" experts, Makers' experts, teaching and research team leaders, and technical professionals. Based on the workshop teaching and research activities, the contents include the construction of school-based Maker curriculum system for decision-making, and grinding for teachers.

There are maker education and research activities in the city. It is mainly based on the online lecture of the quality course of Maker Education. After the teaching and research activities, on the basis of the joint case, the teachers combine the academic situation and the school situation to practice in class. Teachers will share the teaching design after practice, reflection and re-optimization in their own maker education workshop space, and the owner of the workshop will be responsible for organizing the teachers to conduct secondary teaching and research. All workshops will submit and share the "group intelligence" teaching design results after secondary teaching and research to the Yuncheng maker education space.

Yuncheng Maker Education Teaching and Research Activities are cooperated with 54 Maker Education Base Schools, 98 Maker Education Project Schools and 146 Maker Education backbone teachers in Yuncheng, with a total of 183 people.

3.3.2.2 National Well-Known Experts Lead the Rapid Growth of Maker Teachers

The Education Bureau of Yuncheng organized 146 key teachers of Maker education to participate in a series of training for improving the professional quality of Maker teachers. For example, in July 2021, the *Fair, Individualized and Quality Education—Shanxi Smart Education Demonstration Zone Teachers' Information Literacy Improvement Project—2021 Maker Education Special Training Course* jointly organized by the Training Center of the Central Audio-visual Education Center and

Education Bureau of Yuncheng was held in Northwest Normal University. The special training was carried out through various forms such as expert lectures, lesson sharing and hands-on exercises.

3.3.2.3 Local Famous Teachers Lead the Professional Growth of Regional Maker Teachers

Every October, the Education Bureau of Yuncheng organizes the selection of quality courses for Maker education in primary and secondary schools. According to the selection results, it selects quality courses at the municipal level, and carries out teaching observation and demonstration activities in batches by relying on Maker education space and teaching and research activities. Yuncheng also invites experts in Maker education to make targeted comments on the aspects of curriculum design concept, curriculum implementation and teaching evaluation, so as to effectively promote the professional growth of Maker teachers and achieve larger-scale guidance and radiation.

3.4 Reflection and Expectation

After more than two years of Maker education practice, Yuncheng has built a Maker education system based on regional education. Through breakthroughs in different levels such as team building, mechanism innovation, activity guarantee and ecological development, a sustainable regional Maker education ecology has been formed. The future of Maker education in Yuncheng will be an endogenous new variable to stimulate the professional growth of teachers. The whole city will stand at a fresh start to cultivate innovative talents and construct new innovative education forms. It will explore effective paths for the literacy-oriented new curriculum reform process and contribute Yuncheng's experience and wisdom to the cultivation of innovative talents in the central and western regions.

Chapter 4
Build a Smart Education Cloud Platform to Boost the Quality Development of Regional Education

Zhongtao Zhang and Yongping Kang

4.1 Background

In 2019, the Minhang District was selected as the "Smart Education Demonstration Zone" of the Ministry of Education, and then the *Implementation Plan for Establishing a "National Smart Education Demonstration Zone" in the Minhang District* was formulated. The district has promoted the "1258 Project" of tailoring teachers' teaching to students' varied abilities on a large scale.

The smart education in Minhang District has been built early, and the ecological chain of its education informatization is complete. However, with the deeper and deeper application, the flaws of traditional education informatization platform and application construction are gradually exposed, including management problems caused by complicated third-party applications, the inability to effectively integrate data information of various educational units, and lack of data security rules and regulations.

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4.2 Major Measures

4.2.1 Constructing the Digital Base of Minhang Smart Education

The construction of the smart education demonstration zone is based on the cloud platform. The digital base can largely improve personalized teaching management and big data applications for primary and secondary schools in the whole district.

It needs to build a data center. Through building a smart education cloud platform, data interconnection can be promoted significantly. The capabilities of data collection, analysis, governance, and sharing can be given full play. Through multi-department joint evaluation and collaboration, the basic data sources of five types of users in the area and other educational special business data sources are established. At the same time, with the support of multiple units at two levels in urban areas, the basic data is continuously collected and managed to form stable data assets.

A number of theme libraries have to be established. Based on all kinds of basic data and business data in the data center, a special subject database has been built. It could help us realize the sharing of data, and reduce data duplication and storage. Through the parallel promotion mode of "inner circulation" of regional education applications and "outer circulation" of municipal education applications, the service ability of the subject database is verified.

Try to promote the use of the application in the Minghang District. It is urged to evaluate the use coverage, user activity and development planning of educational applications in the region, promote the cloud deployment of educational applications, meet the requirements of intensive management in the new era, and realize the flexible management of resources. Meanwhile, checking the service capability of the cloud platform by applying data, refining educational data standards and business specifications and providing data-sharing services are also encouraged.

Achieve the login process. Through building a unified portal integration application, and promoting the login and logout process in the cloud platform, Minhang District has realized the smooth switch of the account system to the cloud platform. It also manages the existing user data in the Minhang District cloud OA system, teacher growth file system, student registration system, financial media, citizen cloud and other systems.

Minhang District also implemented dynamic monitoring and promoted data management. It develops visual pages of basic data, book borrowing, physical examination, data exchange, one-way network management, cloud application, etc., and presents data convergence and governance results of cloud platform, interface status of business application and dynamic business operation. Thus, it has realized dynamic, multi-dimensional and multi-granularity monitoring data governance and data application.

4.2.2 Promote Data-Driven Individualized Teaching

4.2.2.1 Promote the Smart Education Project

The regional research center cooperates with the technology center to create a project promotion research atlas. In the first year, a total of 103 primary and secondary schools in Minhang District applied for 143 district-level research projects; 43 primary and secondary schools applied for 43 school-level projects. In the second "Promote Data-driven Individualized Teaching" project application, there were 68 small and medium-sized units, and 191 research projects were applied, including 141 district-level projects and 47 school-level projects. Minghang has set up an inter-school group CIO, and allocated district school project liaison officers, and formed a community of project research and implementation that is contacted by special people and coordinated.

4.2.2.2 Create Ecological Smart Education

Build a digital business support system and provide diagnostic services and business support for teachers' professional proficiency with the help of big data. Minghang has set up six education and teaching application and management systems: cloud recording and broadcasting classroom evaluation system, research and research management system, Minzhixuetang online course system, academic quality evaluation system, personalized learning intelligent service system, and electronic files of teachers' professional growth.

Construct a learning support environment for students, and provide students with adaptive growth services by means of a mathematical intelligence teaching system and intelligent homework system. Establish a personalized evaluation model for students, accurately diagnose their personality growth, determine their weak knowledge points and learning paths, and recommend learning resources that match their learning ability.

4.2.2.3 Teaching Analysis Based on Artificial Intelligence

Build an intelligent homework system, realize automatic homework marking, support intelligent evaluation of spoken English, etc., and reduce the burden on teachers. Data collection methods of paper job scanners and dot matrix digital pens are developed to realize multi-path intelligent job data. Mining students' learning quality data embodied in intelligent homework, forming students' portraits, and analyzing students' academic level and value-added evaluation results; Using cluster analysis model, students can be classified, which can be used to guide hierarchical teaching in class. Carry out thematic comprehensive teaching and research activities based on homework data in primary schools. Through the data analysis of node homework,

carry out targeted teaching and research activities, improve related problems and test the effectiveness of problem solving, and realize data-driven accurate teaching and research.

4.2.3 Promote the Construction of Two Assistants

Develop intelligent teaching assistants and students' intelligent learning partners, and provide multi-terminal and multi-platform software services for teachers and students in the basic education section. Teachers' intelligent assistants take teachers' lesson preparation as the breakthrough point, provide teachers with learning information reference based on the ability of gathering and analyzing learning information of intelligent education cloud platform, and provide intelligent teaching aids to help teachers better realize personalized teaching and counseling. Students' Intelligent Learning Companion takes a "three-step method of intelligent learning" as AI learning path planning method, which realizes the overall learning coverage of the weekly study, exam sprint and intelligent vacation, and provides an interactive system with teachers' intelligent assistants, so as to realize the interconnection and cooperation between students and teachers.

4.3 Effect and Achievements

4.3.1 Build a Digital Base with Cloud Platform as the Core

Minhang District Smart Education Cloud Platform has completed the construction of main functions and the governance and convergence of basic data in the whole district, and selected and promoted the cloud management of major educational informatization applications in the whole district in an orderly manner. After two years of construction, the cloud platform has made the following progress:

Build a data warehouse. As of May 2022, the smart education cloud platform has docked 48 education business systems, with 5,282 access data tables and 838,466,120 access data. At the same time, it has completed the construction of 19 professional question banks, including students' physical and mental health data and students' competition data. It provides 44 external data interface services, with 62 business applications calling interfaces, 2,448,061 interface calls and 88.89 million data calls.

Eliminate information gaps. The cloud platform has built three basic user libraries of institutions, students and teachers, and several subject libraries such as school calendar, enrollment schedule, enrollment area and senior high school entrance examination results query. Provide services for third-party applications through various data interfaces; Support kindergarten enrollment in Minhang District; Support the recruitment of teachers. One thing: the data flow is opened

and implemented. In 2021, Minhang, as the pilot of the first batch of accurate education services in the city, successfully completed the first accurate push of education policy in June.

Explore the application of the cloud. The cloud platform has successively completed the first batch of seven educational applications, including a comprehensive information release system, library management system and public service platform. These applications are deployed in containers, and can be flexibly recycled and expanded. The cloud application can call the basic data of the data center and return the business data, thus realizing the sharing and integration of the authoritative data of the cloud platform.

Application unified authentication. At present, the unified identity authentication, single sign-on and logout of five types of users in the cloud platform have been completed. The cloud platform docked and managed the existing user data in the Minhang District Cloud OA system, teacher growth file system, Shanghai student registration system, financial media, citizen cloud and other systems, and realized the smooth switch of account system to cloud platform. Complete the unified certification docking with the Shanghai Education Certification Platform, Shanghai Citizen Cloud, Shanghai One Netcom Office and Minhang Rong Media.

4.3.2 The First Step to Data-Based Large-Scale Individualized Teaching

A regional-oriented big data platform for teachers has been built. Referring to the professional standards of primary and secondary school teachers on the platform, combined with the basic forms of regional data collection and analysis, a three-dimensional portrait system of regional teachers is constructed according to three dimensions: label system, label hierarchy and label attributes. The label system is designed according to personal characteristics, professional characteristics, development preferences and social labels. In addition, a dynamic label generation mechanism is reserved to mine the characteristics of individual teachers and group teachers, and the label system is generated concomitantly.

Promote differentiated teaching practice driven by data under the background of "double reduction". A platform to support differentiated teaching is built, and a unified standard data collection, analysis and application path is constructed. A high-level learning quality analysis model and a learning engagement analysis model are formed, and through the normal analysis of homework data, hierarchical suggestions for students are realized. At the same time, it can carry out interdisciplinary job duration warning, job burden analysis and job behavior analysis, so as to realize the "double reduction" data-driven mode.

4.3.3 Promoting Modernization of Education Governance Based on the One Network Office

After undertaking the pilot work of the municipal government and the municipal education commission, Minhang District has established an information disclosure system for public enterprises and institutions in the area of basic education, formulated a standardized catalogue, built an intensive platform, and accumulated a lot of information and data resources. At the same time, Minhang District pioneered the city's first district-level education public service scenario application. Ten public service items have been launched at the "follow-up" flagship store in Minhang District. The promotion plan of "New Teacher Entry" has been formulated and reported to the District "One Network Office" Promotion Office, No Meeting "to handle all kinds of review approvals, administrative approval network handling rate and the whole network handling rate are among the highest in the region. "Easy to do" matters are basically approved and approved by the District Review and Reform Office and the Administrative Service Center.

4.3.4 Promoting the Construction of Informatization Benchmark School Based on Eight Application Scenarios

Rose Primary School provides more convenient and personalized service by constructing health perception, intelligent lighting, safe recognition, teaching behavior recognition and so on. Minhang High School of Science and Technology Affiliated to ECUST adheres to technical empowerment, enriches teaching form in curriculum construction and implementation, classroom learning environment, teaching and learning mode transformation and virtual hierarchical teaching, and provides intelligent learning and exploration services to students. Based on data-driven grouping, Shanghai HuaEr Private Middle School tries the data integration and interoperability of one school, multi-district and multi-section, and builds the intelligent management platform of the school. The Southwest Project focuses on building the support system and core application of the "Virtual and Real Integration Learning Field". At the same time, three schools, Xincheng School, Xiangyuan Primary School and Aibo Guoguo, have been selected as the third batch of benchmark schools in Shanghai.

4.4 Problems and Experience

Smart education cloud platform demonstration in the process of creation, the same force, achieved initial results. But there are also many problems and difficulties in the process of propulsion.

The mutual restraint between information application advancement and data security. Too much attention is paid to application popularization and convenience, exposing the risks of too many systems, lagging information security management, improper system operation and maintenance, and weak personal privacy protection. Therefore, the region should do a good job of daily operation and maintenance, implement the system running on-line pre-record system, and entrust professional companies to supervise the whole process. At the same time, we should strengthen the education and protection of personal information security of teachers and students in the education system to avoid choking.

Contradiction between data convergence and management convergence. The Education Bureau of Minhang District, in conjunction with the opening of public data resources in the district, conducts business consolidation and data convergence to provide users with a service supply that matches their needs. It has reconstructed the school's smart learning environment and support services system, consolidated and upgraded a batch of "Teaching Cloud, Teacher Cloud, Student Cloud, Parent Cloud" applications, so as to improve service provisioning and user demand matching, and enhance user application experience.

Further steps to explore sustainable incentives under existing conditions. At present, under the condition that the total amount remains unchanged, we can explore incentives for the implementation of smart education projects through the Education Rewards Foundation and the Performance Pay Increase section. In terms of professional title evaluation, appraisal evaluation, talent training, teacher assessment, cadre promotion, subject research, project development, etc., create conditions for teachers to stimulate their enthusiasm under limited conditions.

How to ensure sustained and effective investment in the severe economic situation. Affected by the international situation and the COVID-19 epidemic, the domestic and international economic recovery cycle is long. At present, our district mainly ensures the funds needed for all kinds of projects in the establishment of the smart education demonstration zone through district and town financial funds. However, the investment period of informatization construction is long, and the effect is slow. It is suggested that the Ministry of Education give certain policy support from the top level to the regions that undertake the task of creating smart education demonstration zones, so as to raise funds from various parties and strive for supporting support from municipal and district-level funds.

Chapter 5
Practice and Exploration of Digital Transformation of Integrated Education Between Schools and Urban Areas in Hanyang District

Kui Cai and Ting Tan

Focusing on the general goal of "building an integrated platform of districts and schools, and creating an intelligent education ecology", Hanyang District has built a large platform of intelligent education of urban schools based on the Wuhan Education Cloud. We have implemented three projects and promoted three major actions, and have created a number of intelligent campuses with intelligent teaching, management, evaluation and other functions, initially forming a perceptible, analyzable and self-healing educational ecology of urban schools based on big data.

5.1 Improve the Smart Environment and Promote the New Infrastructure of Smart Education

Upgrade the education metropolitan area network. Hanyang District has promoted the construction of an education metropolitan area network, and upgraded to 5G bandwidth in 2019. At present, all primary and secondary schools in the district have achieved full coverage of 5G+ campus WiFi, and a regional intelligent education wireless network has been built. All schools can log in at one stop and switch seamlessly. The educational private network not only lightens the burden of using the broadband network in schools, but also ensures the large-scale concurrent use of unified applications.

Optimize the construction of educational cloud platform. Relying on Wuhan Education Cloud Platform to customize the "Smart Education Platform of Urban

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School Integration" and integrate the public platform of educational resources and management, on the one hand, Hanyang District continues the common applications of Wuhan Education Cloud, such as high-quality resource sharing, smart classroom teaching, smart campus management, smart marking analysis, educational space intercommunication, teacher course community, and home-school management communication. On the other hand, through joint research and development, the functions of regional high-quality resource gathering, third-party application access and regional OA management are added. In addition, the regional calibration of spatial data can realize the generation, aggregation and processing of all aspects of data. The integration of basic platform, common application, big data and service guarantee between schools and districts has been preliminarily realized.

Build a smart campus model school. Hanyang District has promoted the construction of an intelligent campus from six aspects: intelligent environment, intelligent teaching, intelligent management, intelligent evaluation, intelligent life and intelligent culture. 12 5G virtual laboratories, 30 smart classrooms, 20 artificial intelligence classrooms, 13 intelligent standard examination rooms for physics and chemistry experiments in junior high schools and 14 smart libraries have been built. 94% of primary and secondary schools have maker classrooms or STEAM classrooms, and each school has at least one micro-e-book recording and broadcasting room. At the same time, the city's first district-level innovative education and learning center, one nationally famous flip school, two digital campuses in Hubei Province, 20 four-star smart campuses in Wuhan and six municipal-level flip classroom 2.0 experimental schools have been built, and the hardware environment of smart education in the whole district has been improved significantly.

5.2 Promote Smart Teaching and Lead the New Reform of Classroom Mode

5.2.1 A New Model of Smart Classroom

During the epidemic, Hanyang District has guided the schools in the whole district to carry out the research activities and model competition of "model restart" around "core literacy leading and information technology empowerment" on the basis of the original efficient classroom teaching model. All schools have fully consolidated the practical achievements of "online education", "flipped classroom" and "blended learning". For example, Chucai Middle School's flipped classroom 2.0 model and "happy flipped ABC model" give the flipped classroom teaching model a new connotation; Cuiwei Middle School's "Enlightening Teaching Mode" stimulates students' potential through independent inquiry learning; Second Bridge Middle School's "One Two Four Sunshine Teaching Model" highlights the student-oriented educational concept and promotes students' active development; Chucai Primary School "three sections, four steps and twelve links" flipped the classroom teaching mode,

and actively explored the conversion mode conforming to the development of various disciplines.

In addition, the intelligent teaching application of the integrated platform of district and school provides important support for creating a three-stage intelligent classroom teaching mode. In the pre-class session, we have built a pre-class learning resource library, a classroom teaching courseware library and a personalized question bank consolidated after class, which are shared in the school, with the help of teaching assistants, to support basic autonomous learning (micro-class, resources, testing and questioning). In the middle of class, we use smart classrooms and interactive classrooms to carry out inquiry deep learning (interaction, detection, communication, display, AI data collection). In the after-class session, big data with intelligent detection is used to support the reflective learning process (personalized homework, counseling, reflection and consolidation).

5.2.2 A New Path of Innovative Education

Hanyang District actively explores a brand-new mode of education, and explores a new mode of innovative education by starting the innovative education training program of "Science and Technology Academy", building a district-level innovative education learning center, setting up an innovative education laboratory, launching innovative education series massive open online course and building innovative education curriculum resources in schools.

5.2.3 New Exploration of Virtual Experiment

In July 2020, Hanyang District became one of the six experimental areas of virtual experimental teaching in primary and secondary schools in China, and 12 schools in the district were identified as experimental schools. Against this background, the Education Center of Hanyang District Education Bureau and the Audio-visual Education Center jointly carried out cross-disciplinary teaching and research activities of virtual experiment teaching, carried out relevant training of virtual experiment teaching, and expanded the radiation effect. For example, on October 28th, the Central Audio-visual Education Center held the first regional training meeting of virtual experiment teaching in primary and secondary schools. In addition, in February 2021, Hanyang District Virtual Simulation Teaching Application Experimental Community was successfully selected for the 2020 Education Informatization Teaching Application Practice Community Project of the Science and Technology Department of the Ministry of Education, and passed the implementation scheme verification in May.

5.2.4 New Attempts of Service in the Context of "Double Reduction"

Hanyang District makes full use of the integration platform of urban schools to explore the mode of "Three-Heart Smart Trusteeship". First, "rest assured" means that the attendance of the shift schedule will be pushed immediately. During the club experience course, students will push the attendance information to their parents immediately by swiping their cards, so that parents can know which class their children are taking in which classroom, by which parents can rest assured. Second, "peace of mind" means that the home-school interaction of electronic class cards is timely ordered, which helps parents to ease. If parents can't pick up their children at school in case of emergency, they can leave a message on Renren's mobile phone, or they can communicate with their children through electronic class cards. Teachers will adjust the school time according to the situation to make parents feel at ease. Third, "Comfort" is the live broadcast system of mixed-age service. Parents can keep abreast of students' trusteeship online and make parents feel comfortable.

5.3 Innovate Management Mechanism and Explore the New Normal of Smart Education

In the process of promoting smart education, Hanyang District has initially formed the driving mechanism of "five-in-one collaborative innovation", the guarantee mechanism of "five initiatives" and the service mechanism of "one center for comprehensive research and training".

5.3.1 Collaborative Innovation from 5 Directions

A leading mechanism for cadres under the CIO system of school education has been established, and one CIO of the district education bureau and 55 CIOs of primary and secondary schools have been selected to comprehensively plan and develop the informatization of district schools. The teaching and research department builds the Hanyang District Smart Education Research Center, implements the 1 + 1 + N informatization leading geese training plan, and regularly carries out smart education research and training and applied R&D activities. The Education Bureau of Hanyang adopts the mechanism of joint research and development, pilot school selection, polishing iteration and scale promotion, selects and trains famous teachers of smart education, polishes and perfects an application, and promotes it on a large scale in the whole district. They have also improved the coordinated promotion mechanism of basic education, education center, audio-visual education hall, housing management station, training department and other departments. Network enterprises

in cloud hosting strengthen in-depth service in districts and schools and optimize the mechanism of weekly R&D meetings.

5.3.2 Five Initiatives: Integration of District and School

A big platform for school integration in urban areas, supporting the balanced development of smart education on a large scale. All schools in the district have established online portals through cloud platforms, and all students, parents, teachers and staff of educational institutions have their real names authenticated through unified ID.

The school plans and builds in an all-round way to ensure the real formation of educational big data. The Urban Education Bureau makes a unified plan, integrates the three-level funds of urban schools and makes overall plans for the construction of various infrastructure facilities and supporting software platforms for smart education. For example, the newly built smart classrooms, smart libraries, 5G virtual laboratories, artificial intelligence laboratories, etc. in the whole district ensure that all third-party applications can be connected to the cloud platform before construction, and simultaneously build a district-level application data platform, so as to avoid repeated waste and information islands.

The three levels of resources in the urban area complement each other, which ensures the accuracy and practicality of the smart education resources in a deep level. Wuhan Education Cloud Platform and Massive Open Online Course Platform purchased the teaching resources matching the current textbooks of primary and secondary schools, and provided them to primary and secondary school teachers in the city free of charge. Hanyang Cloud Platform gathers the endogenous characteristic teaching resources in this area as a supplement, including Hanyang Micro-course resources, massive open online course of Science and Technology, Red Course of Moral Education, and Online Parent School. Through resource reprocessing, the school forms school-based resources for teachers to try out. Teachers call various teaching resources for teaching through applications such as "Teaching Assistant", "Interactive Classroom" and "Mobile Platform" of Wuhan Education Cloud Platform.

Community famous teacher studio, normalization to ensure the development of intelligent teaching and research activities. Smart Research Center (research and training base) provides offline space for teachers and researchers to carry out teaching and research. The curriculum community and famous teacher studio on the urban integration platform provide online teaching and research and collection space for famous teachers, researchers and school teachers. Teachers are encouraged to actively carry out exchanges and interactions, so that more teachers can share their professional learning experiences across regions and campuses without being restricted by time and space.

School-level competition for research and training in urban areas promotes the practical application of intelligence. The school has carried out a series of

competitions and training around the goal of "empowerment of intelligent quality education", taking competition instead of training as the starting point to promote the comprehensive reform of intelligent classroom teaching. In addition to the evaluation of high-quality courses, many competitions, such as the evaluation of famous teachers of smart education in Wuhan, the evaluation of outstanding teams of informatization applications in school education, and the evaluation of advanced individuals, are also held.

5.3.3 Comprehensive Research and Training in One Center

Education Bureau of Hanyang District established the Hanyang District Smart Education Research Center to provide four kinds of services for the whole education system. Firstly, they have provided big data analysis based on the integration platform of urban schools for the relevant decision-making of the leaders of the Education Bureau and various management departments. Secondly, they have carried out teaching and research activities based on the application of smart education for all teaching and research staff in teaching and research departments, and provide software and hardware support. Thirdly, they provided a place for teacher training departments to carry out smart teacher training. Fourthly, a series of research and training activities are carried out for Hanyang Smart Education Laboratory (including management laboratory, teaching laboratory, moral education laboratory and innovative education laboratory).

5.4 Relying on the Innovation Pilot, Create a New Model of Smart Education

In order to carry out an innovation pilot and create a new model of smart education, the Education Bureau of Hanyang District selected some leading schools from a number of smart campuses to pilot innovative applications through voluntary declaration and comprehensive evaluation.

Create a digital identity. The Ministry of Education selected Wuhan as a pilot, and Hanyang District, as a pilot area in Wuhan, tried first, and realized the "one person and one education" ID card, which provided important support for giving full play to the utility of educational big data and carrying out all portraits of teachers and students.

Carry out intelligent teaching and research. Hanyang has researched and developed the classroom AI teaching behavior analysis system, collected the behavior data of accompanying classroom videos and eye-protection ink screen terminals, and explored a large-scale personalized smart classroom learning mode. At the same time, a regional Internet school, a smart classroom and a recording and broadcasting

classroom built by Unicom School have been built. With the support of the education metropolitan area network, regional class patrol and AI analysis evaluation have been realized. It will be integrated with the evaluation of teaching and research staff to explore a more high-quality, efficient and intelligent smart teaching mode.

Explore regional governance. It is practical to evaluate schools according to the applied data of school education in cloud hosting. Schools evaluate teachers according to big data, and form an education regional governance ecology that manages big data.

Create ecological education. Based on the Internet of Things technology, the construction and application of intelligent ecological environment base has been carried out. Teachers and students can view relevant ecological environment data and control related equipment work through the integrated platform of the district and school.

Evaluation of innovation. We explored the comprehensive evaluation of students and the files of teachers' growth and thus formed the evaluation of teachers' and students' growth through the accompanying data collection of space application. We aimed to promote the efficient application of space, and make sufficient preparations for the portraits of teachers and students.

Promote smart construction of Party development. We set up the column of "Smart Party Building" on the integration platform of districts and schools to provide various resources for teachers and students to learn the history of the party.

Applied smart sports. We tried the application of intelligent physical education teaching based on body perception technology, and monitor students' physical data through sensors, so as to accurately guide students to carry out physical activities and ensure their health.

Popularize virtual experiment teaching. Explore the virtual experiment teaching mode in depth, provide lessons and models for the whole country, and at the same time increase the promotion and scale promotion of the results in the region.

5.5 Look Forward to the Future and Build a New Ecology of Quality Education

In the future, Hanyang District will accelerate the integration and innovation of information technology and education and teaching through the four major tasks of "optimizing and upgrading smart education, deepening integration and innovative application, comprehensively improving information literacy, and helping to optimize educational governance", and strive to build a new mode of education and teaching under the guidance of student-centered educational concept. In order to realize the overall leap of "intelligent learning management level, innovative teaching methods level, professional teacher training level, refined education governance level, and integrated network security level" in the whole region, Hanyang provides a mode of "intelligent

education and wise future" in the creation of smart education demonstration zone, so as to create a new pattern of future education that is student-oriented.

Chapter 6
Smart Education Promotes the Revitalization of Rural Education

Xiangen Miao, Chenhui Xu, and Meihua Wu

6.1 Overview of Education in Liuyang

Liuyang, located in the east of Hunan, has 388 schools at all levels, including 342 rural schools (including 81 village schools and teaching points with less than 100 students). Liuyang's education needs to achieve high-quality and balanced development continuously, and there are the following main obstacles:

Rural teachers are weak, and it is difficult to complete the curriculum. On the one hand, Liuyang attracts teachers to teach in rural schools through policy guidance and incentive mechanisms such as increasing the training of public-funded normal students, recruiting teachers at fixed points, subsidies for township work and subsidies for remote mountainous areas; on the other hand, it helps rural small-scale schools to improve the quality of education and teaching by volunteering for teaching and walking in their jurisdictions. However, with the acceleration of urbanization, there are more and more small-scale schools in rural areas, and it is a long-term and persistent demand to improve the teaching quality of small-scale schools in rural areas.

Rural teachers' professional development is limited and their growth cycle is long. At present, training is the main way for the professional development of rural teachers. However, teachers' training generally focuses on imparting theoretical knowledge, skills and experience in a unified way, there are few teaching practice activities in which all trainers participate. Moreover, it is easy to ignore the particularity of the geographical area where teachers are located. In addition, teachers in rural schools have a long growth cycle and limited development due to tight staffing,

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heavy teaching tasks, weak school-based research atmosphere and few training and learning opportunities.

The task of balanced development of urban and rural education is heavy and the pressure is high. Although the hardware facilities of rural schools have been greatly improved, the traditional education management and governance are difficult, and the balanced development of education between urban and rural areas and between schools is a heavy task and a heavy pressure because the teachers in rural schools are generally weak, the mobility is high, the quality education resources are few, and the school layout is characterized by many points, long lines and wide areas.

6.2 The Main Solutions

Liuyang is a "pilot province of education informatization 2.0" established by the Ministry of Education of Hunan, and Changsha is the first batch of "smart education demonstration zones". Liuyang fully understands the spirit of the relevant documents of national and provincial education informatization and combines the educational reality in the region to deeply explore "Internet + education", accelerate the circulation of high-quality educational resources, and connect regional, inter-school and urban–rural education with integrated development. It tries its best to promote compulsory education from basic balance to high-quality balance through online collaborative teaching and research in different places.

6.3 Work Measures and Promotion Mechanism

Taking Liuyang's "Three Classrooms" as the starting point, and the network school as the link, the primary and secondary schools in the city form a "network school association" to carry out network teaching, teacher training and inter-school communication, and use big data to implement precise teaching to improve classroom teaching efficiency. The specific measures and promotion mechanisms are as follows.

6.3.1 Create a Strategy-Driven Engine for the Digital Transformation of Education

The first is to build consensus on development. Liuyang Municipal Party Committee and Municipal Government successively issued the *Implementation*

Opinions on Accelerating the Process of Building a Strong Education City, the *Decision on Accelerating the Construction of a Strong Education City to Realize Education Modernization in an All-round Way*, the *14th Five-Year Plan for the Development of Education in Liuyang City and the Plan of Action for Smart Education in Liuyang City*, which explicitly took education informatization as the starting point, built a strong education city in an all-round way, ensured priority investment, deployment and implementation, and the whole city worked together to provide organizational guarantee for promoting education equity and rural education revitalization.

The second is to develop "new infrastructure". Liuyang has built an education metropolitan area network with high standards, realizing a 10-megabit backbone, 100-megabit enrollment and 100-megabit arrival, covering all kinds of schools (including teaching points) at all levels in the city. Build a smart education cloud platform that integrates information systems such as teaching resources, interactive teaching, precision teaching, network research, quality monitoring and education management. It coordinates the construction of all kinds of information intelligent terminals, and provides basic guarantee for promoting education equity and rural education revitalization.

The third is platform integration and interoperability. According to the needs of work, Liuyang has successively developed various educational management and teaching application systems, and built various educational resources by stages. In order to facilitate teachers and students to use and share all kinds of data, Liuyang has integrated and optimized all platforms, realized single sign-on and unified authentication, and provided technical support for promoting education equity and rural education revitalization.

6.3.2 Create a Digital Driven Situation of Rural Information Teaching

With the acceleration of urbanization, there are some practical problems in rural small-scale schools, such as "lack of teachers, lack of teaching, lack of classes, poor schooling" and poor education quality. Therefore, Liuyang makes full use of information technology to expand the coverage of quality education resources, activate the vitality of rural education and narrow the educational gap between urban and rural areas.

First, gather high-quality educational resources to promote the revitalization of rural education. Through extensive publicity and strengthening the appraisal, on the one hand, it is suggested to make good use of national and provincial education public resources, and introduce website resources such as Zhixue.com and Discipline.com. On the other hand, local famous teachers are organized to record high-quality video courses, especially those in primary school music, art and English, and efforts are made to make up for the shortage of professional teachers in rural schools. In order to enhance the attractiveness of after-school services and meet the diverse

needs of students, Liuyang also organized famous backbone teachers to develop characteristic courses and select high-quality teaching resources for rural students to choose to study.

The second is to implement the network joint school project to promote regional education equity. It is encouraged to construct the construction and application mode of county-level network joint school with "three-fixed, four-synchronous" network teaching and "three-fixed, three-in-place" network teaching and research. Urban high-quality schools will help rural weak schools to set up a good curriculum, and organize urban and rural teachers to carry out network teaching and research activities, so that rural children can enjoy urban high-quality classrooms at the same time, and rural teachers can conduct teaching and research together with famous teachers at home. Until now, there are 88 lecture classrooms and 187 interactive lecture classrooms in Liuyang, which cover all rural schools in the city with high-quality teaching resources. Through synchronous interactive classrooms, asynchronous on-demand classrooms and famous teachers' classrooms, teachers in the city are driven to participate in activities such as famous teachers' guidance, online seminars, resource development and application.

The third is to carry out accurate teaching of big data and explore a new mode of classroom teaching. We implement accurate teaching of big data in 69 middle schools in the city, advocate schools to teach students in accordance with their aptitude based on big data, cultivate students' awareness and habits of autonomous learning, and advocate inquiry learning and heuristic learning. For example, the theme study of "three sections and four rings" in No.2 Middle School, the big data precision teaching in No.4 Middle School, Dayao Middle School and Yanqian Middle School, etc., have achieved obvious educational and teaching effects by identifying the breakthrough point of classroom teaching reform.

6.3.3 Construct a Mechanism-Driven Ecology of Smart Education in Liuyang

The first is to build a training mechanism integrating research and training. Taking Liuyang teachers' workshops, famous teachers' studios and smart education lecturers as the starting point, we carried out heterogeneous and interdisciplinary teaching activities in the same class across schools through the platform of "network school association", organized urban and rural teachers to carry out collective lesson preparation, grinding, research and evaluation activities online and offline, and led subject teachers to conduct network training by famous teachers, which enabled teachers to participate in regional teaching and research activities without leaving home, thus promoting the professional growth of rural teachers.

The second is to build a reform mechanism of education and teaching. Liuyang set up the "Smart Education Award" to encourage schools to attach great importance to information-based teaching. We selected 20 primary and secondary schools in

the city as integrated application experimental schools to explore a new learner-centered teaching model. We fully implement big data precision teaching in 69 middle schools in the city, and explore the organic combination of large-scale education and personalized training. We also selected six primary and secondary schools in the city as "smart classroom" pilot schools, focusing on classroom teaching, building new courses, new classrooms and new ecology based on student development, and promoting the integrated development of urban and rural education.

The third is to build a visual management and governance mechanism. Assist in supervising and managing campus security through Liuyang Smart Education Cloud Platform Command Center, and find online feedback, timely rectification and visual return visits when problems are found. Through the teaching quality monitoring system, analyze and diagnose the teaching quality of each school, and provide a scientific decision-making basis for school teaching and management; Through the educational equipment management system, the balanced allocation of the application, distribution and management of educational technology equipment in schools can be realized, and the urban and rural areas can play chess together. Through the intelligent teaching and research system, teachers and researchers can be provided with a platform for remote classroom listening and evaluation, and front-line teachers can be provided with teaching analysis reports, which can effectively improve the teaching quality.

6.4 Achievements and Experience

By vigorously developing "Internet + education", Liuyang has been awarded the title of "Hunan Modern Educational Technology Experimental County", "Hunan Rural Network Joint School Group Construction Experimental County", "Hunan Education Informatization Integration Application Experimental Zone" and Changsha Smart Education Demonstration Zone. Through smart education, it has achieved the following results.

First, co-construction and sharing of high-quality resources will promote the improvement of rural education quality. Through "network joint school", music, fine arts, English and other courses are offered to small rural schools in a normal way, so as to solve the difficulty of "uneven opening and bad opening" of nationally prescribed courses in rural schools. Through the Liuyang Smart Education Cloud Platform, high-quality teaching resources are co-built and shared, platforms are interconnected, applications are diverse, and management is convenient and convenient, which makes up the shortcomings of poor educational resources in rural schools and beyond the reach of management. By means of information technology, we can continuously expand the coverage of high-quality education resources, optimize education management and governance, and promote the high-quality balance of regional education. In recent years, in Liuyang's national compulsory education quality monitoring, the subject quality measured has been obviously improved

compared with the past, and the degree of education equalization has been continuously improved, which has alleviated the main contradiction of rural education and improved the people's satisfaction with education.

The second is to build a "network school association" to promote the professional growth of rural teachers. Relying on the "network-school association", a network teaching and research alliance will be set up. Famous teachers will lead urban and rural teachers to conduct network research, and through online and offline teaching seminars and inter-school exchanges and other activities, teachers' smart education concept will be updated, education and teaching methods will be changed and professional growth will be promoted. By comparing the awards of primary and secondary school teachers' personal growth in our city in recent three years, the number and grade of awards have been greatly improved, especially in the online collective lesson preparation contest of teachers' information technology and subject teaching integration and innovative application in Hunan Province. In 2021, the total number of awards increased by 92% compared with 2020, of which rural teachers accounted for 76.3%.

The third is to implement smart education and comprehensively improve the quality of teachers and students. By vigorously developing "Internet + education", implementing smart education and promoting the reform of education and teaching methods, the comprehensive qualities of teachers and students, such as information literacy and digital literacy, have been greatly improved, the educational concept of primary and secondary school teachers has been updated, the educational level and quality have been improved, and the comprehensive strength of education has been continuously enhanced. In the past 3 years, Liuyang Education has won 30 national honors and 52 provincial honors; In various disciplines, 907 people won national awards and 3493 people won provincial awards; In the scientific and technological innovation competition, 96 achievements were awarded at the national level and 107 at the provincial level.

The fourth is to refine and summarize in time and comprehensively popularize the application results. After years of exploration and practice, a total of 20 papers related to smart education have been published in national and provincial official journals; Thirty-one cases were selected as outstanding cases of smart education in Hunan Province or Changsha City, and the application case of "Network-School Consortium" smart education platform was selected as the case set of "Typical Applications and Solutions of the First New Smart City in Changsha City".

Through years of practice in Liuyang, we have summarized the following working experience. To promote regional education quality balance through educational informatization, firstly, we should adhere to the principle of "demand traction, application is king and sustainable development", and comprehensively use information technology to enlarge advantages and enhance connotation. Second, it is necessary to strengthen environmental construction, such as building software platforms, providing excellent resources, providing information facilities, and providing a single sign-on network teaching environment. Third, improve the working mechanism, and introduce practical incentive measures and evaluation methods. Fourth, pay attention to hierarchical training and constantly improve the information literacy

of management cadres and front-line teachers. Fifth, strengthen coordination, pay attention to the coordination of relevant government departments (such as education, finance, development and reform, industrial information, network information and data resources) and the internal education system (such as basic education, teaching and research, audio-visual education and equipment) to form a joint force.

Chapter 7
Smart Education Promotes the Practice of Urban–Rural Integration

Chunming Li, Xian Wang, Wenfeng Luo, and Qi Zhang

7.1 Baiyun District with Dual Structure of Urban and Rural Areas

7.1.1 Education Status and Problems in Baiyun District

Baiyun District is the largest district in the central city of Guangzhou, with a resident population of more than 3.7 million and migrant workers of more than 2.5 million. Its educational volume ranks first in Guangzhou, with 248 primary and secondary schools, 415 kindergartens, 30,000+ faculty and 350,000+ students. The number of schools, teachers and students in the district ranks first in Guangzhou.

Influenced by historical factors, the regional urban–rural dual structure is obvious. Among them, the number of rural schools exceeds one-third of the whole district, and there are 8,205 full-time teachers in rural schools, accounting for 36.67% of the total number of teachers. The educational imbalance between urban and rural areas and between schools is prominent: First, the allocation of educational infrastructure between urban and rural areas is unbalanced, and the running conditions of rural schools lag behind those of urban schools; Second, there is a big gap between the level of teachers in urban and rural areas, and the educational resources of students in some rural schools are not rich enough; Third, the education process is unequal at the micro level, and some rural school children can't enjoy an equal education process.

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7.1.2 The Solution of Urban–Rural Dual Structure Education Governance

In order to break the dual structure of urban and rural areas, Baiyun District has vigorously promoted the educational measures of "1 platform + 1 paradigm + N fulcrum" by means of resource inclination, education poverty alleviation and education informatization, and made great progress in promoting the fairness of educational resources.

1 Platform is the Big Data Cloud Platform of Smart Baiyun Education (hereinafter referred to as "Cloud Platform"). Create a cloud platform integrating learning, resources, research and management, and provide a unified, accurate and artificial intelligence education information management and teaching service system. Integrating the resources and strength of the school and society, the incentive mechanism and evaluation system for co-construction and sharing of resources have been established. Taking the discipline as the "starting point", we will carry out the construction activities of teachers' online learning space. Combined with the construction of teachers' personal information space, the subject education resources are gathered by collecting free online teaching resources, purchasing company digital teaching resources and self-developing.

1 Paradigm is the Baiyun Paradigm of Smart Classroom. Actively change the traditional classroom teaching form, promote the deep integration of artificial intelligence and education and teaching, implement the "classroom revolution", establish a learner-centered educational environment, and provide accurate push education services. The school supports the creation of smart classrooms with local characteristics according to local conditions, and has now formed a personalized learning model and a local characteristic teaching paradigm, creating a "Baiyun Education Model" belonging to Baiyun District.

N fulcrum is the integrated application of digital textbooks, three classrooms, intelligent teaching and research, 5G+ intelligent education, artificial intelligence + education, etc. Support regional smart teaching through various ways, so that teachers can obtain resources in real time and conveniently, track and analyze classroom teaching status information, and assist teaching decision-making. Efficient classroom interaction enables students to learn independently and purposefully. The deep integration of education and information technology contributes to the balance of regional educational resources and realizes intensive sharing of high-quality resources.

7.2 Practical Case Based on Regional Cloud Platform

7.2.1 Special Education in Urban Schools

"Small eyes, look at the blackboard", "Small mouth, don't talk" and "Small waist, please sit up straight …". These simple routine trainings are difficult for Xiao Ming. Xiao Ming is the first autistic child in a regular class in a city school. The guidance office arranges for teachers to receive corresponding training, so that children can learn basic knowledge and skills in a way acceptable to them. Xiao Ming is encouraged to engage in social activities and enhance his self-confidence. When he first entered school, his state was: just running, just making trouble, just sitting, just tearing … Later, the teacher found that Xiao Ming liked watching animation very much, and he was particularly fascinated by the micro-lessons played in the art class. Through nearly three years' practice and exploration, it is found that micro-class, a new teaching mode, is of great significance to the education of autistic children, which makes Xiaoming make subtle changes in basic living ability and emotional behavior management. Now Xiao Ming has obviously reduced the number of anxiety attacks and radical behavior in art class. In view of Xiao Ming's situation, the art teacher will also "open a small kitchen" for him, connecting multi-pictures, animations and videos into a series, giving Xiao Ming enough imagination and thinking space, and designing a series of micro-courses suitable for him. Upload the learning resources to the cloud platform, so that he can learn repeatedly anytime, anywhere, no matter at school or at home. "Although there are no professional resources like special education teachers in ordinary schools, I can't give my son guidance in my study because of my low professional level. Now having a cloud platform is equivalent to inviting a good teacher home for free." Xiaoming's mother talked about Xiaoming's study experience and was filled with emotion.

7.2.2 Solve the Shortage of Rural Educational Resources

Limited hardware conditions of teaching facilities, lack of teachers and unbalanced educational resources are urgent problems to be solved in rural schools. Baiyun District, by continuously optimizing the cloud platform, builds a regional coordinated innovation system to ensure that the platform's main body can contribute what it can to the ecology, and teachers can get what they need while contributing what they can. During the epidemic, when Mr. Feng made the classroom micro-lesson resources of regional information technology discipline "stopping classes and learning" at home, he found it difficult to find relevant versions of reference materials on the Internet, but found the shared resources of teachers from other schools in the region on the cloud platform. Later, when it was necessary to collect materials to prepare lessons after returning to school, Feng's first thought was to search on the cloud platform. Rural school equipment and conditions can't be improved rapidly due to

many objective reasons, but the construction and application of various platforms have created an effective online learning space for rural schools, and shared a large number of high-quality educational resources, to some extent, making up for the shortage of teaching resources. The application of online learning space and online teaching and research can improve the teaching quality, promote the balance of resources between urban and rural schools, and provide more possibilities for the educational informatization construction of rural schools. Based on Baiyun District's Smart Baiyun Education Big Data Cloud Platform, at present, the number of high-quality education resources has gathered more than 10T, and a local characteristic resource bank has been built. Through the intelligent analysis of the data collected by the platform, accurate teaching and personalized learning can be realized, and data support can be provided for large-scale teaching in accordance with students' aptitude in the whole region.

7.3 Creating Teaching Cases with Local Characteristics

7.3.1 "Smart Pen and Paper" Helps Students Learn Effectively

Xinhe School, located in Zhong Luotan Town, Baiyun District, is a typical rural school. A few years ago, outdated teaching equipment and facilities had a certain impact on teaching. There are many phenomena in school English teaching, such as poor listening comprehension, weak spoken English, small vocabulary and imperfect grammar structure. The teaching time is relatively limited, which means students do not have enough time to practice English listening and speaking. The school comprehensively carries out the practice of "intelligent pen and paper" wisdom teaching, innovates classroom mode, and improves the teaching quality of teachers.

Under the normal application of "smart pen and paper", for classes with a general English foundation, teachers will introduce brainstorming activities in the form of short answer questions, true or false questions or multiple choice questions in the review stage before class. Each student can collect data in real time by writing answers on paper and books with a smart dot-matrix pen, automatically generating analysis, and immediately feeding it back to the teacher. For a class with a good English foundation, brainstorming is designed in the link of introducing new knowledge. Teachers can check the students' learning progress and thinking process in real time in class, and quickly understand the weak knowledge points, so as to implement the teaching in a targeted way. Faced with students with poor English foundation and a lack of initiative and enthusiasm in learning, the introduction of an intelligent pen-and-paper system has enhanced students' interest in learning and provided a great boost to school English teaching.

7.3.2 Normal Application of Smart Classroom on Campus

In order to make the smart classroom better serve the teaching, Baiyun District adheres to the way of "pilot first, innovation leading and pressing ahead", vigorously develops the smart campus construction in batches, and carries out selection, evaluation and examination year by year. By 2022, there will be 100 smart campuses in Baiyun District. Primary and secondary schools in Baiyun District actively change the traditional classroom teaching form, promote the deep integration of information technology and education and teaching, and put the "classroom revolution" into practice. Before class, teachers use WeChat platform to set up parents' WeChat group, communicate with parents in real time, get to know each other about students' homework and give timely online counseling; Establish class groups, show students' excellent homework, show students' problem-solving ideas, show students' reading achievements and publicize students' personalities; Set up small groups, teachers send newspapers for preview, release micro-lessons, let students collect information, and let students review old knowledge, calculations and ideas. In class, teachers make full use of multimedia and interactive learning platform, sort out information collected by students, check students' learning situation of micro-class, and report self-study results; At the same time, create the situation that students like to see and hear, stimulate their interest in learning, guide their independent inquiry and cultivate their independent learning spirit, and cultivate their academic quality. Through digital equipment, the process of students' learning is recorded, and students' classroom learning situation is fed back in real time, which helps teachers understand the weak points of learning, effectively helps students to learn individually, and promotes cooperative inquiry learning in class. After class, let students carry out reading evaluation in the group platform, show their learning results, show their hands-on operation, and talk about ideas and methods; Strive to improve students' oral expression ability, cultivate students' hands-on operation ability and train students' thinking ability; Through display and communication, students in the group can imitate and learn from each other, and show the good results in the group to the class group to share. At present, information technology has been applied in the daily teaching of the pilot class.

7.4 Cases of Promoting the Balance of Regional Educational Resources

7.4.1 "Three Classrooms" to Promote the Rational Flow of Regional Educational Resources

Baiyun District has built a "three classrooms" application cloud platform, with three classroom smart education application alliance bases and cultivation schools as the leaders, and organized more than 200 disciplines from 29 schools to set up "three classroom application communities" in Baiyun District. We will promote the normalization and on-demand application of "Courier Classroom", solve the "persistent problem" of uneven, insufficient and poor curriculum in rural weak schools, and continue to expand the coverage of high-quality educational resources such as the national wisdom cloud platform for primary and secondary schools and shared classrooms in Guangzhou, so as to significantly improve the quality of classroom teaching. Up to now, 2,950 teachers and 88 schools in the whole district have joined the platform, and a total of 656 courier classes have been conducted, and 1,221 high-quality curriculum resources have been uploaded and published, with 96,000 viewers. The normal application of "three classrooms" based on the urban–rural joint teaching community provides an effective path for the professional development of school teachers. Taking No.115 Middle School as an example, Pingsha Peiying, Sanyuanli Middle School and Zhuliao No.3 Middle School have carried out the "three classrooms" joint teaching. In view of the fact that the small number of school history teachers is not conducive to collective lesson preparation, the "three classrooms" have realized long-distance collective lesson preparation and taking turns to attend classes, and promoted the professional growth of school teachers together with other schools. Under the joint discussion and study of history teachers in four schools, the efficiency of collective lesson preparation in history classes has been improved.

7.4.2 Regional Online Joint Research to Help Share Resources

Take the platform of regional smart teaching and research as the carrier to coordinate the implementation and management of regional wisdom teaching and research. Create a regional smart teaching and research model, form a new regional smart teaching and research training system, and promote the in-depth reform and innovation of regional education and teaching.

The first is to improve the working mechanism. Clarify the construction mechanism of intelligent teaching and research, promote it by stages and levels, try the regional cluster teaching and research first, gradually expand the inter-school

teaching and research and school-based teaching and research in districts, and finally form a three-level intelligent teaching and research model of "district-film-school".

The second is to establish a collaborative model. Form an effective cooperation model with the district education research institute as the core, subject teaching and research staff as the guidance and school teachers as the implementation. Unified planning and deployment of teaching and research arrangements by the district teaching and research institute, discipline teaching and research staff to organize and guide according to the teaching progress, school teachers to implement teaching, discussion, communication and evaluation.

The third is to improve the effectiveness of teaching and research. Make full use of information technology, expand the coverage of teaching and research, refine the dimensions of lectures and evaluation, and intelligently count teaching and research data. During the epidemic period, music, English, Chinese and other disciplines have been actively tried, and 7 smart teaching and research activities have been completed. More than 3,200 teachers in the whole district participated in smart teaching and research, and the number of teaching and research observation people exceeded 20,000.

The fourth is to keep resources. Relying on the cloud platform, real-time management and preservation of intelligent teaching and research data, courseware, evaluation, playback and other resources, so that teaching and research can be reviewed and repeated, and the utilization rate of resources can be improved.

7.5 Keep Pace with Urban and Rural Areas

After years of practice, the effect of smart education in Baiyun District has gradually emerged. Baiyun District will continue to take the cloud platform as the starting point, multi-point application as the traction, and with the help of information technology capabilities of smart education platform, solve the uneven educational resources, change the current situation of "unbalanced and inadequate development" in rural education, gradually narrow the gap between urban and rural areas, and finally break the dual structure between urban and rural areas to promote the all-round development of students.

Chapter 8
Focus on the Change of Learning Style and Promote the Practice of "New Three States" in Education

Yi Wang, Shijun Zhu, Jing Ao, and Ainan Zhong

In 2019, the Wuhou District of Chengdu was selected as the first batch of "Smart Education Demonstration Zone" areas, which officially kicked off the construction of smart education in Wuhou.

8.1 Regional Background

Wuhou District is a "high-tech cultural area" named by the State Council. Focusing on the development goal of "the core area of education modernization in the central and western regions", the whole district adheres to the fundamental task of cultivating people with virtue, takes the healthy growth of students as the primary goal, and actively promotes all-round and deep-level changes in regional education. The development level of regional education modernization ranks first in Chengdu.

Wuhou Smart Education puts forward the core goal of "providing adaptive education for students' development" around "individualized growth of students". Striving to realize the four changes of educational paradigm from experience to science, educational goal from knowledge to ability, educational mechanism from management to governance, and educational process from stage to lifelong. Focusing on the goal of educating people, the Wuhou District has identified three core tasks: constructing a new ecology of intelligent teaching, a new pattern of educational services and a new pattern of intelligent governance, which is referred to as "new three states" for short.

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8.2 The Construction Path

Based on the education goal and construction task, Wuhou District put forward and carried out the practice of "classroom reform + data hub + large resource supply" in smart education construction.

8.2.1 Identify One Core

Taking students as the center, focusing on the reform of teaching and learning methods, we will promote the construction of a "double-line integration" education system through the forms of "scene reconstruction, data empowerment and structure optimization", and strive to realize students' individualized chemistry and teachers' differentiated teaching.

First, normalize and explore the accurate reengineering of the teaching process. Unicom classroom blackboards, teachers' tablets and students' terminals can realize personalized push, visual presentation, three-dimensional communication and real-time evaluation, and enhance the interaction and cooperation between teachers and students. The second is to explore the online and offline teaching mode on a large scale, focusing on students' key abilities such as inquiry, creation and problem solving, and relying on the pilot school of the project, to carry out the classroom reform inquiry of "two-line integration". Third, the individualized pilot academic data is accompanied by tracking. Using the big data precision education system, students' staged data is collected in a normal way, and academic reports are formed, which helps teachers to know students' academic situation in real time and quickly, and realize accurate lesson preparation and efficient self-study under the background of big data.

8.2.2 Construct a Base

Wuhou District takes the regional government cloud as the computing resource carrier, integrates the original educational network system platforms at all levels, implements unified authentication, and realizes data interconnection and flow.

Derived Application Scenario 1: Modern Education Governance

The first is horizontal monitoring. By comparing the development trends of other districts (cities) and counties in Chengdu with the development status of each school in the region, we can allocate targeted and personalized resources and generate the report of "one school, one policy".

The second is degree prediction. Integrate the data of public security departments, and form algorithm models in platform development, degree prediction, large class

size warning, etc., so as to provide data support for enrollment plan, school planning, point layout, teacher allocation, etc.

The third is the online inspector. Establish a "responsible supervision" system, implement remote supervision and inspection, share data in real time, comprehensively improve the efficiency of supervision, and promote the high-quality development of schools.

The fourth is the supervision and evaluation system. Simplify the original school supervision and evaluation process, empower new supervision scenarios with a remote data platform, realize hierarchical audit of school supervision data, and automatically generate horizontal and vertical supervision and analysis reports.

Derived Application Scenario 2: Teaching Intelligence Evaluation

Wuhou District focuses on the five dimensions of students' moral development, academic development, physical and mental development, aesthetic accomplishment, labor and social practice, constructs the comprehensive quality framework of students' growth, and objectively depicts the whole picture of Wuhou students' development based on data. The digital portrait of teachers mainly constructs the evaluation index of teachers' professional development from the aspects of teachers' moral cultivation, professional knowledge, teaching and research ability, educational ability and social influence.

8.2.3 Provide Three Types of Services

Wuhou District continues to promote the construction of "scene, technology and resources", exploring open educational scene data, intelligent educational technology environment and precise educational resources, and gradually realizing the "open and on-demand"-oriented large-resource educational service supply mode.

The first is to explore "one size fits all". Wuhou District co-ordinates the school scene resources in the region, and transforms and upgrades libraries, subject laboratories, maker spaces, museums and other venues into theme education centers, which are open to regional students.

The second is the pilot "one network access". Wuhou District selected four pilot schools with different classes, and explored and implemented the "1 + 1 + N" smart campus construction project of building a school-level data hub, a campus management platform and N smart application scenarios through the cooperation mode between government and enterprises.

The third is to implement "one-space general studies". Teachers should provide convenient teaching, construct teachers' space, gather high-quality educational resources, collect teachers' teaching data and optimize teachers' teaching methods. Serve students' personality chemistry, set up students' learning space, set up storage boxes, exchange groups, laboratories and other sections, and guide students to use the learning space to carry out inquiry-based learning and project-based learning, so as to realize ubiquitous and personalized learning.

8.3 Safeguard Mechanism

Intellectual support and research. Wuhou District invited eight well-known experts to form a think tank to guide the top-level design; Signed strategic cooperation agreements with China Academy of Education, Beijing Normal University, University of Electronic Science and Technology of China and Sichuan Normal University to strengthen intellectual support; 45 famous principals and famous teachers' studios have been set up to lead the improvement of information literacy of all staff; Select 8 chief information officers to guide the project construction across schools; Select 150 "seed teachers" to lead the discipline classroom reform; Apply for the provincial major project "Practical Research on the Construction of Smart education System in Regional Primary and Secondary Schools", and promote the practice with the research of the project.

Mechanism coordination and policy support. Set up a "Leading Group for the Construction of Smart Education Demonstration Zone" to coordinate the promotion of smart education. The Education Bureau of Wuhou has set up a special promotion office to coordinate the project units of the district education system, and be responsible for the implementation and supervision of the pilot project. The Institute of Educational Informatization was set up in the District Academy of Education to deepen the theoretical research of teaching reform and formulate implementation strategies.

Regional layout and school pilot. Around the three tasks of teaching, service and governance, seven pilot directions were determined to match the special funds. Through independent declaration and expert evaluation, 23 primary and secondary schools were selected to undertake the pilot project. District Education Bureau, as the lead department, guides the process of the project, evaluates the efficiency of funds, and ensures that the pilot measures are effective.

Government investment and social assistance. Actively explore the tripartite cooperation construction mode of "government, school and enterprise". Since 2019, district-level finance has invested more than 70 million yuan in the creation of smart education, and introduced enterprises have invested more than 30 million yuan, forming a "government-enterprise-school" collaboration system in which the region provides a national demonstration platform, schools provide front-line demand and application feedback, and enterprises provide technical and partial financial support, which continuously provides financial guarantee for the creation.

8.4 Practical Results

After three years of practice and exploration, Wuhou District has made some progress and gains in education and teaching, service supply and intelligent management.

8.4.1 The New Ecology of Smart Teaching

Wuhou District, relying on the smart education pilot school, has carried out school-based classroom reform, forming various types of "new teaching and learning" model courses and hundreds of typical lessons.

1.0 mode: "resource package + live broadcast" online classroom. During the epidemic period, Wuhou District relied on the educational resource platform of "Wuhou Sanguyun" to carry out exploration in all aspects of resource production, data distribution and teachers' information ability training, and adopted the resource supply and teaching form of "resource package + live broadcast" to implement online teaching all over the world, which ensured that the policy of "stopping classes and learning" was effective and efficient. However, objectively, there are some problems in this teaching mode, such as copying offline content, too much one-way teaching by teachers, insufficient interaction between teachers and students, and inability to timely feedback the learning data.

2.0 mode: interactive classroom with "two teachers". Many schools and teachers in Wuhou District have extended the experience accumulated during online teaching to the routine teaching in the post-epidemic era. This mode not only retains the push personalized resources, but also increases the timely feedback and layered application of data in class. However, this mode requires teachers' ability to apply information technology, and the amount of preparation before class is also large. It relies too much on electronic equipment, which is not conducive to students' eyesight protection, and also makes the emotional communication between teachers and students insufficient in class.

8.4.2 New Form of Intelligent Governance

Wuhou District focuses on the construction of data centers, promotes the construction of application middle stations and data hubs at the regional level, and tries to build school-level hubs in 15 schools.

The data hub has been connected to 15 application databases, with a total of 67.8916 million pieces of real-time data, covering regional governance, school governance, teachers, students and parents, and basically eliminating the information island of Wuhou education.

In the application platform, Wuhou District has completed the establishment of 15 intelligent governance application scenarios, the integration of 43 educational application systems, and the unified certification of five applications, such as education statistics, and realized the single sign-on and real-time office work of users.

In terms of education governance, Wuhou District is evaluation-oriented, and has initially formed 10 visual application scenarios, such as education development level monitoring, degree prediction, teaching analysis, equipment remote management, myopia prevention and control, portrait of teachers, portrait of students, etc., which

provide visual, early-warning and adjustable governance guarantee for key objects and key links of regional education governance.

8.4.3 New Patterns of Educational Services

In addition to carrying out the practice in the curriculum teaching prescribed by the state, Wuhou District is also exploring a new mode of educational resource service supply, creating conditions for students to "take a general course" after class. The innovative exploration of "the campus scene is open, and students walk across schools" provides diverse learning options for students with different classes and interests.

At the beginning of the project design, "Wuhou Happy Learning" was designed to solve the problems of large investment and long cycles in the construction of school scene resources, but the actual application benefit is not high and the educational function is not well played. The project has opened the theme education venues of 10 schools, offering 53 courses including artificial intelligence, traditional culture, minority languages, makers and fire safety, with over 4,000 students participating.

8.5 Summary

Wuhou was awarded the "Pilot Unit of Education Data Center" by the Ministry of Education, the Provincial Department of Education and the Municipal Education Bureau during the period of steadily promoting the construction of the Smart Education Demonstration Zone. Selected as "Artificial Intelligence Boosting Teaching Team Construction Reform Pilot Area" by the Ministry of Education; Artificial intelligence teaching and application cases were selected as "Typical Cases of National Artificial Intelligence Social Experimental Areas" by six ministries and commissions including the Central Network Information Office, the National Development and Reform Commission and the Ministry of Education. In the future, the Wuhou District will further promote regional digital transformation. Create a digital base.

Create a digital base. Make full use of the "national smart education platform for primary and secondary schools", and use it in slices in a regional scope, and encourage schools to build their own school-based resource banks in combination with school-running characteristics; With the help of teachers' commonly used teaching tools, such as 101PPT, all-in-one teaching assistant, Zhixue.com, etc., data communication is realized by docking the regional cloud platform; The deduction system of the regional education balance index and degree prediction system were first constructed, which strengthened the accuracy of data collection and the normalization of the application drive.

Achieve unified management. "Digital transformation" is a change in the whole field of basic education, and all kinds of information systems in the system must be

unified, integrated and built to ensure safety. In the future, the Wuhou District will intensify the construction of the integration and application mechanism of various information systems. First, while paying attention to the application of tools and technologies, focus on the mechanism construction and collaborative support; The second is to advocate teaching and research departments to implement digital actions in teachers' teaching, teaching and research assessment on a pilot basis, and encourage digital lesson plans and listening and evaluating lesson records; Third, vigorously promote and improve the collaboration mechanism between government and enterprises, restrict the "occupation" of personal data by enterprises through clauses, and return application data to users.

Chapter 9
Create National Smart Education Demonstration Zone to Promote Digital Transformation

Fang Wang, Rongzhen Du, Dan Xu, Yinghui Wu, and Dapeng Liu

Haidian District is a strong science and technology district in Beijing and the largest basic education district in the city. Based on the idea of "service first, application king," Haidian District explores the construction of new infrastructure, education governance system, education teaching application model and so on based on smart education.

9.1 Regional Integration, Quality Balance

9.1.1 Building a Basic Support System for Smart Education

Building Haidian Smart Education "Cloud Center." The Haidian Smart Education Cloud Platform carries the district-school two-level educational application system platform, providing a computing power guarantee for the formation of cloud, net and terminal information application architecture in the Haidian District. System expansion was completed in March 2021, expanding over 120% of the original resource. To date, there are 86 systems platforms in the Education Cloud, more than 300,000 daily uses, and more than 3,200 educational cloud operations are handled.

Comprehensive promotion of smart classroom construction. Between 2020 and 2021, Haidian Education carried out two consecutive phases of smart classroom construction, upgraded 3555 classrooms in primary and secondary schools in the

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region, installed a smart large screen and recorded broadcast teaching system in 5750 classrooms, and basically achieved full coverage of smart classrooms in the region. The "blackboard" of classrooms has been upgraded to a "resource platform," realizing the timely interactive transformation of text, audio and video, ensuring that all ordinary classrooms in the region have the technical ability to carry out the teaching of air classroom, double teacher classroom, fusion classroom, etc.

Upgrade and optimize Haidian primary and secondary school resource platform. In 2021, the Haidian Primary and Secondary School Resource Management Platform (Air Classroom) has targeted more than 6,000 new educational resources, developed a total of 11,297 large modules and thematic online curriculum resource packages, covering the whole school section and 43 disciplines, and achieved remarkable results in responding to epidemic prevention and implementing double reduction. The resource platform has effectively promoted the balanced radiation of high-quality educational resources across regions. Up to now, 301,957 people have been supported by the resource platform, including Hetian County of Xinjiang, Keyouqian Banner of Inner Mongolia, Aohan Banner of Chifeng City of Inner Mongolia, Yixian County of Hebei and Chicheng County of Hebei.

9.1.2 Creating a Full-Scene Application Model for Smart Education

In Haidian District, the basic functions of "Education Cloud System," "Cloud Classroom Live System," "Primary and Secondary School Resource Platform System," Data Opening and Technology Integration, etc. Combined with the big data platform and the "District Smart Classroom Transformation and Upgrading Project," the whole-scene application of smart education is realized.

Dual-division classes. Thirty-one model schools were selected to explore and build the model of "Double Teacher Classroom." Up to now, the teaching of "double teacher classroom" in Haidian District No. 4 Experimental Primary School, Capital Normal University Affiliated Primary School, Beijing No. 20 Middle School, Haidian District Qinghe Middle School and other schools has been normalized.

There is no suspension of classes. During the period of epidemic prevention and control, the District Education Commission conducted a survey of 194 schools in 17 school districts in Haidian. Under the unified entrance of a smart big screen in a smart classroom, by creating live classroom and pushing daily teaching content, students can simply scan QR code at home to watch and participate in the classroom teaching scenes in real time, to meet the teaching and learning needs of various scenarios under epidemic prevention and control.

Online and offline mixed training. The cloud classroom live broadcast platform supports the whole-process information management such as course release, self-selection, record study, and credit recognition, retaining the structured resources in

the discussion process, forming a mixed study system combining offline study, self-selection, online study, process evaluation and summary evaluation. The platform holds nearly 200 training sessions for teachers and cadres each year, with hundreds of well-known experts giving lectures and a total of about 120,000 training sessions. During the period of epidemic prevention and control, the Platform included 424 schools or units, 132 subject teachers and 35,670 trainees. A total of 147 online training courses were established and 823 formal training activities involving online teaching and research were carried out.

Teaching and Learning Model Inquiry. 1. The autonomous learning mode of students integrated into micro-classes. Taking micro-course research as the starting point, taking micro-course fusion application as the starting point, supplemented by information technology series training to enhance teachers' information technology application ability, provide teachers with a variety of rich learning resources such as micro-class to meet students' independent learning needs, and cultivate students' independent learning ability and deep learning ability. 2. The "three integration" model of the core literacy of internalized disciplines. By exploring new ways of learning and developing the community of teachers and students, online and offline mixed learning, we can realize the mutual promotion of learning, teaching and evaluation. Three. Focus on creative interaction patterns of learning development. Build a unified service platform, promote high-quality resource sharing, promote the creation of a development learning community through multi-campus linkage and multi-project, empower teaching and evaluation of data, and optimize classroom teaching. 4. Cultivate the "programming + mathematics" mode of computational thinking. According to the age characteristics and cognitive laws of the students, the course system of "Programming + Mathematics" covering the whole grade is built, which deepens the students' knowledge of mathematics and improves the students' ability and literacy to solve problems.

9.2 Regional Governance and Characteristic Leadership

Taking the opportunity to develop smart education, the Haidian District established the Haidian Internet Education Research Institute under the direct leadership of the district committee and government. With the aim of resource sharing, collaborative innovation and cooperation, Haidian adopted the implementation path of "government management, expert guidance, enterprise research and development, and school application". Haidian Institute of Internet Education actively plays the role of think tank platform and resource hub. On the one hand, it accelerates collaborative innovation in Industry-University-Research, and unites high-tech enterprises with experts, scholars and front-line teachers in various fields to jointly study the application of new technologies such as artificial intelligence. Combined with Beijing Normal University, Capital Normal University, Tsinghua and other universities, as well as Internet education enterprises in Haidian District, special applied research has been carried out in primary and secondary schools in Haidian District, forming a demonstration

and leading role. On the other hand, explore the wisdom of education crowdfunding, and establish an innovative cooperation mechanism between the government and high-quality enterprises. Unified planning and design, unified standard planning, unified training services, unified operation and maintenance guarantee and unified effectiveness evaluation form a new mechanism for the integration and innovation of high-quality resources, providing a good policy environment and development space for promoting smart education.

9.3 Innovation and Development

Haidian District explores the construction of a new environment of education and teaching that is universal, flexible and intelligent based on the Science and Technology Applied Education Teaching Scenario of Zhongguancun Science City—Beijing 101 Middle School Education Group Future School Project.

9.3.1 Smart Environment Construction

The construction of new basic hardware facilities for education in Haidian District includes: high-speed and safe wired network and wireless network covering the whole school. We manage the campus intelligent hardware environment, including intelligent security system, face recognition access control gate, classroom intelligent access control and classroom Internet of Things, and electronic class boards covering classrooms, laboratories and conference rooms of the whole school. As for the inside of the campus, there is a flexible and ubiquitous learning environment and an intelligent and efficient teaching environment, including a new technology classroom equipped with students' mobile terminals, English listening and speaking model test/teaching computer room classroom, normal direct recording and broadcasting courier interactive classroom, outdoor reading kiosk, self-service library, streaming media center, innovative education laboratory of artificial intelligence, and laboratory of a college of excellence focusing on cultivating top-notch innovative talents, etc.

Haidian District has built a future school platform covering teaching, learning, examination, evaluation, management and research, including a direct recording and broadcasting system, intelligent teaching system, precise teaching system, personalized learning system, school-based resource platform, comprehensive quality evaluation system for students and intelligent office management system.

9.3.2 Smart Teaching

Intelligent readiness. We collect students pre-learning data, homework results and other data, generate visual chemical situation report, help teachers accurately grasp the academic situation. We also provide teachers with teaching materials analysis, teaching design, knowledge inquiry, test training, demonstration example and other types of preparatory teaching resources. Meanwhile, we push teaching resources for teachers and help teachers improve their preparation efficiency through precise markup, intelligent recommendation and search for teaching resources.

Precision teaching. Through classroom teaching multi-screen co-operation seamless interaction, large- and small-screen mixed teaching, we realize interactive teaching and timely academic feedback. Relying on various interactive teaching tools, virtual experiments and other scenarios of chemistry resources, we help teachers to accurately judge academic conditions and pay attention to each student. Classroom teaching brings together student quizzes, classroom exercises, homework, autonomous learning and other academic data to generate digital images of students, helping teachers to teach accurately.

Personality learning. Using knowledge maps and teaching big data as support to build a personalized learning platform for students to push personalized learning resources for targeted learning. With the help of multi-intelligent terminals, students learn universally, including omnipresent reading, error correction and expansion exercises based on intelligent wrong question book, intelligent planning learning path based on knowledge map, intelligent correction of English composition photography, English listening, reading and writing full-scene intelligent training evaluation, etc.

Student development guidance. To build a student development guidance platform to help students understand their own professional interests and personality advantages and other information, and to provide reference suggestions for students' college entrance examination. Study investment evaluation, macro-grasp students' degree of investment in each subject, early warning of insufficient study investment, and provide advice for subject study. Construction of the college entrance examination mock voluntary application system, through the estimation of scores, the position of mock voluntary application, recommended suitable schools and majors for reference by students and parents.

OMO hybrid teaching. To build an online direct-broadcast teaching system for expanding the radiation range of high-quality teachers, such as the delivery classroom and the dual-teacher classroom, to support the development of group-school hybrid teaching and research through informatization, and to provide high-quality resources for weak or counterpart schools in group schools; Support offline new technology classroom teaching, also support online direct/video teaching, online and offline integration teaching, special period air classroom teaching, etc.

Smart Review. Through automatic correction of objective questions, automatic scoring of English math blank questions and intelligent correction of English and Chinese composition, the burden of teacher's homework and examination evaluation is reduced. Teaching assistant assignments are taken, handwritten content of

multiple choice questions is automatically identified, multi-dimensional information reports are automatically generated, and teaching assistant teachers review burden reduction and efficiency gain. To build a simulation examination system, intelligent teaching system and independent training system for English listening and hearing, to support teachers to carry out simultaneous listening and hearing exercises in class, and students to train independently in class to improve the efficiency of English listening and learning.

9.3.3 Smart Examination

Build an online and offline examination system that supports multiple scenarios. Support special period online examinations such as epidemics, teacher's real-time online invigilation, inspection, student's online examinations, post-exam online marking. Offline examinations use an AI qualifying engine to arrange and output multidimensional examination tables, and electronic class cards to push and display test room information. Support the Group School Entrance Examination, Single School Examination, Daily Practice, Support the first reading after sweeping the hand reading form and first sweeping after reading the online reading form. Upon completion of teacher marking, the multi-level examination report is quickly generated, including joint examination report, school-level report, class report, individual student report, teacher after examination timely and efficient carry out targeted assessment and student personalized tutoring.

9.3.4 Smart Evaluation

Comprehensive quality evaluation of students. Based on the development needs of school characteristics, a comprehensive quality evaluation system with 43 indexes is constructed, which is mainly composed of four modules: study, ability, character and vision. Support multi-roles to record, review and score students' daily performance. Record and evaluate students in a process, and generate a record file of students' personal growth. With the help of the Internet, the evaluation results will be pushed to parents in time, and parents will be introduced to cooperate with schools to pay attention to and guide students' comprehensive development and healthy growth.

Evaluation of students' mental health. Build a mental health evaluation system for students, conduct mental health evaluation for freshmen, fully understand freshmen's mental health, personality, values, etc., and conduct appropriate and timely psychological intervention and targeted counseling. During the semester, students' stress assessment will be carried out to fully understand all aspects of students' study and life, and to guide teachers to scientifically and pertinently design and carry out educational and teaching activities.

9.3.5 Smart Management

Haidian has built a "two centers and one platform" intelligent management system in the school, covering all aspects of campus operation guarantee such as OA office, intelligent educational administration and student development. The two centers include "Campus Service Center" and "Campus Call Center", which serve teachers and students in efficient and paperless office and daily life; The first platform is "Campus Communication Service Platform", which includes campus communication PC and mobile APP applications, and carries out campus information exchange, file transfer, mobile office and other scene applications.

In the future, Haidian District will continue to follow the principle of "people-oriented, all-round development, multi-participation, coordinated promotion, innovative mechanism, openness and sharing", focus on enriching the quality supply of education and teaching, insist on educational informatization as strong support for educational modernization, promote the normal application and large-scale popularization of smart education in education and teaching, foster new kinetic energy of educational development with new technologies, boldly explore and do what one can in terms of environment, mode and system, and strive to form a nationwide smart education.

Chapter 10
Drive the High-Quality Development of Education with Data, and Accelerate the Construction of a New Ecology of Smart Education

Xiaochuan Wen and Wei Li

10.1 Upgrade in an All-Round Way, and Continuously Consolidate the Foundation of Smart Education Construction

In recent years, Hexi District has fully implemented the Education Informatization 2.0 Action Plan, and completed three systematic projects: the modernization project of compulsory education schools, the upgrading project of compulsory education schools, and the construction of basic education informatization 'three links and two platforms'. It has achieved full coverage of regional optical fiber network, digital campus system, wireless network, classroom multimedia and teachers' information technology ability training.

Construction of regional network data center, unified export bandwidth of education network in the whole region of 4G, construction of multiple application systems and construction of high school characteristic innovation laboratory group. Establish a video conference system with remote, real-time and interactive functions, centering on the district education bureau, covering the whole district education system. Three-level monitoring projects of all kinds of kindergartens in the jurisdiction will be implemented, and monitoring equipment will be installed at more than 6,000 points in the whole district to realize full coverage and no dead ends of dynamic monitoring of children's activity places. Build a network security prevention and control system based on the concept of situational awareness, and comprehensively improve the network supervision, protection and operation support capabilities. Relying on the Tianjin Education Research Network, a high-quality intelligent education cloud

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platform will be built to realize the full application of online learning space and basic education data platform for teachers and students in the region. Start the pilot work of smart campus and smart classroom, and eight primary and secondary schools in the area are included in the municipal smart campus demonstration units. Under the condition that the utilization rate of "education cloud" resources in the original district-level data center is close to 80%, a big data construction project is implemented, and a new micro-module data center room with energy saving, environmental protection, green and low carbon is built, and the data processing capacity is increased by nearly 10 times. It also supports the realization of a new generation of high-performance computing power represented by Kunpeng's domestic CPU technology, so as to meet the needs of Hexi smart education development in the next five years.

10.2 Draw a Blueprint, and Make Overall Plans for Smart Education

Since Hexi District was selected as the creation area of the "Smart Education Demonstration Zone", smart education has been included in the *14th Five-Year Plan* for national economic and social development and the 14th Five-Year Plan for regional education development. At the same time, the construction of a smart education demonstration zone has been included in key projects of deepening reform of Hexi District Committee, key construction projects of the district government, special supervision contents of high-quality development and education responsibility assessment projects of the district in the *14th Five-Year Plan*, which provides a strong organizational guarantee for the construction of national "Smart Education Demonstration Zone" and provides a strong organizational guarantee for the region.

As a high-end form of educational informatization, smart education aims to build a smart learning environment, change the traditional teaching and learning methods, and give birth to the education system in the intelligent era. Data governance is an important starting point in the process of building smart education. Research on building a big data platform, improving the top-level governance flowchart and exploring governance paths shows that education data governance has a significant role in promoting education development.

10.3 Condense Practice and Explore Education Data Governance Methods

Hexi District promotes education government information integration and data sharing, continuously improves the intelligence level of education management informatization in the district, and realizes intelligent decision-making, visual control, security warning and remote supervision of education.

10.3.1 Building a Data Center to Carry Out Preliminary Governance

Relying on key infrastructure, Hexi District began to build a data center and conduct preliminary attempts at data governance. First, through the data decision visualization system, the modeling analysis found that the distribution of educational resources in Hexi District is "dense in the north and sparse in the south" and made a government recommendation report based on this trend. We assisted the government in planning four school clusters to improve the coverage of educational resources in new and expanded communities. Second, in response to the problem of weak teachers in new schools, a database of teachers employed by the district was set up to keep the Education Bureau informed of teacher assignments and mobility. Third, in order to effectively implement the "double reduction" policy, a database of private education operations supervision was established to include all out-of-school institutions, childcare facilities, and art and sports training schools in the district in the data governance. Through the above measures, Hexi District seeks to give full play to the foresight and refinement of education data governance in three areas: high quality and balanced allocation of education resources, high quality and flow of teachers, and high level of education risk prevention.

10.3.2 Optimizing Data Flow to Help Mechanism Reform

As Hexi District enters a phase of rapid development, the total economic volume grows and the population size expands, creating a need for institutional reform as public expenditure in education increases year by year. In response to the problems, Hexi District tried to promote mechanism reform by optimizing data flow. First, the government led a multi-department working group on education development in conjunction with the Development and Reform Commission, finance, civil affairs, planning, construction commission, public security and health. The health, public security and civil affairs units will provide basic data on the annual birth population, mobile population and pre-accommodation population. Secondly, the Education Bureau will summarize and analyze the number of school places in the

area under its jurisdiction and make annual forecast data according to the ratio of 80 school places per 1,000 people in communities and buildings. Again, the planning and construction committees build new schools or renovate old schools according to the design standards to form construction data that can be tracked and supervised. Finally, education and finance coordinate start-up funds, logistical assets, renovation and construction, and procurement of information technology and multimedia equipment based on construction data, ultimately forming supporting data to be given to school administrators. According to the above data flow governance scheme can basically solve the problems of waiting, relying and asking in construction management, and play the role of data governance for accurate scheduling and scientific management of the project life cycle.

In the context of the double reduction policy, in order to strengthen the governance of out-of-school training institutions and keep abreast of institutional dynamics, Hexi District has used big data thinking to explore the establishment of a private education regulatory mechanism, bringing nearly 1,000 out-of-school institutions, childcare parks, and arts and sports training into the scope of management, providing accurate risk tips with education big data analysis technology, greatly enhancing the scientific decision-making ability of the government and education departments, and achieving the This has greatly improved the scientific decision-making ability of the government and education department, and realized the target requirements of precise policy and targeting in the governance of out-of-school training institutions.

10.4 Empower Innovation and Explore New Modes of Data Application

In recent years, our district has actively undertaken the research of the Ministry of Education's "New Teaching and Learning Model Based on Teaching Reform and Integration of Information Technology" experimental zone, and vigorously implemented Tianjin's "Education Governance Informatization Enhancement Project" and "Smart School Construction Project".

10.4.1 Building Special Curriculum Data to Improve the Information Literacy of Teachers and Students

During the epidemic prevention and control period, Hexi District established the "Hexi Special Curriculum Platform" and the "Hexi Online Classroom Platform", opened online learning platform accounts for 7,000 teachers and 100,000 students in the district, and gathered digital education resources in the district by recording micro-courses and high-quality lessons. The online learning platform has been opened for 7,000 teachers and 100,000 students in the district. The first in the city to

launch the junior high school graduation class online live class, all course resources through the platform directly to the hands of students and parents. We have organized excellent teachers and textbook researchers of all subjects in the district to carefully produce more than 3,400 micro lessons and 5,000 micro videos, recorded more than 200 recorded lessons, developed more than 200 general education curriculum resources, and set up "classroom in the air" through various media channels such as cable TV, Unicom, telecom and mobile, allowing 90,000 students in Hexi to learn through The "Air Classroom" allows 90,000 students in Hexi to independently choose high-quality learning resources and online learning guidance services through cell phones, computers, cable TV, etc. Junior and senior students will watch the review course through live streaming, while other students will choose their own learning content according to their needs and learning progress.

On February 10, 2020, the first day of online learning guidance in our district, the number of simultaneous visitors to the "Hexi special course platform" reached 53,000, creating a historical access flood. By the time classes resumed, the cumulative frequency of visits to the platform exceeded 30 million times. At present, the district has initially established a learning "diagnosis-correction" system based on big data of student development, making it possible to realize accurate teaching and personalized teaching.

10.4.2 Sharing Quality Data and Universal Resources for "Thousands of Miles"

In response to the hot issue of uneven distribution of high-quality educational resources, the district has vigorously implemented the "One Lesson, Special Curriculum Platform" project, based on regional characteristics and school-based characteristics, in compliance with the laws of physical and mental development of students and the laws of education and teaching, to build a special curriculum system. At present, a regional curriculum system with forward-looking and contemporary characteristics has been initially established, including 58 different types and subjects such as Beijing opera, tea art, Chinese costume, cooking, astronomy and geography. At present, the cumulative amount of uploaded videos exceeds 4,000 and the frequency of user visits exceeds 3 million.

In the region's pilot work to promote home care services, Hexi Education has taken the initiative to create the "Banyan Tree Classroom" and actively build a home care education resource system, incorporating party building, opera, tea art, clothing, chess and other courses into the platform, so that the elderly can enjoy quality community education at home. In deepening the work of poverty alleviation collaboration, and actively innovative ideas, participate in the "Jin Long two cloud bridge" activities, and Pingliang City, Gansu Province to establish Jin Long education support mechanism, the "network cloud thinking politics" and "national unity education" The teaching content is shared through the "cloud bridge", so that students in Pingliang

City know the history of the Party and understand the ideology. In the "Thousands of Miles of Non-Foreign Heritage in Jingu" activity, we shared a classroom with a famous teacher in Nanping City, Fujian Province. Nanping teachers offered "Jianjian pottery class", and students in Hexi District listened to teachers explain the history and production process of Jianjian online, and tried to make pottery tires under the guidance of teachers around them offline. The students and teachers from the two regions were able to experience the profundity of Chinese culture through online and offline classes.

10.4.3 Grasp Dynamic Data to Optimize Teaching

Since the reform of the new college entrance examination system in 2017, the examination and enrollment system has undergone radical changes, and the right to choose courses has been handed over to students, and class selection has become an effective way to meet students' personalized course choices. Each school establishes a class selection system, oriented to students' personalized development, regulates the number of classes and class sizes to meet students' needs to the maximum, uses good teachers, one class schedule for one person and one class schedule for one subject, and students punch in and sign in through electronic class cards. With the support of information technology, class selection and class teaching can be promoted in an orderly manner, and students' personalized development is solidly guaranteed and supported.

10.5 Leading Education Big Data Governance with the Construction of Smart Education Demonstration Zone

Data governance is a comprehensive social project that requires multi-sectoral coordination and linkage, from the innovation of institutional mechanisms to the breakdown and refinement of methods and measures, all of which produce disruptive changes to the current workflow. Data analysis provides a layered perspective, forming the ability to overlook social development and gain insight into the trajectory of reform, which is an inevitable way to achieve quality and balanced education. During the 14th Five-Year Plan period, education data governance will be an important tool for promoting education informatization. We aim to create a smart education system that integrates the five education aspects of "future schools, future teachers and future students", and take the basic principles of "holistic thinking, integrated planning, synchronized construction, interoperability and sharing, step-by-step promotion, and use to promote construction" as our goal. The construction model of "one, three, seven" is clear, that is, one goal—to build a demonstration area of intelligent education; three

action dimensions—to create a wise education Heshi, smart and goodness of Heshi; seven major The seven major projects—the implementation of education model innovation project, education evaluation reform project, information literacy cultivation project, governance capacity enhancement project, education environment construction project, resource supply optimization project, and special intelligent innovation project. Steadily promote the four-step rhythm of "setting standards and building a platform, grasping management through data, gathering data for teaching, and using data for change", comprehensively connect the overall data links of bureaus, schools and individuals, ensure the unification and integration of various application systems, data sharing and mining analysis, and realize the integration of intelligent education data from macroscopic decision-making to microscopic services. By 2024, the district will have built a "smart education" ecosystem that matches the core area of the modern socialist metropolis, realizing "learning for all, learning everywhere, and learning at all times".

Chapter 11
Technology-Enabled Project-Based Learning: Let Every Child Embrace "Good Learning"

Jia Zhang, Jiang Wu, Xiqin Sun, Yijie Yang, and Mengchen Zhou

11.1 Story of Development

Project-based learning is a way for students to reconstruct and transfer their core knowledge through continuous exploration of real and challenging problems over a period of time, which helps trigger deep learning and develop students' higher-order thinking and core literacy.

In the survey results of project-based learning, 88.6% of teachers said it was difficult to design project-based learning, 58.9% said it was difficult to select authentic and appropriate driving questions, 48.9% said it was difficult to design and achieve higher-order learning objectives, 42.9% said the time and space for project-based learning was limited, and 40.1% said it was difficult to precisely and effectively guide students to The teachers said that it was difficult to guide students to personalized learning.

The leaders of the Education Bureau of the park and experts at all levels brought ideas to solve the problem—technology empowerment, exploring new teaching and learning models, and cracking the difficulties of project-based learning. In recent

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years, the Education Bureau of the park has been actively building a cloud-based integrated "Easy Plus" platform that runs through the whole teaching process, focuses on classroom teaching, and empowers new teaching, providing strong support for classroom teaching that integrates people and networks and a new regional teaching ecology based on core literacy.

11.2 The Constant Exploration

Combined with the core elements of project-based learning, it is clear that the following five major problems need to be solved to further cultivate students' core literacy and develop higher-order thinking.

- How to solve the lack of personalized learning resources for teachers and students?
- How to create authentic and driving questions to attract students' active engagement?
- How to help students personalize their learning experience?
- How to effectively organize students' collaborative learning and promote interactive communication?
- How to better break through time and space constraints to achieve diverse practice and dynamic assessment?

11.2.1 Systematic Resource Co-construction

The complexity and diversity of real problems in project-based learning require various types of resource construction. Yijia has created synchronous resources, including teaching design, teaching courseware, guidance plan, teaching reference, test papers, materials and other plates. The materials plate fully meets the multi-form incorporation of knowledge and experience in the project, such as documents, pictures, videos and so on. Starting from the needs of after-class projects, Yi Jia has created a weiyun course and question bank, which can not only complete the supplementary study of knowledge, experiments and methods that can't be expanded in class, but also complete the test of what has been learned.

With such a systematic construction idea, we invite team teachers to cooperate in developing curriculum resources. Developed "special subject course + general education course". The special subject course refers to the specific class hours in the project, and the general education course refers to the method instruction course of project-based learning, such as interview, questionnaire, investigation report writing, scheme design and other courses. At the same time, in order to facilitate teachers and students to find and learn resources, the platform has set up multi-level and multi-dimensional classification. By binding the chapters, knowledge points, subject literacy points and key competence points of the teaching materials, resources are interrelated and accurately pushed.

11.2.2 Literacy-Oriented Learning Path Reconstruction

"Let learning happen to students, make learning their own business, and let students learn in their own way". This is the significance of project-based learning-from "knowledge-oriented" education to "literacy development" oriented learning development. Project-based learning emphasizes the integration of high-level learning and low-level learning. Solving the needs and difficulties of "driving problem design, personalized learning, collaborative learning, diversified results" put forward by teachers and students one by one will also help cultivate students' core literacy and higher-order thinking. Based on the above thinking, we designed the whole learning process of "pre-learning, co-learning, and extension of learning", and constructed a new learning path of "self-testing, independent learning, personality exploration, synergetics, co-evaluation, and dynamic testing".

11.2.2.1 Create Initiative Problems for Students

In the early stage, the project study was from top to bottom, and the school and teachers specified the project theme. As the executors, students sometimes lacked interest, which was defined as "the task assigned by the teacher" rather than "the theme I want to study". The real driving problems should originate from life and students, enhance students' cohesion to the project, and make the learning process a meaningful one.

Through the "self-test" of Yijia College, the pre-class investigation, evaluation and analysis are carried out, the project is carried out uniformly, and the learning situation is analyzed dynamically, so as to establish a suitable starting point for curriculum development. For example, the cultural project "How to Tell the Story of Suzhou Streets", the self-oriented project "How to Carry out Effective Home Learning for Primary School Students during the Epidemic Period" and the agricultural project "How to Meet the Double Twelve Festival with Fresh School" are all driving issues, which are all carried out with high efficiency through the investigation of the academic situation, after understanding students' confusion, needs and interests in the real world, discussed and determined, thus realizing students' autonomy and making the project truly enter students' hearts.

11.2.2.2 Realize Personalized Learning

Professor Howard Gardner, a psychology professor at Harvard University, pointed out that the reform of school education must pay attention to "individual differences of students". Students also look forward to personalized learning and personalized results. Through "learning before adding", students can come into the classroom with questions, make cognitive preparations. For example, in the elevator project, after

completing the "self-test" related to the questionnaire survey, the system will automatically push the survey method instruction micro-course for students who don't have enough methods. Teachers will also push the video "Four Types of Common Elevators" through pre-learning. Students will "learn independently" before class, study together in class, and learn before teaching, so that the classroom can pay more attention to students' confusion and realize burden reduction and efficiency increase.

Through the task of "personality exploration" and "synergetics", we can build a more accurate learning bracket for students. For example, in exploring the characteristics of streets and alleys, each group chooses different streets and alleys, so Yi Jia can push the matching resources to realize differentiated guidance. According to different learning needs and habits, the group realizes the individuation of inquiry and the diversification of results. When students are confused, Yi Jia can push related resources according to the students' situation, to realize teaching students in accordance with their aptitude to the greatest extent, and truly " I am the master of my study".

11.2.2.3 Promote Collaborative Learning

Collaborative learning is helpful for project learning members to learn from each other, so as to carry out high-level learning activities such as comprehensive analysis, problem solving and evaluation, and carry out social practices such as listening, discussion and cooperation. Yijia College has strengthened the design of learning interaction, which makes the whole process of collaborative learning explicit, richer in learning forms, more interactive and interesting.

With the help of the platform, in the "Synergetics" session, group partners can freely discuss and carry out various group activities such as project selection, task division and cooperative inquiry. For example, students can discuss the naming and classification of streets and lanes through easy-to-add games, and learn cognitively. Before the field visit, students draw pictures in circles on the tour route map, and jointly look for research points. When it comes to the booth design, students drag the schematic diagram on the whiteboard and design the floor plan of the booth layout together. In the "co-exhibition and evaluation" link, the platform's "mutual evaluation and feedback" technology can reproduce students' interest points and confusion points in real time; Easy voting has realized the timely sharing of group results and the collision of thinking; It is easy to collect pictures and upload homework, so that more people can be seen and share them after class.

11.2.2.4 Realize Diverse Practices and Dynamic Evaluation.

Interviews show that students' research motivation is weakened due to lack of guidance and communication in practice. Through online resource guidance, homework collection, teachers' questions and answers, growth documentary and learning circle sharing, Yijia College breaks through the time and space constraints and realizes

"ubiquitous learning" and "dynamic testing" anytime and anywhere. For example, in the street project, before the street visit, online micro-courses guide the development of travel plans; After the visit, the students uploaded the video works to Yijia Learning Circle to share and evaluate the level of the works; In the elevator project, the construction of the improved elevator model and the extension after class have both the instruction course of model making and the channel of homework submission and evaluation, which provide support for the improvement of elevator model works.

11.3 Tangible Growth

On April 23, 2022, the new curriculum plan and curriculum standards were released, which defined the requirements of interdisciplinary learning. So, back to the original question, what changes have been brought about by project-based learning under technology empowerment, and have they solved our problems and puzzles? Let's answer this question from different perspectives.

11.3.1 Embrace a More Comprehensive and Individual Self

> In the activity, we show our strengths and share in real time. Through the learning of Easy Plus platform, we can also learn what I am interested in at any time. I feel that I am more 'all-powerful' now!
>
> —— Students who participated in the project.

Under technical empowerment, the research process, the form of achievement, the form of publication and the form of interaction of student projects are more three-dimensional and real time. Taking "Street Project" and "Elevator Project" as examples, the pre-and post-test of students' literacy is carried out through the platform, and it is investigated from three aspects: knowledge level, ability level and emotional attitude and values. First, in terms of students' excellent achievement rate, both programs focus on exploring students' advanced learning abilities such as problem-solving, system analysis, decision-making, originality and research. The excellent rate of students in the "Elevator Project" has increased by 37.1%; The excellent rate of students in the "Street and Lane Project" increased by 54.26%. Second, the improvement of a certain ability point of students. Let's take "the ability to find and ask questions" as an example. For the control group students who did not participate in the project for one semester, the natural increment was only 1%, while the students who participated in the project increased by 20%. It can be seen that the project-based learning after Yi Jia's empowerment has greatly improved students' comprehensive quality.

11.3.2 Meet a Fairer and More Promising School

> We all want our children to have the best learning resources, but many subjective and objective factors such as geographical restrictions and family conditions make it impossible for us to guarantee that every child gets the best. Can project-based learning under technology empowerment make students grow more 'fairly'?
>
> ——From the voice of parents.

Project-based learning under technology empowerment promotes educational equity and inclusiveness. From knowledge transmission to literacy development, from uniformity to precision supply, different learning spaces, materials and opportunities are provided for each child, so that students at different levels can enjoy fair and quality education. Judging from the pre-and post-test of students' literacy, project-based learning under technology empowerment has significantly improved the literacy of students in development zone schools and urban schools. As a result of technical empowerment, the improvement of the knowledge level of different students is very close, and the "fairness" of the learning effect has been realized. Influenced by objective factors such as growth environment and social resources, urban school students still have a slight advantage in ability level, emotional attitude and values, which is also the thinking point that can continue to optimize curriculum design by using cutting-edge technology in the future.

11.4 A Better Future

11.4.1 Experience that Can Be Used for Reference

Under the technical empowerment, we continue to explore, innovate, practice and reflect, and have formed a series of experiences in research objectives, core contents, research mechanisms and promotion strategies, thus constructing a new pattern of regional project-based learning.

Empirical research mechanism. Summarized and practiced the research mechanism of regional project-based teaching based on empirical research. Through the empirical research and practice in three different stages: problem-oriented, demand-oriented and achievement-oriented, it constantly catalyzed the technology update and iteration, constantly changed the new teaching and learning pattern, and formed a closed-loop circular promotion paradigm of regional project-based learning.

Advance strategy of system design. Formed a "five-power" promotion strategy of "regional dominance and platform empowerment". Regional "administrative promotion" provides a high-level standard for development, the research technology of

"teaching and research" of business departments is deeply integrated with project-based learning, the subjectivity of "school action" is built according to its characteristics, the base is interactive, an alliance school is established for joint research, and teachers are actively involved in research.

Reproducible whole-course model. The successful experience of wisdom-enabled project learning points to the whole learning model of precision learning, individuality learning and ubiquitous learning. It can also be applied in other traditional disciplines, copying and promoting smart education to intervene in traditional disciplines, and realizing the efficient improvement of discipline ability and core literacy.

11.4.2 The Promising Future

Project-based learning under technology empowerment has changed the traditional teaching methods, successfully broken the limitations of time and space, fully mobilized more effective resources and efficiently served the students' study and research. In the process of using smart education to solve the bottleneck of project-based learning, new contradictions between teaching and learning are often encountered and generated. For example: 1. New technology but how to solve the problem of "information island" between disciplines? 2. How to accurately depict the portrait of learners' practical research process? 3. How to develop a more immersive learning scene under the support of 5G? 4. How to make big data carry out project development and intelligent teaching and research according to teacher portraits?

We will continue to carry out problem-based action research, and make use of emerging new technologies, continue to iterate and upgrade, change technologies with technologies, and promote educational changes with technological innovations, so that every child can experience truly "good learning".

Chapter 12
"Six Actions" to Promote the Iterative Upgrade of Smart Education

Yuandong Hou and Yuanfu Ma

12.1 Background

Wenzhou is a prefecture-level city under the jurisdiction of Zhejiang Province, with a registered population of 8.328 million and 1.4442 million students in primary and secondary schools (kindergartens), with a total of 1,027 primary and secondary schools and 1,341 kindergartens. The development of smart education in Wenzhou has a good foundation, but it also faces many problems and challenges: first, there is no standard and ready-made path for smart education; Second, the challenge of new technology applications leads to the phenomenon of uneven development among schools, isolated data island, resource fragmentation and unsystematic application. Third, the traditional educational informatization construction system and promotion mechanism are outdated, and information security restricts the application and popularization of large-scale innovation; Fourthly, focusing on the background of national education digitalization strategy, the focus of smart education is to deepen the reform of information technology education and teaching application.

12.2 Draw a Blueprint

In 2021, Wenzhou was shortlisted for the second batch of 10 "Establishment of Smart Education Demonstration Zones" projects of the Ministry of Education, and in June of the same year, the *Implementation Plan for Establishing National Smart Education Demonstration Zones in Wenzhou City* (hereinafter referred to as the Plan) was formulated and issued. The "Program" adheres to the "innovative education mode,

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cultivating innovative talents", strengthens the top-level design around "cultivating people in virtue, teaching students in accordance with their aptitude", and builds the "12,456" creation system, that is, taking the overall wisdom of digital push education and the iteration of education and teaching wisdom as the value core, and taking the collaborative innovation platform with multi-agent joint participation and the intelligent service platform of "digital brain" as the system support. The main task is to promote the smart campus to cover all schools, teaching applications to cover all teachers, learning applications to cover all school-age students, and artificial intelligence education to cover all schools. The creation goals are to achieve a high-level promotion of information integration and application, high-quality improvement of teachers and students' information literacy, high-quality promotion of large-scale education, high-efficiency promotion of teaching students in accordance with their aptitude, and high-intelligence promotion of educational modernization.

12.3 The Practical Results

Digital-driven iterative upgrading of smart education has become an important strategy to promote the high-quality development of Wenzhou education, showing a new trend of collaborative innovation among government, scientific research, schools, enterprises and society.

12.3.1 The Overall Formation of the "Big Community" Platform Promotion Mechanism

The party committee led the promotion. The establishment of the demonstration zone will be included in the annual list of key reforms of the municipal party committee, the focus of government work and the content of educational supervision, and the annual objectives and tasks will be listed as the assessment content. We establish a diversified funding guarantee mechanism, prepare a three-year project budget for the establishment of the demonstration area, and list key projects such as the construction of interactive multimedia in ordinary classrooms as the government's "practical work for people's livelihood" project. From 2022, it is planned to purchase more than 12,000 sets in three years to achieve full popularization and 8,000 sets of new teaching spaces.

Establish a regional inter-school community. We improve the linkage mechanism of smart education promotion in cities, counties and schools, and promote it in an orderly and powerful way by twinning regional "educational communities", "teaching and research alliance schools" and "Internet + education" schools. On the basis of the construction of urban and rural education communities and the twinning of cross-regional education communities, aiming at the structural shortage of subject

teachers in 140 small-scale rural schools with less than 200 students in the city, a new type of subject internet school was set up, and the rural "flying class" was carried out as a normal aid to teaching. In 2022, 44 teams and 224 music teachers were recruited for the music discipline, and 44 rural schools were twinned, and the fine arts discipline also carried out the "flying class" pilot to realize one.

Establish a community of political and research cooperation. We set up Wenzhou Research Institute, the National Digital Learning Engineering Technology Research Center, together with Huazhong Normal University, developed the evaluation standard of the regional intelligent education development index and the establishment standard of intelligent campus 2.0, etc., carried out a cooperation project with East China Normal University on training chief information officers (CIOs) and "intelligent education teachers" in primary and secondary schools, and established Wenzhou "National Artificial Intelligence Education Cultivation Zone for primary and secondary schools" with Modern Education Technology Branch of China Electronics Institute, and hired experts from the Ministry of Education and domestic key universities to form an expert group. We also carry out regional twinning of smart education in urban and rural areas by expert teams to build a common prosperity, select six professional guidance groups composed of more than 50 experts from six mountainous island counties to give guidance, determine 13 regional characteristic projects and 38 benchmark schools for smart campuses, promote 18 pairs of smart campuses to help schools, implement "one-on-one" guidance, build an interschool smart education alliance with the best and the weak, and promote the balanced development of high-quality education in the whole city.

Establish a community of integration of production and education. In 2015, we cooperated with enterprises to jointly develop the "cloud marking" digital adaptation system, which was piloted from the large-scale joint entrance examination to realize the normalization of school digital adaptation. In 2019, Wenzhou Education signed a strategic cooperation agreement with Alibaba to promote "warm education nail" on a pilot basis. During the epidemic in 2020, a global "organization online" was quickly established, and the digital work of "communication online, collaborative online, business online, and ecological online" of the education system was realized. At present, "nail management school" has been realized all over the world, and there are at least 10 digital application scenarios in schools. Wenzhou's "Cloud Map" realizes the digitalization of book management and digital reading in primary and secondary schools all over the world. We will jointly develop basic applications such as "Bright Eyes and Bright Teeth", "Knowledge Proficiency", online answering by famous teachers, "comprehensive service system for admission and enrollment" and "deduction" of artificial intelligence education.

Case 1: "Wenzhou Xuetongtong" famous teacher online

The online platform of "Wenzhou Xuetongtong", a famous teacher launched in 2017, after an iterative upgrade, integrates the functions of a famous teacher forum, online micro-question bank, through-train for answering questions, self-study cloud

service, etc., to assist students to study independently after class, and realize human–computer co-assistance. The platform gathers famous teachers from all over the city, and provides online free Q&A service for students in the whole city all day long.

Based on the needs of students' phased learning methods, academic literacy and improvement of thinking ability, "Famous Teacher Forum" launched 111 lecture courses for municipal famous teachers in 2021, with a total audience of 320,000. In October 2021, the computer-aided column of "Online Micro-Question Bank" was launched, which integrated micro-lessons for difficult homework guidance, and automatically screened micro-lessons to provide guidance according to the student questioning platform. By May, 2022, it had provided 2.21 million person-times. The famous teachers in the "Q&A Express Train" column are on duty online. Students can submit questions by taking photos, writing, voice and video, etc. Teachers provide online guidance and answer questions on the same screen in real time, with an average of 1,200 person-times per month (junior and senior middle schools). "Self-school Cloud Service" has launched its own school teachers to provide online accurate online services for its students in the pilot area, which is very popular among parents and students. This project has been listed as a provincial promotion project by the Zhejiang Education Department.

12.3.2 "Digital Brain" Drives the Overall Intellectual Governance of Education

The data hub platform is basically completed. We realized the convergence of data information between provinces, cities, counties and schools, gathered 1.29 billion pieces of various data, and formed 21 visual decision-making cockpits, such as intelligent application monitoring, a map of educational wisdom, basic data of education, myopia prevention and control, and data operation and maintenance monitoring, to realize unified entrance, unified certification and personalized application.

"Learning in Wenzhou" integrated digital application. The platform radiates to the whole region with the flexible supply mode of "standardization + configuration". Build a portal platform of digital service "capability pool" with multiple portals on PC and mobile, and integrate 58 application systems of education and teaching. The centralized supply, personalized addition and intelligent push of user applications are realized. The third-party applications provide a generic application "cockpit" for decision-makers from the whole life cycle management of creation, registration, review, shelving and authorization, and support hierarchical decentralized management according to different levels and user roles.

Focus on the scene to promote the overall smart governance of education. Focusing on "a picture of **smart governance of education** ", efforts will be made to create a number of scene applications with Wenzhou's educational recognition, comprehensively support digital services and digital learning of education for all, and accelerate the reform of educational governance in the information age. In July 2021,

Wenzhou held the first "Tianyi Cup" Digital Reform and Innovation Application Competition in the field of education, and 83 outstanding cases emerged, of which 11 key application scenarios were selected as key projects of digital reform in provinces and cities.

Case 2: convenient data exchange, education, collaborative smart governance

In June 2021, the application scenario of "Admission Handheld" was launched in Zhejiang Office, Zhejiang Government Nail and Digital Social Portal. Focus on the problem of public enrollment, establish 40 indicators and 250 data fields, realize six decision-making early warning services, and form three closed loops: school planning early warning, enrollment early warning and scientific decision-making early warning. In 2021, 46,033 students enrolled in kindergartens, 94,378 students enrolled in primary schools and 93,738 students enrolled in junior high schools were registered online. The accumulated data was verified 1,709,560 times, and the enrollment rate of parents was over 90%. It was successfully selected for the second batch of the provincial-level list of "Exposing the List" of Zhejiang Development and Reform Commission.

Case 3: Data Mining Boosts the Reform of Educational Evaluation

In 2019, Wenzhou took Ouhai district as a pilot area to develop the "Smart Moral Education" student growth evaluation system, and successively developed more than 20 scene applications, 6 intelligent evaluation hardware models, 2 practical patents and 11 software copyrights, covering more than 30,000 teachers and students. Teachers evaluated more than 90% of daily users, and the average monthly evaluation coverage rate of students was 100%, which realized the evaluation applications in three scenarios: the comprehensive quality of school students, the growth of family students and the sociology generation field. At present, it has been popularized in Lucheng District, Longwan District, Ruian City, Yueqing City and Yongjia County of Wenzhou City.

12.3.3 "Digital Portrait" Empowers the Iterative Upgrade of Smart Campus

Building a Smart Campus 2.0. Developed the *2.0 Standard Evaluation System* and outlined the Wenzhou version of the 2.0 "Portrait" of Smart Campus with 27 indicators. It is planned that by 2023, 200 smart campus 2.0 schools will be built on a pilot basis, and 500 smart campus standard schools will be established. By 2025, the city's primary and secondary schools will have full coverage of smart campuses. In 2022, the acceptance of the first batch of 20 "Three Clouds" Smart Kindergartens has been completed, and the work of "health care, conservation, education and management" in kindergartens has basically achieved man–machine collaboration.

Accurate teaching of data empowerment. The "cloud marking" digital system has served the evaluation of the city's education quality since 2015, and the effect of empowering regional teaching and management decisions with big data is quite remarkable. From 2017 to 2022, Wenzhou's teaching quality has fallen behind the provincial average level to the first echelon of the province's quality. At present, there are 209 schools that use "cloud marking" to carry out digital adaptation in middle schools, accounting for about 42%. Many schools use "Zhixue.com" and "Geek Big Data" to carry out digital adaptation, and the schools in middle schools that are normally used account for more than 50%.

Drive the conventional iterative transformation of data teaching. We promote intelligent teaching tools, and assist teachers to realize new classroom routines such as cloud-based lesson preparation, interactive teaching, digital correction homework, online answering, online teaching and research, and online listening and evaluation. The application of the Xuele Cloud teaching platform has been promoted in Wencheng county. The cumulative activation rate of teachers has reached 86.6%, the average daily online time of students is 101 min, and the average daily online time of students is 17.6 min, which realizes real-time and accurate collection of classroom data and supports teaching diagnosis and educational decision-making.

12.3.4 Intensive Digital Resource Supply of "One Map of All People's Smart Learning"

The opening rate of teaching space is over 99%. Wenzhou Education Cinema, as a characteristic course video resource network, gathers 8196 video resources and 21,588 supporting resources such as local micro-courses, micro-movies, famous teachers' courses and local non-legacy courses. Wenzhou Primary and Secondary School Cloud Library covers 1008 primary and secondary schools in the city, forming a digital management database of 29.02 million paper books, and establishing OTO (online and offline) reading ecology supported by paper books and electronic resources. "Wenzhou Xuetongtong", a famous teacher online (Q&A) platform provides online services for backbone teachers at the municipal level above three levels. Unified purchase of high school examination questions resources and test paper function, for all high schools in the city to use free of charge, forming a complete curriculum resource system matching the current teaching materials.

12.3.5 Popularize Artificial Intelligence Education and Cultivate Students' Innovative Quality

In 2022, the *Implementation Plan for Promoting Artificial Intelligence Education in Primary and Secondary Schools in Wenzhou City* was issued, and according to the

idea of "5133", the popularization of artificial intelligence education was promoted all over the world.

Promote the construction of artificial intelligence campus. We build a "five-in-one" ecosystem of artificial intelligence education with "one school, one AI course, one AI team, one innovation project, one intelligent space and one brand activity", focusing on cultivating 1,000 experimental schools of artificial intelligence and 100 demonstration schools of artificial intelligence education.

Build a unified AI education and teaching platform. We build Wenzhou's "AI Brain", set up online and offline multi-collaborative activity platform, and integrate the functions of "teaching, learning, management, evaluation, practice, measurement and creation" to realize the effective sharing of high-quality resources, excellent teachers, educational data and information dividends.

Build an artificial intelligence education system. We construct a three-level curriculum system of "basic popularization, community expansion and comprehensive promotion" to cultivate students' interest, discover innovative potential students and cultivate innovative talents. Build a "100 thousand" three-level teacher training system, build a "school + teachers + students" three-dimensional innovation literacy evaluation system, and hold all kinds of maker and artificial intelligence activities at all levels.

12.3.6 "One Platform, Four Abilities" Empowers Teachers to Improve Their Ability

Micro-team building to promote the leadership of school informatization. The principal serves as the chief information officer (CIO), and the principal, the principal in charge and the director of the information office form the CIO "micro-team". we organize the special training of school CIO micro-teams for 1–2 times a year, implement the annual assessment of CIO, and select 3–5 outstanding teams to lead the informatization construction and development of primary and secondary schools in the city.

Training the lecturers' group, improving the information guiding power of backbone teachers. We set up a lecturer group for Future Institute of Educational Technology (the first batch of 50 lecturers), introduced the responsibilities and management measures of the lecturer group, compiled the research cases of the lecturer group, and played an exemplary role in radiation.

Research on this topic promotes teachers' informatization research ability. We promote the research of regional informatization application projects (projects), strengthen the management of project establishment, project opening, mid-term report and final evaluation, and organize the training of project opening and final report writing. The research ability of primary and secondary school teachers in informatization application has been significantly improved. In 2021, 27 provincial education informatization projects were established. Multi-ways to improve

teachers' informatization application. Vigorously, we promote the IT literacy training of primary and secondary school teachers, set up the IT application training menu for teachers according to the training needs of different regions and levels, and make full use of the strength of lecturers and teachers from universities and enterprises to implement the new technology "send training to school".

12.4 Experience

Wenzhou smart education is still in the initial exploration stage. It will take the initiative to aim at the future education direction, deepen the application of digital intelligence technology, solve the dilemma of intelligence education, promote the deep-seated reform of education mode, and promote the modernization of the education governance system and governance capacity. In the next step, we will actively introduce new technologies, new projects and new tools, build an intelligent, ubiquitous, personalized and lifelong smart education ecology, and promote students' all-round development and personalized growth; Further deepen the demonstration pilot construction of counties and schools, carry out the whole process of project performance evaluation, regularly publish the annual regional smart education development index report, speed up the typical case mining, refine the model experience, enhance the ability of standardization and transformation, and promote the iterative upgrading of global smart education.

Chapter 13
Construction, Application Practice of "Smart School" Based on "Government-Enterprise-School-Research" Collaboration

Yuanli Duan, Wei Tang, and Huiping Xie

13.1 The Construction Background of "Smart School" in Bengbu

In 2019, Bengbu City, through the way of "municipal co-ordination, enterprise agent construction, graded payment, innovative application", landed the smart school construction project promoted by municipal co-ordination, and completed the smart school construction work covering more than 800 schools in three counties and six districts of the city at one time.

Different from the traditional ideas of construction and application, Bengbu's "Smart School" has adopted a new mechanism of "total integration and total service", established a cooperative mechanism based on "government-enterprise-school-research collaboration", and formed a joint force. Through teaching and research guidance, government supervision, school practice and enterprise service, it can solve the problems in the construction and application of "Smart School" and promote its in-depth application.

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13.2 Exploration of "Government-Enterprise-School-Research" Collaboration

Focusing on the key issues in the process of building a "smart school" in Bengbu, such as overall and coordinated implementation, establishment of training system, promotion of teaching mode, implementation of normal application, and construction of management mechanism, Bengbu Education Bureau adopted the working idea of building, practicing, summarizing, and improving, and gradually explored a path for "government-enterprise-school-research" to promote the construction and application of a "smart school".

13.2.1 The Overview of the Model

The mode of "government-enterprise-school-research" collaboration in Bengbu is to give full play to the advantages of the government, enterprises, schools and research institutions, clarify their respective division of labor and functions, and formulate work promotion plans and management assessment mechanisms in accordance with the operation mechanism of "project management" in the process of promoting the application of "smart schools".

Teaching and research leads the way. With the help of research institutions, we formulate an action plan for the construction and application of "smart schools" in Bengbu, and define the development direction, construction mode and research topics. We follow up the progress of the overall construction and the effect of practice, revise the work plan and plan, study the application rules of various businesses in specific teaching scenarios, and formulate application norms and guidelines, so as to promote research and use, promote research and use, and form a benign interaction.

Summary of school practice. Through the selection and construction of model schools, base schools and experimental schools, Bengbu City has formed a number of advanced models and set application benchmarks. According to its own development needs and actual characteristics, the school, through twinning with the work guidance group of research institutions, regularly holds seminars by using the network teaching and research system, and conducts special seminars on practical problems, so as to ensure that the experience can be summed up and refined in time, and promoted and applied.

Enterprise technical support. Enterprises need to establish a long-term cooperative relationship with schools and build a high-quality support system. Bengbu Smart School construction defined the service content when bidding and purchasing. The period is 60 months, and service personnel are stationed in each school to ensure the guarantee and support in application training, equipment maintenance, product optimization, etc.

The government coordinates as a whole. The government plays the role of leadership, supervision, coordination and resource scheduling in the construction of smart schools. It is necessary to formulate a service supervision system and standard system, examine the implementation effect and ensure that education services can be maintained in time. Bengbu City has set up a "Smart School Construction Project Office" composed of education bureaus, schools and enterprises, and established a management and scheduling mechanism of "online last week scheduling, face-to-face last month scheduling and key node re-scheduling".

13.2.2 The Value of the Collaboration Model in Bengbu City

13.2.2.1 It is Conducive to the Co-construction and Sharing of Resources

"Government-enterprise-university-research cooperation" has realized the diversification of participants, unified planning, unified design, unified standards, unified platform, unified data resource database, and maximized their respective advantages. At the same time, it can avoid the problems of poor resource coordination, repetitive construction and inefficient construction caused by the barriers between departments, greatly improving the efficiency and the construction effect.

13.2.2.2 It is Conducive to the Further Advancement of Application

Bengbu City, according to the task list, will incorporate all the work into the performance appraisal of the person in charge of each unit, and commend and encourage the departments, counties and schools with outstanding appraisal, so as to supervise and promote the application. Take a combination of special supervision and regular inspection, visit randomly, push the door and attend lectures, and improve the efficiency and accuracy of inspection and supervision. Through the collection of data statistics, the system of weekly and monthly reports is formed, and timely feedback is conducive to further promoting the application of smart schools.

13.2.2.3 Innovation of Teaching Mode

Bengbu City has formulated the "Standards for the Evaluation of Smart Classroom Teaching in Primary and Secondary Schools", including the evaluation index system of the teaching design scheme, the evaluation index system of the whole teaching process, the analysis framework of evaluation results and data processing tools. It has been applied in Bengbu elementary school, junior high school and senior high school's "data-driven teaching students in accordance with their aptitude" quality class competition and "Jiangong Zhucheng Bengbu Young Teachers'

Smart Classroom Teaching Competition Municipal Finals", which has formed a certain influence.

13.2.2.4 It is Conducive to the Construction of Teachers' Team

In the process of building and applying smart schools in Bengbu, a teacher training mode with hierarchical grading and online and offline integration has been formed. Classify, build a training system, and build a medium-and long-term training plan that is coordinated from top to bottom and horizontal. Precipitate outstanding achievements, high-quality teaching and training resources, and form an experience-sharing mechanism. After systematic training and team building, teachers' information literacy has been significantly improved.

13.2.3 Typical Practices in the Collaborative Process of "Government-Enterprise-School-Research" in Bengbu City

In the academic year of 2020–2021, Anhui Audio-visual Education Center's supervision statistics on the application data of smart classrooms in Anhui Province show that Bengbu smart classroom application data ranks first in the province.

13.2.3.1 Establish Bengbu Smart School Construction Project Office and Build a Smart Education Research Institute

Bengbu Smart School Construction Project Office consists of project coordination group, project audit group, project acceptance group, project training group, project application group and technical support group. Each group's corresponding lead department and relevant departments of counties and districts shall transfer key responsible comrades to the project office of the Municipal Education Bureau full-time, and be responsible for the management, construction, implementation, training and application of the project. Eight well-known professors are employed to form an expert committee to provide expert advice and guidance for the development of smart education in Bengbu City, and to formulate educational informatization planning in line with the situation of Bengbu City. Relying on the Jianghuai Institute of Smart Education, we will build a model of integration of Industry-University-Research, a collaboration between government and enterprises, and provide guidance, technical and service support.

13.2.3.2 Build a Smart Training Academy and Build a Hierarchical and Classified Teacher Training System

Build a smart training academy to realize the integration of teachers' research, training, learning, management and testing. In 2021, a total of 33 online trainings for trainee teachers in secondary vocational schools and primary and secondary schools were conducted. Carry out "Talent Training in Smart Classroom". In 2021, there were 134 talent training activities in the city, with a total of 3,826 teachers participating in the training, of which 1,062 were awarded the honorary title of "Star of Smart Teaching". With the goal of deepening the application in an all-round way, the training plan should be formulated by roles, levels and stages. As of April 2022, there were 1,487 training sessions for school principals (CIO), applied training for subject teachers, teaching and research training for teaching and research staff, and operation and maintenance support training for information administrators, covering more than 33,320 teachers, including 10,190 rural teachers.

13.2.3.3 Hold Bengbu City High-Quality Class Competition and Smart Classroom Sample Competition

In 2021, a high-quality class competition covering three sections of elementary school and high school will be held in the whole city, and 67 primary school teachers will be selected through three counties and six districts. 127 teachers from junior high school and 112 teachers from senior high school participated in the finals. Through the competition of high-quality courses, a number of high-quality courses have been precipitated, which can be used to guide experts to conduct research and analysis, and form the teaching mode of each section. In 2022, a sample contest of smart classroom teaching was carried out in the whole city. A total of 18 teachers were randomly selected from three schools in three counties, six districts and bureaus every week to participate in the contest, which lasted for nine weeks and involved 23 subjects in primary and secondary schools, which greatly promoted the application of smart classrooms.

13.2.3.4 Select Experimental Schools, Base Schools and Model Schools, and Carry Out In-Depth Research on Key Teacher Training and Application

A total of 90 smart school construction model schools and base schools were selected and constructed, and 12 experimental schools were selected and constructed. Relying on the expert team of Northwest Normal University, the training of key teachers and research on applied topics are carried out in depth. Cai Ke, secretary general of the national informatization teaching experimental area of the Ministry of Education and professor of Capital Normal University, Guo Jiong, professor of Northwest Normal University, and Liu Bangqi, dean and professor of Xunfei Institute of Educational

Technology, personally give lectures to key teachers. Around 12 research topics, a total of 6 topic guidance groups are set up, and a doctoral team from Northwest Normal University forms an expert guidance group to attend the school for counseling.

13.2.3.5 Carry Out Smart Classroom Teaching Exhibition Week to Promote Research and Application

The Education Bureau of Bengbu launched the Smart Classroom Teaching Exhibition Week in the whole city, fully demonstrating the new teaching and research mode supported by information technology. Bengbu No.1 Middle School integrated online teaching and research into the exhibition week, and teachers from three counties and six districts in the city participated in the exchange and discussion. Since the construction of Smart School, as of April 2022, 758 teaching and research activities have been carried out at the provincial, municipal, district and county levels, including 315 public classes, 124 seminars, 67 observation meetings, 77 academic and research activities, 81 competition activities and 50 other teaching and research activities.

13.2.3.6 Data-Driven Individualized Teaching and Full Coverage of High Schools in Big Data Service Centers

The Education Bureau of Bengbu has completed the construction of the "Big Data Service Center for Teaching Students in accordance with Their Aptitude" in all high schools. Taking Bengbu No.2 Middle School as an example, by collecting homework, testing and training data in the daily teaching process, intelligent scanning, cloud marking, intelligent correction, and the generation of academic report, teachers can be guided to "teach accurately" and "research efficiently"; Based on the analysis of academic data, we will construct students' personal portraits, accurately push high-quality resources, customize exclusive personalized learning programs, help students to do fewer questions, do well in them, do the right questions, bid farewell to the sea tactics, help students to "learn personality", and realize burden reduction and efficiency increase.

13.2.3.7 Form a Typical Case-Sharing Mechanism Around the New Teaching and Learning Model

In order to solve the problems of structural shortage of high-quality resources, scattered organizational forms, limited sharing and application, etc., the collection of application cases for the construction of smart schools in Bengbu and the selection of "three classrooms" in Bengbu were carried out. More than 2,000 application cases have been collected and collected into a book through teachers' reports, regional screening and municipal commendation. For outstanding cases, Bengbu Education

Bureau specially held commendation meetings, awarded certificates and rewards, which greatly improved teachers' enthusiasm for participating in activities, provided support for the promotion of teaching mode, teachers' independent research and professional development, and formed a data-driven typical case sharing mechanism for teaching students in accordance with their aptitude.

13.3 The Optimization Strategy for the Construction and Application of "Smart Schools" in Bengbu

Strengthen financial security. Further increase funding, strengthen the level of construction, application and operation and maintenance of software and hardware, and realize unified monitoring, hierarchical management and coordination of network basic resources, Internet of Things equipment, application information systems and network information security to ensure the orderly implementation of the work.

Strengthen supervision and evaluation. We ought to strictly implement various management policies and systems, implement the leadership responsibility system of each district and county, strengthen the "number one" responsibility system of principals, and give full play to the school CIO work function.

Strengthen process management and control. It is practical to establish monitoring and evaluation mechanism of sustainability assessment, strengthen dynamic management of the working process, and comprehensively improve the efficiency, effect and benefit of Bengbu smart education construction.

Increase training and promotion. We should promote the application of the smart education application system in regional administrative departments and schools, formulate detailed promotion plans, and ensure that smart teaching tools are applied to the classroom. At each stage of training, we should pay attention to digging and cultivating seed teachers in various schools. Give full play to the demonstration, radiation and guidance role of seed teachers, so as to promote the formation of a new normal of smart teaching of "classroom use, frequent use and universal use".

13.4 Conclusion

The Education Bureau of Bengbu takes the construction of "double zones" in the experimental area and demonstration area and the pilot project of artificial intelligence boosting teachers' team construction as the key work, which runs through the whole process of the city's education during the 14th Five-Year Plan. In the next step, the Municipal Education Bureau will take the construction of "two districts and one point" as the strategic fulcrum, update the educational concept, deepen the reform of education methods, and build a contingent of outstanding teachers.

Taking educational data as the core element, innovating classroom teaching mode, perfecting smart evaluation system, empowering education governance, deepening the reform of education supply side, and promoting the balance of education quality. By teaching students in accordance with their aptitude on a large scale, systematically constructing a high-quality education system, educating people in an all-round way with five domains at the same time, and striving hard for innovation, we will forge ahead to strengthen the national education city.

Chapter 14
Exploration and Practice of Regional Intelligent Operation Application

Yingjie Ji, Yajun Wan, and Ying Wang

14.1 Background: Smart Homework, Responding to the New Call of Smart Education

Nanchang has created a new mode of education by focusing on smart enrollment, smart examination and smart homework, and realized a new way of education based on educational data to make people run fewer errands and more data. It is a supplement to homework classroom teaching and an important means for students to consolidate their knowledge, improve their ability, expand their thinking and broaden their horizons. However, the common practice provided by the traditional homework mode is difficult to realize the individualized improvement of students, the blind area of knowledge cannot be cleared away, and the learning problems are difficult to cure. The "birth" of homework perfectly combines multimedia information technology with a home-school learning environment, greatly improves students' autonomy in participating in after-school learning, and helps teachers effectively improve classroom teaching efficiency and students' comprehensive quality.

14.2 Concept: Smart Homework, Helping the New Ecology of Smart Education

Homework is an important starting point to promote the popularization of smart education, and rich experiences and results have been achieved in the practice of smart education.

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14.2.1 Follow the Law of Regional Development and Vigorously Promote the Development of Regional Intelligent Operations

According to the basic conditions of each district and city, the Provincial Department of Education has formed a spatial development strategic pattern with Nanchang, the provincial capital, as the guide, Ganzhou taking the lead, Yichun following closely, Shangrao spreading out and Jiujiang promoting "four plates", making efforts to improve the application concentration, regional synergy and overall competitiveness of smart work, gradually forming a "smart work" sharing circle, and finally radiating to 11 districts and cities in the province.

14.2.2 Based on the Location Advantages, to Do Better in Nanchang Smart Education Model

Based on its geographical advantages, Nanchang City has transformed the advantages of key talents into the leading demonstration advantages of applying intelligent homework, giving full play to their influence and appeal among teachers and students in schools, paving the way for the comprehensive popularization of the application of "intelligent homework". Up to now, the use of smart homework in the city has basically covered 838 primary and secondary schools and 18,544 teachers in the city, and the service has benefited more than 73,786 students, with 864,269 person-times of homework collection, 1,998,580 lessons on wrong questions, and 98,722 layered homework assignments.

14.2.3 Implement the Application of Intelligent Homework and Continuously Improve the Teaching Effect of Regional Education

Actively explore the application mode of "Smart Homework", guide teachers and students to make good use of the application system of "Smart Homework", build a learner-centered academic evaluation system, accurately push high-quality learning resources for students, provide teachers with learning situation analysis based on "Smart Homework", and effectively support the reform of teachers' teaching methods and students' learning methods. In the province, it is the first to apply the hierarchical homework design system of intelligent homework, assist teachers in personalized homework design, actively explore the way of "painting students with data", and use the hierarchical homework system to help teachers and parents discover their children's superior potential, teach students in accordance with their aptitude, form

students' learning track files, and promote students' personalized growth. As of April this year, 176 teachers have arranged 49,331 sets of layered personalized homework through the intelligent homework platform, and students have completed 98,722 personalized homework.

14.3 Practice: Smart Homework, Creating A New Model of Smart Education

In recent years, our city has seized the new historical opportunity of information development and actively explored the deep integration of intelligent homework and subject courses. The practice of intelligent operation in the whole city reflects the characteristics of "114" construction, that is, building a base, focusing on a brain and reproducing four kinds of application scenarios.

14.3.1 Build a Base to Build a Foundation

On the basis of an intelligent operation platform, a large-scale cloud computing infrastructure is built by using information technologies such as big data, cloud computing and artificial intelligence, and three forms, such as dot matrix pen, high-speed scanner and so on, are used to provide dynamic collection support for students' homework and learning information for the upper application of intelligent operation.

14.3.2 Focus on "One Brain"

Relying on the core advantages of independent and controllable information support technology, massive data collection and processing capabilities, open platform ecosystem, etc., the intelligent homework brain is constructed, which includes advanced technology applications such as optical scanning recognition, cloud question bank, artificial intelligence, big data analysis, etc., and realizes the coordinated deployment of students' homework elements in all time and space, process data sharing, and scene intelligence.

14.3.3 Presenting Four Types of Application Scenarios

In the era of educational informatization 2.0, the four application scenarios that intelligent homework can achieve are intelligent homework dynamics, intelligent

homework stratification, intelligent homework evaluation and intelligent education service. In addition, it can also be used to know the latest children's learning status in real time through the intelligent homework platform, so as to realize the information exchange among teachers, parents and students, and promote students' classroom enthusiasm and teaching efficiency.

Application Scenario 1: Accurate insight into the full-time operation situation of the job.

We collect the teaching and learning data from the feedback of daily homework, and use the digital education decision-making platform as the basis for decision-making. The application of learning big data in the field of education can promote the effectiveness of teaching and learning, improve the quality monitoring system, realize dynamic quality management, and promote the scientific decision-making of education.

Application Scenario 2: empowering and strengthening the refinement and stratification of homework.

"Smart Homework" explores the way from three levels: daily study, review before and summary after the exam, dismantling teaching problems and breaking down learning difficulties one by one, and providing students with efficient "targeted homework": dynamically capturing students' process learning data by using smart pen and high-beat instrument through students' daily paper-based teaching aids, wrong questions in test papers and homework, and uniformly summarizing the wrong questions at the end of the chapter, providing a set of questions by drawing inferences from others, including Before the exam, it can provide teachers with the analysis of the wrong questions in students' daily homework, and also summarize the weak knowledge points for students; After the exam, students will automatically count and deeply analyze the wrong questions, generate typical explanations, and provide targeted post-exam summaries.

Application Scenario 3: Reducing burden and increasing efficiency to support the "double reduction" policy.

In the final analysis, scientific decision-making and hierarchical homework are to improve learning efficiency and really help teachers, students and parents reduce their burdens. The teaching method of "teaching students in accordance with their aptitude and teaching in different levels" is conducive to "cultivating excellent students and making up for poor ones", and helps teachers to know the knowledge level of class students in a short time through the application of layered homework. Questions that students can't know in homework can be personalized by watching micro-lessons. It is also possible to get rid of the "unified" sea-topic model of traditional homework through layered homework assigned by teachers, which greatly improves students' learning efficiency.

Application Scenario 4: Benefiting education and people's livelihood and improving teachers' and students' happiness.

Based on the problems of students' long learning time, low efficiency and low happiness, the intelligent homework platform displays the mastery and degree of students' knowledge points in the form of atlas, and pushes personalized learning resources according to students' knowledge atlas. It pushes personalized variant training according to wrong questions to realize hierarchical learning. Introduce accurate teaching, personalized learning, intelligent teaching and research, intelligent evaluation and intelligent management based on big data, empower teachers' accurate and personalized teaching. Based on the data, we can adjust the teaching content and reconstruct the teaching process in real time, strengthen the teaching effect of teachers and students, and enhance their happiness.

14.4 Practice: Smart Homework, Showing a New Style of Smart Education

14.4.1 Application Cases in Qingyunpu District

Qingyunpu District is a marginal city with urban–rural integration and mixed suburbs. Problems such as the late start of education reform, the weak teaching infrastructure and the scarcity of educational resources have been the fetters of education development in this region. Combined with the actual situation of education and teaching reform and development in the Qingyunpu district, we have started a number of pilot projects of circular investigation, practice, reflection, optimization and re-investigation in a "co-creation" way with Soft Cloud Technology.

14.4.1.1 Take Homework as the Entry Point, and Realize Data Empowerment Layered Teaching

Qingyunpu District focuses on building a new big data monitoring model for homework teaching covering the whole region. By enriching the district-level question bank, school-level question bank and individual question bank, the breadth and depth of intelligent homework are expanded; Through the data generated by the students, we can accurately diagnose the weaknesses of students' knowledge and ability, realize personalized and accurate push of exercises, reduce the burden and increase efficiency for students, and build a layered homework design platform with Qingyunpu Scenic Resort characteristics. In the process of practice, it is also found that there is empiricism in teachers' mastery of students' learning situation, as well as fuzziness over a long time span. Using the platform diagnosis and analysis module, through the diagnosis and analysis of the collected process data and stage data, the student

portrait analysis, class situation analysis and regional data analysis are generated, which provides a scientific basis for teachers' precise teaching.

14.4.1.2 Take the Platform as the Foothold to Reduce the Burden of Education and Teaching for Teachers and Students

Through many investigations, Qingyunpu District Education and Sports Bureau found that front-line teachers have great resistance to various platforms with complicated operations. How to make intelligent homework simple and easy to operate without increasing teachers' extra burden? First, login unification; Second, collection diversification; Third, the operation is normalized, without changing the working habits; The fourth is to correct intellectualization.

In the process of regional practice in the past two years, at present, the number of students registered on the platform is 26,585, the number of teachers registered is 1,205, and there are 22 schools using it. The acquisition equipment also covers the whole area in the form of entering classes, and the teachers and students have a good response. With the support of the city, it will become the 2021 Nanchang Smart Campus Demonstration Zone. At the same time, as a representative, it will exchange and share experiences in the 2021 Jiangxi training program, and it will also be publicized and reported by the provincial and national magazine Educator. In the future, Qingyunpu district will try to integrate sports, fine arts, music and other disciplines, covering various types of data such as homework, daily tests and academic examinations, actively explore comprehensive quality evaluation, break the "score-only" theory, and give full play to the value-added function of evaluation.

14.4.2 School Application Cases of Nanchang No. 28 Middle School Qingyun School

Nanchang No. 28 Middle School Qingyun School, as a pilot unit of smart education in Qingyunpu district, has set up a special group to fully implement the wisdom homework project. At the same time, students are equipped with a smart homework AI study room with 16 intelligent computers and 3 printers. There are 44 intelligence-gathering machines in each class of primary and secondary schools. Teachers in grades four to nine can actively analyze the learning data of students on the platform, use the platform to generate test papers, and combine some subjects in grades seven and eight with layered homework to achieve classroom integration.

At the beginning of the project's landing, the school asked the class to use all the teaching and auxiliary homework and exercises. After a period of data accumulation, detailed subject analysis, class analysis and students' individual reports can be presented on the "Hierarchical Precision Work" system. The reports will show the common weaknesses, common wrong questions, and the distribution of important

and difficult questions in the subject/class. Each discipline group regularly discusses the causes through the common weak knowledge points of this grade, combined with the years and characteristics of the discipline, and forms a standardized discipline promotion lesson plan, which effectively improves the overall teaching effect of the discipline. Every year, a review plan for weak items will be set for each subject in Grade 7, and the class will consolidate and test the weak items according to the cycle in this plan.

14.4.3 The Overall Application Case of Wanli Administration

At present, there are 21 primary and secondary schools in Nanchang Wanli Administration, with more than 10,000 primary and secondary students and more than 500 teachers. At present, there are some problems: we can't know the teaching situation and progress level of each school in time, and how to ensure that rural schools get homogeneous teaching resources under the "double reduction" policy. To solve the above dilemma, in 2021, Wanli Bureau started to use the smart pen mode of "smart homework" in primary and secondary schools all over the world, relying on the platform of "smart homework" set up by Jiangxi Provincial Department of Education and combining the actual situation of local education and teaching reform and development.

Help precise teaching. The convenience of collecting teachers' smart pens expands the breadth and breadth of "smart homework". Wanli Administration matches teachers' smart pens to each teacher in the school in stages. Under the premise of not changing students' writing homework, teachers' habit of correcting homework and normal teaching, smart pens are used to dynamically collect students' daily homework learning situation, count the amount of homework questions in each school, and generate each student's exclusive set of wrong questions. We push the systematic homework analysis micro-course and similar consolidation exercises jointly developed by famous teachers in primary and secondary schools for free and accurately. Parents of students choose voluntarily, and they can view the wrong micro-course through electromechanical boxes, computers and other ways to accurately solve homework problems, and send high-quality famous teacher resources to every child to help them with wisdom accurately.

Guarantee "suspension of classes and non-stop learning". Students use ordinary pens to write homework and take photos with teachers or class groups. After receiving students' homework, teachers enter the online correction mode of small programs, compare students' information, and use smart pen to correct on their own teaching assistants, so as to collect students' daily homework and learning information, and let teachers know students' learning situation at home, thus ensuring the teaching effect.

Improve the quality of teaching. With the introduction of "Smart Homework", some changes have been made to teachers' teaching methods. Through more accurate data analysis of students' learning situation in class and after class, students'

learning situation is presented in a digitized chart, so that teachers can have a deeper understanding of students' strengths, weaknesses, learning habits and attitudes, pay more attention to them, prepare lessons more accurately, and take a step closer to real personalized learning. From the spring of 2021 to the spring of April of 2022, the average correct rate of primary school homework in Wanli Administration increased from 78.14 to 91.69%, and that of junior high school homework increased from 81.94 to 92.24%, which also reflected the progress of overall teaching effect.

Chapter 15
Promoting the Popularization of Artificial Intelligence Education

Jianyong Huang and Xiaomei Li

Qingdao takes the promotion of educational informatization 2.0 as the core, the reform and innovation as the driving force, and the deep integration of educational informatization and education and teaching as the center, and has taken a path of educational informatization in Qingdao.

15.1 Outline

Guidance Outline of Artificial Intelligence Education Curriculum in Primary and Secondary Schools (hereinafter referred to as "Outline") defines artificial intelligence curriculum as a course with the characteristics of the times, comprehensiveness and practicality, which is a course that integrates science and humanities, is guided by ability and literacy, is based on the core concepts of artificial intelligence, and emphasizes problem-solving and innovative application.

Accordingly, the implementation of artificial intelligence courses in primary and secondary schools in Qingdao adheres to the target orientation of three-dimensional popularization, expansion and training of excellent courses, pays attention to the cultivation of artificial intelligence disciplines such as computational thinking, technology application and innovation, and intelligent social responsibility, and builds an artificial intelligence curriculum system of "outline first, one course with multiple books and coaches combined". The top-level leads artificial intelligence education to create a new journey.

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15.2 The Classification of Classes

Based on the learning characteristics of students in the basic education stage, Qingdao takes the Outline as the core, carries out innovative research on artificial intelligence education, strengthens the internal relationship between artificial intelligence and information technology, makers, robots, STEAM and programming, and determines the teaching mode of "three sections and four layers" (the three sections are: primary school, junior high school and senior high school respectively; The four levels are: enlightenment in grades 1–3, popularization in grades 4–6, popularization in junior high school + excellent training, and popularization in senior high school + excellent training).

15.2.1 Case: The Enlightenment Teaching Case "Who Moved My Card"

Students in grades 1–3 are fresh to artificial intelligence, but they are young and have little knowledge of artificial intelligence. Enlightenment teaching is to fully mobilize students' multi-sensory participation, establish intuitive and perceptual knowledge of artificial intelligence, and cultivate students' interest in the field of artificial intelligence through the combination of playing artificial intelligence enlightenment videos and game experience activities in class. This lesson example is the process of guiding primary school students to "parity check" two pictures to quickly find out passive cards and complete the game tasks through the game "Who Moved My Cards". After learning, students can also make card games by themselves, interact with classmates and parents, and achieve the effect of entertaining.

15.2.2 Case: Popularize the Teaching Lesson Course "Exploring the Secret of " Facial Recognition System"

This lesson mainly teaches the principle and application of face recognition technology in artificial intelligence image recognition, and by feeling the impact of face recognition technology on life and study, it can stimulate students' interest in learning, and enhance their innovation and inquiry thoughts.

The whole teaching links are: creating scenarios to introduce new lessons, program experience understanding algorithms, task-driven exploration of new knowledge, work display, exchange and sharing, expanding and improving life applications, and applying what you have learned in after-class exercises.

In the classroom, students understand the principle of face recognition through life experience + program experience; Using the combination of Mind + programming and control board, write the access control system of face recognition to further

understand face recognition; Feel the impact of facial recognition technology on life and learning, and enhance their innovation and inquiry.

In the teaching link, the tasks are intertwined and progressive, from shallow to deep, leading students to gradually understand face recognition and logical thinking, and give full play to students' subjectivity.

15.3 Teachers Education and Training

In order to meet the needs of education and teaching, Qingdao is committed to creating a group of "three highs" (high professional quality, high teaching level, high teaching and research ability) famous teachers with Qingdao characteristics to ensure that the curriculum takes root.

15.3.1 Select Teachers and Build a Team System

Qingdao innovated the path of teacher building, established a "2 + 7" full-time and part-time teaching and research team, and cultivated more than 800 artificial intelligence teachers from information, mathematics, geography, physics and other disciplines through selection, training, teaching and research, and preparation activities, and initially formed a citywide artificial intelligence teacher team system.

Through online popularization and offline special training every year, on-site meetings and high-quality class observation and display activities are carried out every month, teaching and research and preparation activities are carried out every week, so that outstanding teachers can carry out course displays, share teaching experience, and improve the overall teaching ability of the teaching team.

15.3.2 Strengthen Training and Upgrade Teachers' Skills

In order to improve teaching and practical ability and change the current situation of front-line teachers' general lack of artificial intelligence teaching literacy, teachers are trained in artificial intelligence professional training in batches. In 2021 alone, 34 themed activities, 11 periods of artificial intelligence teacher training, and 20 expert demonstration courses were completed, benefiting more than 1,000 teachers in Qingdao and receiving more than 500 people from Changzhou and other foreign cities.

We comprehensively innovate the training methods of AI backbone teachers, and put the original expert teaching and experience exchange training online. We also carry out project-based training offline, that is, analyze problems in a group cooperation manner according to the specific problem situation, use advanced artificial

intelligence suite, use artificial intelligence image recognition, speech recognition, natural language processing, machine learning and other technologies, according to the way of district and city grouping - group collaboration - production of works - stage display, to provide a platform for each participating teacher to learn from each other and show themselves, and mobilize the enthusiasm of teachers.

15.3.3 Use Theoretical Research to Improve the Quality of Teaching

Qingdao seized the opportunity and successfully applied for the Ministry of Education's "Artificial Intelligence Education Course Teaching and Applied Research Practice Community", the 13th Five-Year Plan Major Project "Qingdao Primary and Secondary School Implementation of Artificial Intelligence Education Research" and other projects, and successfully completed the final work.

At the same time, the major topics of artificial intelligence education in Qingdao were established, and research results were continuously carried out to form research results from the aspects of exploring the teaching mode of artificial intelligence education courses, building a resource library of artificial intelligence courses in Qingdao, carrying out students' artificial intelligence learning evaluation, and promoting the application of artificial intelligence-enabled education, so as to provide a theoretical basis for the comprehensive popularization of artificial intelligence education in Qingdao.

15.4 Improve the Environment and Consolidate the Foundation of Teaching

Qingdao has built an infrastructure that combines software and hardware, and through the completion and use of supercomputing centers, teaching platforms and artificial intelligence laboratories, it truly solves the problem of "how to teach well" in artificial intelligence courses and attracts students to deeply participate in artificial intelligence learning.

15.4.1 Build a Supercomputer Center to Provide Environmental Support

In accordance with the requirements of the city's overall planning and the step-by-step implementation of the district and city, more than 70 million yuan was invested in advance to build 5 intensive artificial intelligence education supercomputing centers

with "computing power support, data sharing, and network transmission" at one time, providing a total of 72 CPU nodes and 24 GPU nodes, the maximum concurrency can carry 218 classes at the same time. At the same time, the time-sharing multiplexing method is adopted to increase the overall utilization of the original basic equipment and improve the utilization rate of core equipment.

15.4.2 Upgrade the Teaching Platform to Support Education and Teaching

In order to enrich the learning experience, comprehensively support AI education and teaching, and build an integrated AI education service platform of "course teaching, content creation, and open source innovation". Set up an artificial intelligence education course learning system module on the Qingdao education e-platform to provide a one-stop service for artificial intelligence education for teachers, students and education managers of primary and secondary schools in Qingdao. Relying on the artificial intelligence education service platform, it integrates courses, experiments, training, exhibitions and other content, bringing together more than 20 programming modules and more than 100 independent learning projects.

15.4.3 Introduce a List of Laboratories to Lay the Foundation for Construction

According to the current requirements and future planning, the construction standards of artificial intelligence laboratories that meet the development requirements have been completed, and a list of artificial intelligence laboratories has been introduced, and more than 300 laboratories have been built in total, providing display, experience and operation platforms for more than 200,000 students. In 2024, it is expected to invest 100 million yuan as a whole to complete the popularization of artificial intelligence laboratories and create a number of comprehensive artificial intelligence laboratories integrating "course teaching, application practice, and interactive experience".

15.5 Input Global Coordination to Achieve Full Popularization of Artificial Intelligence Courses

15.5.1 Embracing Expert Guidance to Optimize Course Implementation

Relying on the expert team, we will give follow-up and normal communication guidance to schools and teachers. Organize a team of experts to regularly visit the school, listen to the open classes of front-line teachers throughout the process, and inspect the construction and equipment of artificial intelligence laboratories. At the same time, exchange seminars will be held to answer the problems and confusions encountered by schools and teachers in the promotion and teaching of artificial intelligence education, and put forward targeted guiding opinions. Organize a professional team to complete the delivery of courses to the school in the form of sending courses, resources, and experts. In 2021, the teaching team of artificial intelligence doctoral has been organized to visit 22 schools and send 116 high-quality courses covering all sections of primary and secondary schools.

15.5.2 Coordinate Urban and Rural Areas and Carry Out Regular Class Activities

For some weak districts and cities and weak schools, based on the current situation, "class delivery teaching based on weak schools" has been carried out, through the education development advantage areas to the relatively weak areas to achieve the sharing and exchange of advantageous resources, and the weak areas of education receive the teaching resources of the exporter through the supporting classrooms to solve problems such as weak teachers and lack of educational resources.

15.5.3 Case: "Dream Village-Relay Help" Artificial Intelligence Teaching Activity

In order to make artificial intelligence education benefit every student in Qingdao City, the Information Center of the District Education and Sports Bureau called on the artificial intelligence professional teachers in the district to dedicate a piece of love to the whole district, set up a volunteer teaching team, take turns to go to the mountain villages, and teach the children on a voluntary basis in the mode of "relay teaching".

At the beginning of each semester, artificial intelligence teachers in municipal schools in Chengyang District, Qingdao City, will usher in a "fierce competition".

Some of the teachers who signed up lived in Shangma and Hetao streets in the westernmost part of Chengyang, and some lived in other districts and cities such as Shibei and Licang, although their home addresses were very far away from the schools they taught, they still did not stop the teachers' enthusiasm for dedicating love. Under the organization of the relevant person in charge of the street, they will go to the corresponding mountain school one week in advance to listen to the class, actively communicate, communicate and discuss with the teachers after class, carefully understand the students' learning status and course progress, and then carefully prepare for next week's artificial intelligence teaching course according to the actual learning situation of the students. Every volunteer teacher prepares the volunteer class as if it were an open class, and the exquisite courseware and the board stickers prepared carefully are strong proof. Some teachers even prepared 3D-printed small works and notebooks made by students in their own schools as small gifts to reward children who listened carefully. The volunteer teachers all drove private cars or multi-class buses into the mountain villages to attend classes, and no matter how windy or rainy, they did not leave the children in the mountain villages behind a single artificial intelligence class.

15.6 Conduct Assessments to Test the Results of Educational Practices

Benchmark against the international and build an overall framework. In line with the International Student Assessment Project (PISA), the "Qingdao Primary and Middle School Students Artificial Intelligence Education Assessment Program" was compiled. The five content systems of perception, representation and reasoning, machine learning, human–computer interaction, and social impact of the three sections are clarified, the four core competencies such as information awareness, computational thinking, digital learning and innovation, and information social responsibility, as well as the three supporting factors of knowledge, skills and attitude, and the overall framework is built on the basis of fully studying the influencing factors and evaluation strategies.

Diverse evaluation, pay attention to the cultivation of virtue and cultivate people. Combine test questions, questionnaires with project assessment methods, summative evaluation and formative evaluation, quantitative evaluation and qualitative evaluation, so that students, peers, teachers, schools, regions and parents can participate together, highlighting students' innovative application ability based on real situation problem-solving. At the same time, it pays attention to cultivating morality and cultivating people, organically infiltrates emotion, attitude and value education, and evaluates the degree of good information literacy.

Analyze data to clarify educational thinking. 2,441 teachers and more than 160,000 students participated in the evaluation work in the city's schools. The results of the report show that students' awareness of artificial intelligence, application of

intelligent technology, practical innovative thinking, and intelligent social responsibility have been greatly improved, and teachers have been significantly stimulated and improved in terms of role reshaping, subjective awareness, and teaching effectiveness.

15.7 Strengthen Publicity and Tell the Story of Qingdao's Artificial Intelligence Education

Qingdao Municipal Education Bureau implemented "platform thinking" and established the International Artificial Intelligence Education Alliance to achieve multi-party cooperation and innovation between government and enterprise research and learning. Regularly carry out on-site meetings, seminars and exchange meetings on artificial intelligence education to summarize the typical experience and practices of artificial intelligence education in Qingdao. Through the "International Alliance for Artificial Intelligence Education" public account, website, special newspapers and briefings and other multi-level and multi-channel publicity work, more than 300 publicity manuscripts have been carried out, creating an official publicity platform for artificial intelligence education to the outside world. At the same time, it pays attention to external publicity, and has published nearly 100 reports in global network, China Net, Guangming Daily and other media, and exported the rich experience and practices accumulated in the curriculum promotion mode and enabling application of artificial intelligence education.

The intelligent era of "human–machine collaboration, cross-border integration, co-creation and sharing" has arrived, cultivating a large number of high-end artificial intelligence talents with innovative ability and cooperation spirit is the mission of artificial intelligence education, Qingdao will explore the construction of a new artificial intelligence talent training system as its own responsibility, continue the spirit of the International Education Informatization Conference, promote education and teaching innovation supported by new technologies, and contribute Qingdao strength to running a satisfactory education for the people.

Chapter 16
Strive to Build a Smart Education Public Service System with "Six Standards"

Huimin Zhang, Xiaoliang Wei, Liang Feng, and Jianling Deng

16.1 Background

In February 2021, Shenzhen was selected for the list of regions created by the Ministry of Education's 2020 "Smart Education Demonstration Zone". According to the overall deployment and work requirements of the Ministry of Education on the construction of "Smart Education Demonstration Zone" and the actual situation of our city, the *implementation plan of "Smart Education Demonstration Zone in Shenzhen"* was formulated, and the work of smart education demonstration zone was fully started.

According to the *Implementation Opinions on Accelerating Degree Construction and Promoting High-quality Development of Basic Education* issued by Shenzhen Municipal Party Committee and Municipal Government, by 2025, there will be 1 million new degrees in basic education, and nearly 400 new schools need to be renovated and expanded. This is an unprecedented "super project" in the history of Shenzhen education. Shenzhen education needs to take intelligence as the path and means to deal with a series of challenges, such as the balance of high-quality education, the development of school characteristics and the cultivation of innovative talents.

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16.2 Key Initiatives and Results

16.2.1 Plan the Path of Smart Education Public Services

Plan for the development of education in the 14th Five-Year Plan and highlight the vision of smart education. In the *14th Five-Year Plan for Education Development of Shenzhen*, it is clearly proposed to build a national smart education demonstration zone. The *14th Five-Year Plan for Basic Education Informatization in Shenzhen* proposes to rely on the core engine status of Shenzhen Bay Area, integrate resources from all parties, focus on consolidating the digital foundation of Shenzhen education, build a "Pengjiao intelligent community", empower the high-quality development of education, realize the digital transformation of Shenzhen education, accelerate the promotion of intelligent upgrading, and comprehensively expand the radiation role and influence of smart education in the Bay Area. The above policy documents show the vision and goals featuring smart education.

Clarify the positioning of the city, promote the implementation of smart education. In terms of new infrastructure, it is clear to further strengthen the construction of new education infrastructure, and propose smart education infrastructure improvement projects, intelligent campus construction projects, and BIM/CIM projects for campus management; In terms of talent team, the *Implementation Plan of Shenzhen Smart Education Pilot Talent Training Project (2022–2025)* was formulated and issued; In terms of education data, the Shenzhen local standard *Classroom Teaching Behavior Data Exchange Specification (DB4403T 198–2021)* was formulated and released; In terms of teaching and learning organization, the study issued the *Guiding Opinions of the Shenzhen Municipal Bureau of Education on the Normalization of Online and Offline Hybrid Teaching in Ordinary Primary and Secondary Schools.*

16.2.2 Draw a Blueprint for Smart Education Public Services

The education public management service platform has been preliminarily built, and the unified portal, unified identity authentication, single sign-on, open development, information exchange, unified big data and integrated operation and maintenance capabilities of Shenzhen education management are provided.

16.2.2.1 Establish a Digital Pedestal for the Education System to Support the city's Large-Scale Epidemic Prevention for All People

Develop a health data system in the field of education to achieve dynamic updates. The system entered the whitelist information of 2.82 million teachers,

students and employees in the city, including all school students, teaching staff, logistics personnel, family members living on campus and third-party special operation personnel in Shenzhen, and dynamically updated the "Yue Kang code", nucleic acid testing and new coronavirus vaccination data of all the aforementioned personnel every day. In the spring semester of 2022, Shenzhen Education Organization 2,832 schools created 3,188 school codes, 349,384 Faculty and staff completed health declarations and created 58,143 class codes, 2,510,922 students completed health declarations. Determine whether teachers, students and staff meet the conditions for returning to school according to health information, health code color, and nucleic acid testing, assist schools in completing statistics and management, and effectively reduce the pressure of epidemic prevention management in various districts and schools.

The development of class group codes enables real-time collection of large-scale health information data. On May 31, the Shenzhen Municipal Bureau of Education issued the Notice on Promoting the Application of the "Group Code" Function of the Guangdong Provincial Affairs APP in School Epidemic Prevention Work, encouraging all schools in the city to apply the "group code" to school epidemic prevention work in combination with their own epidemic prevention management needs, so as to reduce the burden on schools, staff and students' parents. As of June 24, the number of "class group codes" created in schools in Shenzhen has reached 100,000, and the number of binding people has exceeded 4 million.

16.2.2.2 Rely on the "Shenzhihui" Platform to Help Make Decisions on Degree Construction

Shenzhen has built a three-year cycle of education "one-network unified management" education governance system, continuously improved the level of intelligent management, and built an education data capability service system. Uniformly carry out data aggregation, storage, sharing, and governance, build a data management and service operation system, promote more national and provincial business systems to share data in Shenzhen, and regularly compare data correction mechanisms with education administrative departments and schools in various districts, promote the coordinated linkage of education statistics and business data, strengthen the docking with authoritative basic data sources such as the city's population, legal persons, housing, natural resources, and spatial geography, and gradually improve the city's data resources in the field of education.

16.2.3 Promote the Innovation of Smart Education Public Service Models

16.2.3.1 In-Depth Construction of Cloud Schools to Promote Future Education Practice and Mechanism Innovation

As the world's first innovative school that uses physical schools to run Internet education, Shenzhen Cloud School has explored the dual-teacher teaching mode of "main lecture + auxiliary lecture, online + offline", realizing cross-school sharing of high-quality classrooms and rapid growth of young teachers.

In terms of teaching, "normalization, multi-main lectures, live broadcast interaction + intelligent assistance" makes "teaching" more intelligent and diverse, and invites famous teachers to their classrooms; Layered personalized cloud assignments are targeted at students' learning and promote individualized teaching. In terms of learning, the self-learning mode of "cross-school group classes, multi-teacher collaboration, optimal student assistance, seamless online/offline integration, and free switching" makes "learning" more free and autonomous; The good interaction of the online classroom greatly stimulates students' internal motivation and promotes students' group learning and research learning. "8:30 tonight" cloud teachers answered questions online, solved the problem of students' after-school homework guidance, and effectively implemented the "double reduction" policy. In terms of teaching and research, the embedded teaching and research mode of "municipal teaching and research staff stationed on-site guidance, led by famous teachers in the city" makes "research" more accurate and profound.

16.2.3.2 Explore a Hybrid Online and Offline Teaching Model to Ensure that Teachers and Students Teach and Learn Simultaneously

In the face of the new problems and new situations brought by the epidemic to teaching, primary and secondary schools in Shenzhen have actively explored a new hybrid online and offline teaching mode that meets the development needs of the intelligent era, so as to ensure that teachers who have not returned to school for some reason can teach synchronously and students can learn synchronously.

After returning to school in April, the affiliated school of Longhua District Academy of Education Sciences still has 2 teachers and 28 students in the lockdown or control area, and 5 Students in Shenzhen Welfare Institute, the school ensures the synchronous teaching and learning of these teachers and students with blended teaching. Qilin Middle School of Nanshan Experimental Education Group adopts a mixed teaching model and a teaching assistant follow-up mechanism to cope with the situation that teachers and students cannot return to school on time due to epidemic prevention and control.

16.2.4 Construct Public Service Resources for Smart Education

Shenzhen Education Cloud Platform realizes a large resource system with full coverage. At present, Shenzhen has developed 7866 online teaching course resource packages, which are free and open 40,000 high-quality lessons, covering a total of 45 subjects in primary, junior high and high schools. A total of 4,543 homework examples were developed for 12 subjects in primary and junior high schools. In addition to subject content, there are also 9 thematic education contents such as patriotic education and health and hygiene. During the online teaching period in the spring semester of 2022, from February 21 to April 19, the number of visits to the Shenzhen Education Cloud Resource Platform exceeded 18 million visitors, with a maximum of 1.35 million visits in a single day. The teaching resource package based on micro-video effectively helps teachers to carry out online teaching and promote the quality and balance of online teaching. In addition to subject curriculum resources, there are also a variety of art resources such as online concerts, and "aesthetic education micro-classrooms", to enrich children's cultural and entertainment life and achieve educating five domains at the same time.

Resource application data analysis explores a new pay-for-performance mechanism. At the same time, the education cloud platform explores a new mechanism for pay-for-performance resource construction, innovates the digital resource generation model, upgrades the digital resource ecological environment, and gradually builds an open, integrated and high-quality digital education resource service system. In 2021, Shenzhen carried out classroom teaching behavior data collection and application evaluation activities, and at the same time, using the education cloud big data analysis capability, the anonymous and desensitized classroom behavior data was analyzed and mined to form a diagnostic report with school characteristics, providing data decision support for optimizing teaching methods and improving the quality of education and teaching.

16.2.5 Build a Smart Education Public Service Team

The "Pioneer Teacher Innovation Class" explores new forms of future teachers. The "Pioneer Teacher Innovation Class" of the Shenzhen education system selects 25 young backbone teachers from the whole city to participate in the training and conducts two sessions a year to explore new forms of future teachers. The training is conducted in the form of "five-stage training + mentor training", which includes five stages: theoretical research, thematic network training, research and study, visits, learning and posting, and promotion and summary. At present, two phases of training for 50 young backbone teachers with demonstration and leadership have been completed. After Zhang Sheng, a teacher at Shenzhen No. 3 Senior High School,

participated in the pioneer program, he regularly used virtual reality and other information technology to visualize subject knowledge in the classroom, guide teachers of other disciplines to solve teaching problems, and truly play the "pioneer" role of pioneer teachers.

Launch the smart education pilot talent training project. On April 2, the Shenzhen Municipal Bureau of Education issued the "Implementation Plan for Shenzhen Smart Education Pilot Talent Training Project (2022–2025)", establishing and improving the echelon of smart education talents and cultivating a group of high-quality professional and innovative teachers who meet the needs of smart education. Provide important intellectual support and talent guarantee for the pilot demonstration of basic education in Shenzhen.

16.2.6 Improve Regional Smart Education Public Services

The cross-departmental coordination mechanism promotes work efficiently and pragmatically. Coordinate the administrative departments, teaching and research departments, and information departments of the coordinating organs to jointly promote and coordinate development, integrate and optimize the positioning and functions of institutions, establish and improve the flow mechanism of information and resources in the construction of smart education demonstration zones, and promote efficient coordination. For example, the basic education department is responsible for overall planning, supervision and inspection and other overall promotion work, the education department is responsible for the guidance and practical work such as curriculum construction, teacher training, and project research, and the education information technology center is responsible for program planning, standard formulation, resource construction, application training, etc.

The cooperation between the city, district and school communities is flexible and orderly. As a city-wide promotion unit, Shenzhen adhered to the coordination between the municipal level and the district school at the beginning of the planning to build a three-level cooperation community of the urban school. At the municipal level, strengthen top-level design and overall planning, formulate and issue policy documents, plan and deploy overall construction work, promote the implementation of key municipal projects, and formulate work plans around district-level projects in each district to activate the kinetic energy of schools in the region and actively promote it. In the cross-regional exchange work plan, the city-level overall annual plan is planned, and multiple districts are organized to exchange and display results every quarter according to the direction of experimental projects, and school representatives display the results of school-based pilots in combination with regional characteristics.

16.3 Features and Experience

Shenzhen has made all-around efforts to promote the construction of smart education demonstration zones, boldly carried out mechanism construction and innovation, and actively created a new situation for the integrated development of urban schools.

16.3.1 Districts and Schools Become Co-Builders of Smart Education

Shenzhen guides all districts to choose appropriate project directions based on the actual needs and basic conditions of the region on the basis of retaining regional characteristics, and systematically promotes reform experiments. The district-level experimental project adopts the "1 + 2" model, and each district chooses one of the three experimental directions of curriculum reform and interdisciplinary integration, teaching and learning model innovation, and big data collection and application, and carries out teacher team construction and institutional mechanism reform at the same time. According to the principle of regional balance, the Shenzhen Municipal Education Bureau selected 100 experimental schools in the city, covering public and private schools in multiple sections such as primary schools, junior high schools and high schools. According to the "theme + self-selection" model, 100 experimental schools focus on 18 experimental sub-directions such as teaching and learning mode exploration and carry out special pilots to explore advanced experiences and typical models.

16.3.2 Future Teachers Build a Smart Education Construction

Since 2017, Shenzhen has established a management system for the construction of chief information officers (CIOs) in basic education, and increased the intensity of information literacy and leadership improvement of principals. Shenzhen has completed the CIO training of 624 primary and secondary school principals and vice principals. Nanshan District implements the "1 + 1 + N" leading talent training plan for education informatization, and the pilot primary and secondary schools in the district are led by one famous subject teacher and one subject technical tutor In the way of N subject teachers, an online master teacher studio is organized, so that the two teams of subject technology tutors and education technology teachers can improve their abilities in working together to tackle tough problems.

In the construction of the "Smart Education Demonstration Zone", Shenzhen will pay closer attention to the overall requirements of the Ministry of Education, implement the mission of building a socialist pilot demonstration zone, focus on

the connotation of the "Smart Education Demonstration Zone", promote the supply-side reform of resources in the education system, establish a high-quality education resource supply mechanism that serves urban development, form a collaborative sharing and integration mechanism to serve the construction of the Bay Area, explore a top-notch innovative talent training mechanism that supports the national strategy, and establish a model for smart education public services.

Chapter 17
Construction and Application Practice Exploration of "District-School Integration" Smart Education Cloud Platform

Shuwen Ye, Wei Tan, and Nan Dai

17.1 Platform Construction and Dilemma

With the development of education informatization, it has entered 2 in stage 0, the regional smart education platform plays an important role in promoting regional education development, optimizing education governance, deepening educational reform, and helping the implementation of "double reduction". The survey results of the application of cloud platforms at the county level in China show that the contradictions in the normalization of platform applications mainly come from regional schools, teachers and students, including parents, who have a low understanding of information development and lack of guidance, resulting in "not wanting to use"; The inconsistency between cloud platform resources and the actual education development needs of the region leads to "poor use"; Some education normal businesses have non-information work inertia, and they are unable or unwilling to get involved, resulting in "unusability". In addition, the district- and county-level education cloud platform should not only provide data collection, statistics and analysis functions, but also provide data feedback, push, and early warning functions to deepen the use of results.

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17.2 The Practice of Platform Construction

17.2.1 Ensure "Full Coverage" for Users

In 2018, Chenghua District launched the "Chenghua District Smart Education Three-Year Action Plan", and successfully completed the basic goal of "one platform, two centers and three coverage" in 2020. One of the core construction projects, "One Platform", is to build a smart education cloud platform covering all users of citizen-run schools.

Covers all citizen-run schools in the area. Of particular importance is the coverage of private schools. At present, the cloud platform provides one-stop services for 67 primary and secondary schools (including school sites), 6,567 teachers and administrators, 62,476 parents and 101,820 primary and secondary school students in the district.

Take the construction of online learning space as the core. The large platform built in Chenghua District is a comprehensive education business platform that highlights the application of online learning space. Up to now, the platform has provided a total of 81 education teaching and management applications in five categories: teaching, learning, evaluation, research and training, and management, developed and introduced more than 6.49 million three-level digital resources, 53 normal active applications on the whole platform, and an average of 2.2 active users per day on weekdays About 50,000 people.

Procurement of cloud services for intensive construction. Through government procurement services, Chenghua District provides smart education cloud platform services to teachers and students in the district in an intensive and unified manner. Under the normal application of "school focus management, teachers focus on teaching, and students focus on growth", the accompanying data aggregation and efficient utilization of business data on the whole platform are realized, serving educational science decision-making and effectively improving regional education data governance capabilities.

17.2.2 Ensure that the Platform Interface is "Fully Open"

Open construction promotes the development of high-quality schools. When building a large regional platform, fully attach importance to and retain the demonstration and leading projects of high-quality schools in the development of informatization. For example, Huaxi Middle School in Chengdu, Sichuan Province, which was rated as a demonstration school of digital schools in Chengdu in 2017, was organized by the District Education Bureau to cooperate with technical forces to

tackle key problems, integrating the "campus patrol system" independently developed by the school and the application data accumulated for four years into the regional platform, and coordinated a number of enterprises to connect the access control temperature measurement system required for the safety of high school residents to the large platform to ensure "one-code access" for teachers, students and parents. In 2021, West China Middle School was successfully awarded the 2020 Excellent School of Online Learning Space Application Popularization Activities by the Ministry of Education.

Professional introduction promotes the benefit of literature resources throughout the region. According to the development trend of regional education and the demands of teachers, Chenghua District introduced the general database of Chinese basic education literature resources, purchased the right to use users on the whole platform, and introduced it into the regional cloud platform application module by logging in with a seamless package library account. More than 100,000 registered users of the cloud platform are based on the "one-code universal" function, which greatly reduces the threshold for resource retrieval and download. In just half a year since its introduction, the number of literature searches and downloads on the platform has reached 41,097 times.

17.2.3 Ensure that Construction Services Are Keeping Pace of Students

Elastic storage is stable to help regional networks ensure education. During the "new crown" epidemic in 2020, Chenghua District made full use of the "smart education cloud platform" to innovate and carry out various forms of online education and teaching activities. During the online school guarantee period from February 17 to May 6, the cumulative number of visits to the cloud platform Renren Space reached 4 1.8 billion times, with 6 daily active users More than 50,000 people, with an average daily click on the app of 4.7 million. Among them, the daily application of "pre-class guidance" and "after-school homework" for students in the district has reached 300,000–400,000 times.

Customized service innovation promotes regional education governance. A total of 137 operation and technical support personnel serve the Chenghua cloud platform, participating in application promotion and operation and maintenance and customized business development services. At present, the cloud platform has served more than 230,000 times in three years, and customized and developed 142 district-level smart campus application modules. At the same time, it provides education cloud data integration analysis for the District Education Bureau, integrates 7 major platforms such as campus security, bright kitchen bright stove, and intelligent patrol examination, customizes and develops 6 auxiliary education decision-making systems such as campus distribution, vision monitoring, and smart health, and sets up digital library school courses, artificial intelligence courses, top-notch talent training,

Sino-foreign people-to-people exchanges, and community learning spaces43 Xiang Chenghua featured online learning space services.

17.3 Innovative Exploration of the Platform

17.3.1 Consolidate the Foundation of Information Application Capabilities

Improve the "leadership" of school informatization. In September 2019, the Chenghua District Education Bureau took the lead in formulating the "Chenghua District Primary and Secondary School CIO Management Measures" in Chengdu, and organized the "Chenghua District Primary and Secondary School CIO" composed of 45 CIOs Smart Education Literacy Improvement Training Course", went to Central China Normal University to carry out a week-long closed smart education special training, updated the educational philosophy of the participating CIOs, and improved the comprehensive management level of the participating CIOs.

Improve the "guiding power" of information application. In March 2021, Chenghua District organized CTOs of primary and secondary schools in the district to go to Chengdu University for one week of closed training, using a combination of centralized face-to-face training and remote guidance to carry out hybrid training, and focusing on some CTOs in the theoretical research of informatization and discipline integration. The training guidance has been strengthened, and the understanding of the promotion of smart education by the CTO of each school has been deepened, which has fully guaranteed the application and popularization of the school cloud platform.

Improve the "application ability" of teachers' informatization. Since 2019, Chenghua District has implemented the "Chenghua District Three-Year Action Plan for Improving TPACK for Primary and Secondary School Teachers", with the annual themes of "Building Spatial Analysis Literacy and Condensing Consensus", "Integrating Technology and Gathering Resources and Sharing" and "Reintegrating Optimal Classroom Change Methods", and all staff have implemented the action of improving teachers' subject literacy and information literacy. In 2021, the district's teacher information technology application ability improvement project 2 0 work, innovatively build its own micro-capability point "A0 regional smart education platform and deep integration of education and teaching", including the compulsory content of primary and secondary school teachers in the district, and guide schools to rely on the cloud platform functional section to implement scientific, efficient and sustainable school-based training.

17.3.2 Lead the Real Improvement of the School's Informatization Capability

Through the education and teaching management application covering primary and secondary school teachers in the district, the cloud platform collects data from five dimensions of individual teachers, including space construction, teaching guidance, teacher-student interaction, teacher training, and campus management, and builds a two-level in-depth application index data cockpit for district schools through 17 region-level unified index data such as interactive teaching, resource retrieval, activity organization, and campus office. Guiding school administrators to shift from paying attention to teachers' personal information technology capabilities to paying attention to the overall improvement of information literacy of all teachers in schools, and scientific and accurate assistance to the overall improvement of regional information application level.

It has built a diversified incentive mechanism to help the development of basic education informatization, established a points trading mechanism for the development, sharing, and exchange and utilization of original resources in the platform system, and set up a regional activity reward and annual in-depth application points exchange mechanism to comprehensively stimulate the vitality of teacher resource development, activity participation and platform application, and effectively break through the problem of teachers "not wanting to use".

17.3.3 Deepen Regional Digital Resource Supply-Side Reform

District school integration. Based on the teacher training activities during the winter and summer vacations, the "Gathering Technology and Sharing Resources" activity was carried out, covering different sections and disciplines in an all-around way. In the past two years, a total of 132 activities have been carried out, with 4,311 participating teachers and 43 visits 360,000. At the same time, it has built a training community with famous teachers as the core, bringing together 81 localized courses and a total of more than 22,922 subject resources.

Teaching and research pioneers. A total of 8,121 teachers and administrators have joined the corresponding regional teaching and research communities to carry out online normalized teaching and research and large-scale curriculum research and development, and have accumulated more than 40,000 high-quality subject resources, completed the construction of a resource library covering all sections, disciplines and courses of compulsory education in the district, and realized the intelligent collection and classification of resources. Intelligently push to the teaching terminal of teachers in the district, and continuously optimize and update, basically breaking through the problem of "difficult to use" resources.

Uniform specifications. In 2019, Chenghua District vigorously implemented the construction of a "library school" curriculum, developed and introduced social learning resources and non-subject learning resources, focused on the integration of social resources and platforms such as digital libraries, digital museums, and digital science and technology museums, and explored the construction of a larger range of resource supply mechanisms.

17.3.4 Drive Business Process Re-Engineering and Efficiency Improvement

Chenghua District adheres to the demand orientation, responds to endogenous needs, relies on the "Internet + education" platform, innovates teaching, evaluation, research and management and other applications, and completely breaks through the problem of "unusable" business.

17.3.4.1 Integrated Development and Popularization of Teaching Applications

Carry out the reform practice of online teaching and research. In August 2021, the cloud platform version was upgraded, and functions such as online teaching and research, research and training management were fully optimized. It is more convenient to carry out teaching and research work, and with the help of the integrated teaching and research system of the district school, various teaching and research and learning tasks organized by the district education and science institutes are implemented, and regional teachers are promoted to share and exchange teaching methods and methods. At present, the subject community has covered all disciplines in primary and secondary schools, with a coverage rate of 100%; 41 schools have opened teaching and research communities, with a coverage rate of 73%.

Build a smart classroom model practice. In 2021, the Chenghua District Academy of Education and Sciences established the "5I" smart teaching model research group to launch the "smart education special project" project establishment work. The "teaching assistant" interconnected with the cloud platform has served more than 50,000 teachers and students in the area, and can analyze students' knowledge mastery according to students' pre-class answers, in-class feedback and post-class testing, so that teachers can adjust teaching in time and students carry out personalized independent learning.

Implement artificial intelligence course practice. Build AI and STEAM maker classrooms in many primary and secondary schools, and develop district-based and school-based AI courses. At the regional level, relying on the cloud platform, the K12 artificial intelligence course area in Chenghua District has been opened to provide

artificial intelligence enlightenment courses. At the school level, Shuanglin Primary School, the experimental school of artificial intelligence courses of the Central Electric Education Center, will open artificial intelligence courses for all students in 2021 (a total of 72 lessons per semester), which are divided into low, medium and high robot programming courses.

17.3.4.2 Endogenous Drives Lead to Innovative Applications

Research and development of remote supervision applications. Build a remote supervision information system, and build a new model of education supervision confirmed by the intersection of "remote investigation + field supervision" in the new era. Establish an early warning system for the allocation of high-quality and balanced resources for compulsory education, as well as a questionnaire survey system for social satisfaction, establish a hierarchical and hierarchical push and early warning mechanism for responsible supervision information, and form a closed loop of data collection, statistics, analysis, push, feedback, early warning and behavior modification to serve educational decision-making and education supervision.

Technology-enabled distance learning. Since 2019, the Chenghua District Education Bureau and the Danba County Education Bureau have established the "Danba High School Chenghua Class" to build a new model of precise education support and intellectual aid to Tibet. As of 2021, the implementation of the project has entered its third year, and three one-on-one interactive "Danba High School Chenghua Classes" have been built in the first year, second year of high school and senior three years, realizing resource sharing and online communication between teachers and students in the two places on the same platform, and promoting the professional ability of teachers in Tibetan schools.

Help regional home-school co-education. Since 2020, the Chenghua District Education Bureau has been carrying out the 4C capability improvement action for new parents on the cloud platform every year. Research and development of "4 + 4" family education curriculum resources to build a family education curriculum system; Build an "online + offline" three-dimensional learning platform, organize parents to carry out special course learning and online consultation; Establish a "compulsory + elective" completion certification system, parents participate in the "4C" ability improvement knowledge learning and test online, and obtain the "4C" ability improvement learning completion certificate online. Every year, more than 40,000 students learn online courses for 4C parents.

Focus on "educating five domains simultaneously" at the same time. Smart football: developed a campus football zone on the cloud platform, introduced football function testing projects, and successfully created a national youth campus football pilot area. Smart reading: Relying on the cloud platform to share 1.35 million digital books and 1,640 digital periodicals, popularize the construction of campus self-service lending terminals, and realize the intelligent collection of student lending

data. Prevention and control of myopia in adolescents: research and development of "refractive development files and dynamic monitoring information system for children and adolescents", the establishment of dynamic monitoring files of students' vision, and targeted early and accurate intervention.

17.3.4.3 Serve and Educate People and Deepen Intelligent Management

Smart health. In 2020, based on the needs of normalized epidemic prevention and control, a smart health real-time data monitoring system was developed, which was upgraded and optimized into a smart health early warning system for primary and secondary schools in 2021, covering 56 public and private schools in the region, covering more than 70,000 teachers and students. Intelligent safety level early warning for all schools provides accurate auxiliary decision-making for the direction of disease control in the regional education system.

Student e-portfolios. In 2021, the implementation plan for the comprehensive quality evaluation of educating five domains simultaneously in the new era for primary and secondary school students in China will be developed, and the construction of a three-dimensional and multi-dimensional evaluation index system will be explored. In April 2021, four schools were selected to carry out the pilot application of student growth files, and the cloud platform Renren Tong APP growth record module was used to collect students' extracurricular and extracurricular life data, count the number of growth stars obtained by students in the five dimensions of moral education, learning, sports, talent and practice, and explore regional practice samples of school-level student growth files.

Teacher Development e-portfolios. The "Teacher Professional Development Evaluation" system was customized, and four pilot schools were selected to carry out the pilot work of school-level teacher professional development evaluation, and the annual professional development evaluation report of teachers could be formed according to the statistical reports generated in the system. Up to now, the system has covered more than 600 teachers in 4 schools, and will be promoted and used in the whole district after optimization and improvement, and explore the feasibility of regional teacher professional development evaluation models.

Chenghua District standardizes and scientifically implements the construction of the "district-school integration" smart education platform, actively carries out the integration and application and innovative practice of the regional smart education cloud platform with education teaching and research and regional education governance, continues to promote the large-scale normalization and in-depth application of informatization in primary and secondary schools, and helps Chenghua District be selected as a national smart education demonstration zone in February 2021. It has effectively promoted the modernization process of regional education and promoted the high-quality, balanced and high-quality development of regional education.

Chapter 18
Selected Practice Briefs on Regional Smart Education Construction

Zhisheng Li

18.1 Construction and Application of "Data Brain" of Smart Education in Dongcheng, Beijing[1]

In order to achieve the overall goal of smart education in Dongcheng District, in view of problems such as inconsistent data standards, poor linkage, and failure to exert the value of data assets, the District Education Committee actively promotes the construction and application of "data brain" to provide data services and platform support for the high-quality development of regional education. Based on a unified service support platform, the "data brain" of Dongcheng Education built around the construction center of regional big data services in Dongcheng District integrates various educational resources in the region through a unified standard system and supervision system, so as to realize the sharing of various educational resources in the region, which is helpful to solve the stubborn problems such as repeated construction and data islands in the process of promoting education informatization. Focusing on the smart education cloud service platform, the district has fully popularized the "one person, one space" for online teaching and learning for teachers and students in the district, and has opened 106,247 student spaces, 21,576 teacher spaces and 193 school spaces. With the data governance service platform as the core, we integrate the system data and business data of various departments through data governance, supplemented by the capacity center of data processing, data analysis, data management, data security and data service. Combined with the corresponding strategic services, we derive N intelligent education applications, including the construction

[1] DU Bin, ZHANG Zhixiong, ZHANG Shuo, WANG Tianyang, HOU Xiaoyan, SU Ning, Beijing Dongcheng District Smart Education Research Center.

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of digital archives and analysis reports, statistical analysis of educational undertakings, intelligent sports monitoring, etc., and actively exert the value of data to move from education management to education governance. In the process of "data brain" construction in Dongcheng District, through the promotion mechanism of urban linkage and multi-department coordination, Dongcheng District has constructed a multi-supply mode of introducing high-quality resources and establishing Internet applications, forming a regional educational data resource system with clear structure and complete elements, and realizing the integration and sharing of educational data, educational resources, educational services and educational applications with the Municipal Education Commission, the district government and subordinate educational units.

18.2 The "Three Classrooms" Empower the Improvement of the Quality of Education in Yongji Village[2]

Yongji City's rural schools have backward information technology equipment, and a series of practical problems such as a structural shortage of teachers in English, music, art and other subjects, resulting in a continuous flow of rural students to the city, and urban schools have been affected by the sharp increase in class capacity. In order to achieve the balanced development of regional education, in the spring of 2020, Yongji City, as a pilot county of the second phase of the Yuncheng Smart Education Project, started the reform of rural education with "three classrooms" as the core. First of all, Yongji City has strengthened the software and hardware facilities of rural education and built a "three classrooms" management platform to meet the needs of data aggregation and management, online normal teaching, and dynamic supervision. Secondly, a "three classrooms" collaborative service team with linkage and multi-party participation was set up, and more than 300 trainings were carried out, including "three classrooms" application training for primary and secondary school students, campus network management, online live broadcasting, and high-quality recording applications, covering more than 4,000 teachers. Finally, Yongji City promoted the improvement of rural education quality through model innovation, and carried out teaching activities 63 times in special classrooms, directly benefiting more than 12,000 students. 24 famous teacher studios have been set up, pairing with weak schools and sending teachers to the countryside more than 280 times through a combination of online and offline methods. Based on the consignment city smart education cloud platform, the "famous school online classroom" help model has been opened. Through three classrooms, all state-prescribed courses have been fully opened in the county, and the resources of urban high-quality famous schools have been continuously promoted to share and radiate to rural areas, and from 2019 to 2021, the total number of students in the four rural schools under the jurisdiction of

[2] SHI Baisheng, ZHANG Yuxia, Yongji Education Bureau of Yuncheng City, Shanxi Province.

Chengxi Central School is 1206 The number rose to 1418, and Yongji rural education gradually "warmed up".

18.3 The Large-Scale Application of Smart Education Helps Students[3]

Wuhan Economic and Technological Development Zone (Hannan District) seized the opportunity of the establishment of the first batch of "smart education demonstration zones" in Wuhan and actively explored the help of smart education to improve the quality and efficiency of regional education. Relying on the large-scale application project of smart education and the innovation of the five-in-one collaborative education mechanism, an expert team including Central China Normal University, Wuhan Academy of Education Sciences, and iFLYTEK has been established. We deploy a regionally integrated smart education platform, build a smart campus infrastructure, and help teachers accurately "teach" and students' personalized "learning"; Relying on university experts, regional famous teachers and cross-school collaborative teaching and research as the carrier, teaching plans with regional characteristics and school characteristics have been developed. We will build a multi-level curriculum system with five education characteristics, and use the intelligent five education student evaluation system to organize five education practice activities that combine online and offline. Taking the characteristic development of schools in our city as a breakthrough, we will actively explore the innovation of the five-education teaching mode that integrates intelligent technology, enrich the teaching path of intelligent moral education, construct a "learning-centered" intelligent classroom teaching mode, implement the precise monitoring of physical education classroom teaching, carry out the practice of intelligent aesthetic education classroom teaching, construct a new scene of intelligent labor education, and cultivate new talents of the times with all-round development of morality, intelligence, body, beauty and labor. In 2021, the Economic Development Zone completed the goal of building a city-level modern school two years ahead of schedule with 96 schools with an 88% compliance rate, and achieved a great leap in the connotation and quality of regional smart education. Relying on the large-scale application project of smart education, we actively promote the infrastructure construction of regional smart education, effectively develop, integrate and share the high-quality digital resources of five education, and realize the normal application of smart education products in five education teaching in primary and secondary schools.

[3] XIONG Baili, HAN Jin, WANG Wei, HUANG Lei, ZHENG Yunqiao, Education Bureau of Wuhan Economic and Technological Development Zone (Hannan District).

18.4 "Microlight Project"—Exploration of Promoting the Digital Transformation of Education in China's Optics Valley Region[4]

In 2018, Optics Valley of China proposed the "Microlight Plan" education informatization promotion plan of "Gathering Micro Power and Gathering Optics Valley". Through the establishment of expert think tanks, the establishment of campus CIOs, and the normalization of training and competition activities, Optics Valley District comprehensively improves the information leadership of principals, the information teaching ability of teachers, and the information guidance ability of training teams. Comprehensively upgrade the campus network and intelligent teaching facilities, encourage all teachers to participate in resource development through the combination of purchase and self-production, and build a high-quality resource library of micro-courses, micro-exercises, and micro-tutoring with the characteristics of Optics Valley. Every year, we continue to create and cultivate one provincial-level smart campus demonstration school, eight municipal smart campus demonstration schools and two district-level maker education space bases, rely on the Wuhan education cloud platform and smart teaching environment to carry out pilot smart classrooms in primary and secondary schools, comprehensively popularize artificial intelligence courses and carry out a series of "aerial teaching and research" activities. Through the implementation of the "Microlight Plan", Optics Valley District has successfully built 4 provincial-level smart campus demonstration schools, successfully created and declared 19 municipal "four-star" smart campus demonstration schools, and radiated to lead the development of smart education in the Optics Valley region. It has built a "three micro" learning resource library based on a knowledge graph, created 100,000+ micro-lessons and exercises, encouraged students to learn independently, and actively implemented the "double reduction" to reduce burden and increase efficiency. It has formed a group of smart classroom teaching modes that learn first and then teach, teach by learning, mix online and offline, and connect inside and outside the classroom, produce a group of smart education teachers, and launch a number of smart classroom teaching cases, which promotes the deep integration of information technology and classroom teaching.

[4] CHEN Kebin[1], HE Defu[2], SHU Xiaohui[1], LI Yan[1], CHEN Xiaopeng[1].

1. Wuhan East Lake New Technology Development Zone Education Development Research Institute; 2. Hubei Provincial.

18.5 Relying on the Construction of Smart Campuses, Promote the Development of Regional Smart Education[5]

Hebei Xiong'an New Area is one of the first batches of "smart education demonstration areas" in China, and the *Xiong'an New Area Smart Education Five-Year Action Plan (2021–2025)* clearly proposes to "build a smart education cloud platform, build a smart education data center, build a smart campus integrated service system, and build a school intelligent terminal system". In order to create "Xiong'an quality" in the field of education and meet the diversified, personalized, all-age and intelligent learning needs, Xiong'an New Area selected 7 "smart campuses" and 16 "Smart Classroom" experimental school construction pilot to promote the development of regional smart education with smart campus construction. Xiong'an New Area actively connects with smart education enterprises and explores the implementation path. It has successively organized more than ten enterprises with research and achievements in smart education, such as China Mobile, China Unicom and iFLYTEK. Focusing on the themes of wisdom classroom, wisdom campus and artificial intelligence education, it has jointly studied and discussed the typical cases of smart education in each enterprise, summed up the experiences that can be used for reference, and planned the landing scheme and implementation path. For example, Biancun Middle School in Anxin County, Xiong'an New Area, Hebei Province, uses modern information technology such as big data, cloud computing, and mobile Internet to realize the application of the whole process before, during and after class. The new classroom reform is implemented from three aspects: smart classroom standard class, big data precision teaching system, and Changyan teaching assistant, and provides personalized and accurate guidance for students. The construction of smart campus facilities and the reform of smart classroom education and teaching in the Xiong'an New Area have been steadily advancing, and a new "smart education ecology" is quietly emerging.

[5] HUA Yufeng[1], ZHAO Hui[2], ZANG Xuan[3], HU Youyong[2], 1 Beijing No. 80 Middle School Xiong'an Campus (Anxin County No. 2 Middle School); 2. Beijing No. 80 Middle School; 3. Management Committee of Xiong'an New Area, Hebei.

18.6 A Way to Transform the Way of Learning in Integrated Practical Activities in the Mobile LoT Environment[6]

The state attaches more and more importance to the status of comprehensive practical activity courses in primary and secondary schools, but there are problems such as single form, insufficient technical support, shortage of resources, and poor practical results in the actual development of various localities. Wuzhong District, Suzhou City, changes students' traditional learning methods, breaks disciplinary boundaries, improves the implementation effect of comprehensive practical activity courses, and promotes students' all-round development by constructing a comprehensive practical activity environment that integrates virtual and real reality, developing curriculum reform paradigms, and summarizing the characteristic results of regional practical research. The research team conducted questionnaire surveys and field research on 15 primary and secondary schools and comprehensive practice schools for primary and secondary school students in Wuzhong District to understand the implementation status and existing problems of integrated practice courses, and determined the theoretical support of experiential learning through literature research. We formulate a regional smart ecological teaching system construction plan, introduce the Internet of Things and smart ecological maker kit, and build a learning environment space that integrates virtual and real reality. We also improve the project-based hierarchical management model of "leading group + base + school", and a total of 21 primary and secondary schools in the district have joined the project research. At the same time, we create a new teaching model of comprehensive practical activities for primary and secondary school students in the mobile IoT environment, actively declare and establish related topics and projects, and explore the implementation path of the curriculum. After three years of practical exploration, Wuzhong District put forward a new proposition of "educating five domains simultaneously" in the mobile IoT environment, built a smart ecological education learning platform for online learning observation, developed a series of courses, teaching materials and lesson examples for comprehensive practical activities in primary and secondary schools, and finally formed a variety of theoretical and practical achievements that won provincial awards or above, benefiting tens of thousands of students in the district.

[6] ZHANG Ruijun, HU Xiaoqin, Suzhou Wuzhong District Teacher Development Center.

18.7 Shenzhen Cloud School: A New Pattern of Smart Education[7]

Cloud school is a key project for Shenzhen to build a pilot demonstration zone of socialism with Chinese characteristics and explore future education, and it is also a construction project in Shenzhen's "National Information Teaching Experimental Area" and "Smart Education Demonstration Zone" of the core content. The cloud school breaks the physical boundary and physical space of traditional schools, and explores a new form of "1 + N" community schools-cross-school group classes and cross-district schools, and the headquarters school drives the coordinated development of all the resident schools. This form adopts a new cloud-based double-teacher teaching mode of "lecture + supplementary lecture", in which the lecture teachers broadcast the core content live with high efficiency and high level, and the auxiliary lecture teachers in each class guide and organize the students in this class to actively participate in the cloud interaction. We improve students' learning efficiency in various scenes such as home-based self-study/online learning through new personalized learning methods such as cross-school group classes and cloud Q&A. At the same time, we have created the "embedded research and training" teaching and research mode with the deep participation of well-known national experts, the resident guidance of urban teaching and research staff and the leadership of famous urban teachers to ensure the teaching quality of cloud classroom. This innovative community school-running mode is helpful to solve educational problems such as difficulty in going to school, school choice fever and remedial classes fever, and provides new methods and new ideas for teaching students in accordance with their aptitude, which is helpful to promote the balanced development of high-quality education. Since the school started in September 2021, Cloud School has provided eight scene services through platform construction, such as live interactive classroom, multi-teacher research and training, application of lesson preparation resources, homework collection and push, characteristic delay service, personalized learning support, cloud Q&A, intelligent education management, etc., to provide personalized and diversified teaching and learning services for teachers and students.

The cloud-based teaching mode of the school has been widely praised by teachers, students and parents. According to the results of the questionnaire, 95% of the students "like the teaching mode of Shenzhen Cloud School", and 93% of the students think that "they can interact with the lecturers and feel excited and happy". Teachers and students have formed a good cloud literacy represented by information literacy.

[7] GONG Weidong, TANG Xingchu, CHEN Hao, Shenzhen Cloud School.

18.8 Online Teaching Practice and Innovation in Lanzhou Under the Background of the Epidemic[8]

During the epidemic prevention and control period, the Education Bureau of Lanzhou decided to give full play to the advantages of online teaching on the Internet, launched the "Lanzhou Smart Education Famous Teachers Online" platform, and carried out public welfare live broadcasts for junior and senior high schools. The Education Bureau of Lanzhou has adopted a variety of strategic measures to promote online teaching to radiate to the whole city, improve the quality of online teaching, strengthen learning supervision, ensure the network environment, and improve teachers' information literacy during the online teaching period. It establishes a multi-level selection system for teaching teachers, and selects outstanding teachers with high teaching literacy and subject influence. It also invites well-known teachers to serve as subject group experts, coordinate teaching progress, formulate online teaching plans, and standardize online teaching behavior. The bureau carries out teaching in the form of "live broadcast + on-demand", strengthens online learning guidance, and pays attention to students' mental health. Teachers strengthen supervision through real-time point-to-point, desktop lock, inattentive reminders, etc. In view of the lack of hardware equipment and network traffic of many students in remote areas, we will make every effort to ensure the logistics of power supply, network, and teacher epidemic prevention; Carry out special training on the use of the platform, train teachers in online teaching skills, and track the quality of online teaching in real time. During the epidemic, large-scale online teaching in Lanzhou effectively ensured the home learning of students at Guangzhou University, and after-class online surveys showed that students' feedback was "satisfactory" by more than 90%. Since its launch on February 3, 2020, Lanzhou has nearly 130,000 middle school students and 772 10,000 people actively participated in online learning. During the peak period, the average number of online lectures in a single class was 7,405, with most classes exceeding 10,000 people, and the highest in the first grade was 1 80,000 people; At the same time, the number of online learners remained above 60,000, peaking at 110,000.

[8] NAN Xinghui, WANG Juan, YUAN Shilong, DUAN Shufang, MA Yuan, Lanzhou Electrochemical Education Center.

18.9 Promote the Digital Transformation of Education in Baoshan District and Reshape the New Mode of Teaching and Learning[9]

The education scale of Baoshan District ranks third in Shanghai. As educational informatization enters the digital transformation period, the existing application construction mode, information sharing mode and resource management mode gradually show bottlenecks. In order to implement the strategic action of the Ministry of Education and the Shanghai Municipal Education Commission on the digital transformation of education, Baoshan District takes the lead in planning and practical exploration, focusing on application scenarios such as teaching, learning, management, examination, evaluation, research and resources, building a ubiquitous and intelligent education environment, and stimulating the endogenous power and vitality of education and teaching development. Relying on the smart education cloud platform of Baoshan District and docking with the national smart education public service platform, we provide mixed teaching resources and services that integrate online and offline, and connect inside and outside the classroom, which strongly supports the "non-stop learning" during the Shanghai epidemic. We carry out interactive classroom activities to support students' individualized and autonomous learning, and teachers explore a variety of new teaching modes, such as flipped classroom, double-teacher classroom and project-based learning, to realize large-scale individualized teaching. We promote smart peer class, build interactive digital education environment, realize collaborative teaching and research among teachers, help common development among schools, promote cross-regional teaching assistance, generate digital portraits of teachers and students, and create a new mode of cooperative learning. In the end, Baoshan District formed a systematic application mode of "school-based, regional promotion", established a collaborative practice mode of "research-training-learning" integration, and opened up an application path of "before-after-class" full coverage. At present, we have promoted more than 50 schools in the region to carry out normalization pilot work, forming representative and innovative practice cases at the regional level.

18.10 Smart Training Promotes Growth, and Cloud Teaching and Research Enhances Improvement[10]

Xinjiang Uygur Autonomous Region has a vast territory and a large number of nationalities, so the teachers' level can't meet the current social demand for education and teaching. During the epidemic period, in order to effectively improve teachers' informatization application level and teaching and research ability, Xinjiang

[9] Zhang Zhi, Zhang Yunfeng, Shanghai Baoshan District Education Bureau.

[10] QUAN Liyan, Xinjiang Uygur Autonomous Region Electrochemical Education Center.

constructed an innovative wisdom training mode. First, make overall plans for the construction of the basic environment of intelligent training, mainly relying on the ClassIn platform, set up a remote service team, and carry out adaptive training for different users. Second, make a platform promotion plan, comprehensively promote "wisdom training" through teaching competitions, project research, special lectures, seminars, etc., and create a new form of cloud-based, intelligent and interactive training classroom. Third, deepen the training reform, determine the real needs of teachers through thorough investigation, two-way communication, clear training contents and programs, and implement precise training. Since 2021, we have trained 1.434 million teachers online and offline, which has effectively improved the IT application ability of the teaching team. At the same time, in various competitions organized by us, the number of declared works has increased from 1,500 in 2021 to 5,500 in 2022, and the scientific and technological content of works has also increased year by year. During the epidemic prevention and control in COVID-19, we provided education and teaching resources in various ways, organized 1888 high-quality courses from primary school to high school to record, and 2.04 billion primary and middle school students studied through online classrooms. Through wisdom training, the network security publicity of the education system in the whole region was carried out, and more than 2,500 publicity activities and 85 network security knowledge contests were held, with a total of more than 1.27 million participants. After a year of innovative exploration and training practice, the mode of "wisdom training" in Xinjiang has been gradually normalized and applied on demand, and teachers' information literacy and ideas have been significantly improved.

18.11 Build a Smart Education Cloud Platform to Improve Quality and Efficiency Through Science and Education[11]

In 2021, Khorgos City issued *the Implementation Plan for the High-quality and Balanced Development of Compulsory Education (2021–2024)*, which successively put forward new requirements and plans for smart education. In order to promote the reconstruction of regional education ecology, Khorgos City has established a smart education cloud platform to build a comprehensive quality evaluation system for students oriented to core literacy. According to the *Compulsory Education Curriculum Plan and Curriculum Standards (2022 Edition),* learning objectives that point to the core knowledge and key competencies of the subject are formulated. Invite 200 people, including discipline experts, education experts, key teachers of primary and secondary schools, and education administrators, to form an academic team to support the construction of evaluation theory. Based on emerging technologies such as artificial intelligence, big data, cloud computing, and the Internet of

[11] LIU Diyi[1] Quan Liyan[2.] 1. Education Bureau of Khorgos City, Ili Prefecture, Xinjiang Uygur Autonomous Region; 2. Xinjiang Uygur Autonomous Region Electrochemical Education Center.

Things, the smart education cloud platform focuses on the reform and application of the integration of "teaching evaluation" with smart classrooms as the core, and builds a diversified new education evaluation system. The cloud platform preparation teaching system is used to fully match the evaluation tasks corresponding to the learning objectives, and widely carry out a variety of smart classrooms such as flipped classrooms and PBL project-based classrooms to build a personalized teaching support service environment. We built a cloud platform resource center, adapt to supply high-quality resources from other provinces and cities, and customize the supply of characteristic resources that meet local needs, and the total amount of resources has reached 18 million+, and the needs of teachers and students in the city are fully covered. Relying on the interconnected cloud platform, real-time collection of the whole process data such as teachers' classroom teaching, students' online learning, and student growth records to promote the implementation of students' comprehensive quality evaluation. The construction of the smart education cloud platform has effectively improved the regional education resource supply and service capabilities, realized regional data aggregation and supervision, fully implemented the comprehensive quality evaluation of students, and effectively improved the regional teaching quality and teaching management efficiency.

18.12 Online Education Composes New Chapters, and the Integration of Five Domains of Education Promotes Development[12]

During the epidemic prevention and control in Yiling District, Yichang City, Hubei Province, online teaching was carried out, and digital work and learning methods became the norm, which accelerated the cognition of teachers, students and parents on online education. In terms of moral education, the District Education Bureau relies on the online classroom to carry out moral education activities in special periods, so as to cultivate the patriotic spirit of "cultivating feelings and being brave in taking responsibility" for all teachers and students. In terms of intellectual education, each school has formed an online education mode adapted to local conditions. For example, Yiling Experimental Junior High School has formed an online teaching mode of collective discussion, centralized lesson preparation, division of labor and cooperation, and hierarchical teaching. In terms of sports, the Yiling District Teaching and Research Center has prepared personalized "exercise prescriptions" and family physical exercises, games and activities for primary and secondary school students, recorded demonstration videos, and encouraged schools to hold fun games at home. In terms of aesthetic education, Xiaoxita No.2 Primary School integrates into life with various art forms. For example, teachers carry out painting, music, dance and other art courses in the form of "live + micro-classes", and organize online reading clubs, online concerts and other activities to enrich their home life and cultivate students'

[12] LIAO Qiong, Yichang Yiling District Education Technology Equipment Station.

artistic literacy. In terms of labor education, Xiabaoping Primary and Secondary Schools in Yiling District, combined with the actual situation, carried out local labor education such as "agricultural planting" and "tea picking". Teachers explained the materials, methods and precautions needed for labor education online, and displayed and evaluated the results at regular class meetings. Yiling District has established a perfect regional online education network system with the help of multi-platform collaborative applications such as Xiwo, Yichang Education Cloud and DingTalk, and set up "1 + N + X" online learning instruction course, which has formed high-quality online education resources in the region, and was selected as the "Smart education" experimental area of Hubei Information and Basic Education Balanced Development Collaborative Innovation Center in 2022.

18.13 Build Seven Synergistic Mechanisms to Promote the Development Process of Jinshui Education Informatization[13]

In order to effectively promote the development process of education informatization, Jinshui District of Zhengzhou City has formulated a multi-subject collaborative development strategy, built seven collaborative mechanisms, and formed a new idea of joint progress, efficient operation and coordinated development. Through departmental collaboration, group collaboration and departmental collaboration, we do a good job in top-level planning and task division. Universities, experts and intellectual groups collaborate to provide intellectual support. Through the coordination between districts and schools, we have formed a development model of "regional unified application and school-level characteristic application". Through the coordination between government and enterprises, we should listen to the outstanding successful cases of various enterprises in the way of "please come in and go out" to ensure their competitiveness and advancement. With the support of the seven coordination mechanisms, Jinshui District has improved the network environment, education and teaching environment, and achieved the full coverage of network core equipment such as 10 Gigabit interconnection, Gigabit optical fiber to class and wireless cable. It has built and put into use 29 multi-functional computer voice classrooms, 17 intelligent interactive classrooms and 5 artificial intelligence innovative education classroom laboratories, and implemented the security campus upgrade in 34 schools; Provide intelligent services and high-quality resources for teachers and students, build Jinshui Education Cloud Platform, launch more than 60 educational applications covering multiple scenarios, introduce resources of famous schools, aggregate resources of district schools, and access high-quality free resources of the state, province and city. We continue to explore innovative teaching modes, forming a new mode of "three-stage and ten-step" intelligent classroom teaching, enabling

[13] LI Zheng, Hu Peilin, CAO Pengju, DUAN Liqun, Zhengzhou Jinshui District Education Bureau.

intelligent learning by science and technology to realize "teaching students in accordance with their aptitude", innovating the layered operation mode, and reducing the burden and increasing efficiency. As a result, the information literacy of teachers and students has been improved, hierarchical and classified training has been strengthened, relying on well-known universities or research institutes to train and cultivate teachers, opening up all-information courses, and implementing Maker and Artificial Intelligence courses in the form of school-based courses and clubs.

18.14 Digital Government Empowerment to Build a New Ecosystem of Smart Education[14]

In recent years, Dongguan has actively implemented the "Internet + Education" strategy, promoted the construction of education informatization in infrastructure, platform system, digital resources, smart campus, integrated application and other aspects, and has made initial achievements. Combining with the opportunity of digital government construction, Dongguan has empowered the construction of a high-quality education system, made overall planning, and formulated relevant policies and plans with high quality, such as the 12th Action Plan for Building Quality Education in Dongguan City and the Action Plan for Promoting Smart Education in Dongguan City (2021–2025), compiled a guide for smart campus construction, and formulated a network security assessment method. Under the construction principle of "a chess game" of digital government, Dongguan has built a regional smart education platform that is integrated and shared with the city wisdom brain, and built a high-standard Dongguan education big data center, an integrated education management and service platform and an online learning platform of Dongguan education exchange. We also build a new ecology of smart governance, smart service and smart learning in regional education. Dongguan adheres to application-driven and mechanism innovation in the construction of educational informatization, and finally realizes the integrated development mode of combining normal application with all-around innovation. Data-driven educational governance capacity has been improved, the supply of educational services has become richer and more diversified, online and offline education has been organically integrated, teaching has become more flexible and personalized, evaluation has become more scientific and accurate, and educational governance capacity has been significantly improved. We have continuously improved the supply and service capacity of regional educational resources, realized the co-construction and sharing of online courses in the whole city, formed a regional online learning platform with Dongguan characteristics, and generally built a high-quality digital education public service system with Dongguan characteristics.

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Part III
Research Findings

Chapter 19
Reflections on Integrating Interaction to Build a New Normal of Teaching in the Post-epidemic Era

Lili Zhang, Shulin Zhang, Xu Shu, Liang Huang, Fang Rao, and Chuanhao Li

Through the questionnaire survey and research on the blended teaching of basic education teachers in Dongcheng District, it is found that the blended teaching of teachers is difficult to achieve classroom interaction and online and offline integration, and students' online learning is monitored Based on the research and analysis, a series of strategies and suggestions to promote the blended teaching of primary and secondary school teachers in the region are proposed.

19.1 Current Status and Needs of Regional Blended Teaching

Teachers have a good understanding of blended teaching overall, and have a sense of active learning related theories, and most teachers have a positive understanding of the relationship between online and offline teaching in blended teaching: 44.19% of primary and secondary school teachers in the survey said they understand blended teaching/ learning, most teachers believe that blended teaching is a combination of face-to-face teaching and online learning, and is an optimal combination of teaching methods, media, modes, content, resources, environment and other teaching

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elements; 60.47% of teachers carried out mixed teaching, and among the reasons for not carrying out mixed teaching, the top three were the difficulty of monitoring students' online learning, the course was not suitable for online teaching, and the difficulty of course opening, which can be seen as teachers should choose different courses and content before conducting blended teaching, and strengthen the monitoring of students' online learning during the teaching process.

The survey results show that in the implementation of blended teaching, teachers pay attention to organizing students to discuss and share learning results in the classroom and provide personalized learning guidance to students, and need to be improved in guiding students to conduct online self-directed learning and effectively use online teaching technologies and tools. The main problems encountered in teaching are the effective supervision of online learning, the difficulty of classroom interaction and the integration of online learning resources, with 22.22% and 13.47%, respectively, and 10.61%; The way teachers carried out an evaluation in blended teaching was to evaluate students' online homework upload, students' online answer to questions, and students' participation in online classes 20.15% and 18.48%, which shows that the methods and strategies of blended teaching evaluation should be more diversified.

19.2 Strategies to Promote Blended Teaching Among Primary and Secondary Teachers in the Region

Concept change: focus on improving teachers' education and teaching concepts, teachers need to continuously cultivate Internet thinking, rationally use educational technology, improve information literacy capabilities, organically combine the advantages of online teaching and traditional teaching, and organically integrate all elements of online and offline teaching; Regional training institutions should strengthen the training and management of teachers' online teaching, provide teachers with special training in online teaching, the design and implementation of blended teaching, and platform operation, and encourage experienced teachers to exhibit, exchange and share.

Platform support: Cities and districts should further strengthen the construction of resource platforms for teachers to use uniformly, build a support system for blended teaching, so that they can realize online live teaching, recorded class observation, discussion and answer, communication and interaction, record students' learning situation throughout the process, and finally analyze it through big data. Provide data support for teachers and students to teach and learn accurately and efficiently.

Model innovation: According to the survey, blended teaching has become the most popular teaching mode for students in addition to face-to-face teaching and the online teaching mode is mainly used by teachers in addition to live classes. Teachers can use the two-line three-stage blended teaching model as a general model to enrich and

innovate by subject; Selected teaching content before class and published on the platform, teachers guide explanation, evaluation, and clarification during class, students upload learning results after class, and teachers evaluate and feedback students' learning achievements on the platform.

Integration and interaction: To achieve the deep and organic integration of online and offline, we must not only pay attention to the subjectivity and enthusiasm of students' learning, but also strengthen the guidance and support of teachers, effectively stimulate the internal drive of students' active learning, give full play to the advantages of dual-line integration, and comprehensively apply various resources, platforms and tools to carry out hybrid teaching in different links according to the dynamic needs of teaching, so that online and offline teaching can complement and improve each other. Better enhance teaching and learning.

Pay attention to evaluation: teachers should pay attention to the development of systematic evaluation scales in teaching, and the evaluation of students' learning can take into account both online and offline, and pay attention to the evaluation of students' learning effects; A multi-subject and multi-form evaluation strategy should be adopted, such as formulating online learning, discussion rules and grading standards, and evaluating students' participation in discussions, browsing videos, completing tutorials and quizzes, etc.; Teachers should also give full play to the advantages of the teaching and learning community such as peer assistance and homework mutual evaluation, enrich the form, content and improve the evaluation effect, such as evaluating the teacher-student interaction in live classes, and conducting teacher comments and student mutual evaluation of homework in the form of online videos; At the same time, an online supervision and management system should be established to improve the effectiveness of students' online learning.

Chapter 20
Research on the Design of Systematic Model of Hybrid Learning and the Research on Effective Model

Yonghai Zhu, Yingying Xu, Yingjie Peng, Hongwei Xiao, Yanghe Cai, Jiechang Jiang, Chujun Zhou, Zhijian Huang, and Xiang Zhang

The study constructed a "stepwise deepening" blended teaching model (GMSDBL), and carried out a 2-month quasi-experimental study in a school in Foshan, mainly solving "how to design blended learning" and " How to determine which blended learning mode is more effective", the study shows that there are significant differences in deep learning capabilities in multiple blended learning modes.

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20.1 Theoretical Construction and Research Tool Design

The experiment carried out a systematic design of hybrid teaching systematization mode, and sorted out the common mixed teaching elements through literature analysis, namely learning methods (unified lecture + interactive diagnostic test, independent inquiry). + Discussion + Interactive Diagnostic Test), learning content (refined knowledge, structured knowledge), learning activities (personal precision exercises group problem solving/micro-project-based teaching) and learning assessment, which mainly discusses the impact of the design of the first three elements on blended learning outcomes. Using the orthogonal design method, four groups of experiments were determined: experimental class C1-lecture-structured-advanced mode, experimental class C2-autonomous-refined-–advanced mode, experimental class C3-autonomous-structured-reinforcement mode, lab class C4-autonomous-structured-advanced mode.

20.2 Experimental Practice Under Blended Learning Mode

The study was based on fourth-grade students from two experimental schools in Foshan City, each of which selected four parallel nature class students C1-C4, and randomly selected a parallel class C0 with the same grade level as the control class. In order to minimize the interference of other influencing factors in this study, all classes selected by the practice are selected with teachers of the same teaching level (same title or teaching age), and the same learning knowledge points, due to multiple practices It is difficult to ensure the starting point of students' learning in the experimental teaching in the original environment, and classes with similar student levels are selected as much as possible.

In addition to the traditional advanced experimental class, the remaining three classes need to use a combination of online + offline teaching, and the researchers will communicate with the instructor in advance about the online course learning unit design list, and carry out about 2–3 per week according to the actual situation of the new teaching In this research class, the pre-class researcher will provide teachers with the required online learning videos or tutorial plans, as well as corresponding advanced assignments, and teachers need to modify the lesson plans of each research lesson according to the corresponding learning mode of each class. Through the before and after testing of students' thinking level and knowledge level, using the observation table to record the teacher's course in time, and using multiple people to score the average, it was found that one of the school's experimental data showed strong regularity.

20.3 Diverse Use of the Blended Learning Systematization Model

Through the comparison of three comprehensive data value-added in the experimental process, it is shown that the value-added score of the C2 class in the autonomous-refined-advanced mode is higher than that of other classes, and the class emphasizes the need for students to strengthen independent inquiry, and teachers break through one by one around the refined knowledge points. Group learning based on advanced tasks is organized to foster students' collaboration and inquiry skills.

Experiments have proved that at the beginning of classroom teaching of hybrid learning, teachers focus on the problems existing in the online "learning content" and adopt the method of "explaining refined knowledge points" to "strengthen and consolidate the learning of online 'knowledge points'", which is better than "explaining structured knowledge" in this link. Therefore, supplementing and targeted explanations for weak links in online learning are better than online teaching when there are still knowledge points that are not firmly mastered, and the effect of blindly using structured knowledge explanations is better. That is, the "precision teaching" in this link is better than "structured teaching".

On the whole, hybrid advanced and hybrid reinforcement can help students improve their deep learning ability in three dimensions (cognitive, interpersonal, and personal). The traditional advanced type is only helpful for cognitive dimension improvement, while the autonomous-structured-advanced mode C4 is helpful for cognitive dimension and interpersonal dimension. From the perspective of the different levels of the three factors, the use of the "independent inquiry" mode (mixed progressive, mixed progressive, mixed reinforcement) can better enhance students' ability in the individual dimension, and adopt "group problem solving" (Traditional Advanced, Hybrid Advanced, Hybrid Reinforcement) can improve students' interpersonal skills. Based on the comprehensive analysis results, the hybrid advanced type and the hybrid reinforcement type can comprehensively promote the improvement of students' deep learning ability.

The results of orthogonal experimental analysis show that the combination of autonomous-structured-advanced mode (C4) is the most effective in cultivating students' deep learning ability. The combination of autonomous-refined-advanced mode (C2) is most effective in developing academic achievement in mathematics.

Chapter 21
Research on Personalized Diagnosis and Feedback of Primary School Students' Physical Health Based on Big Data

Guimei Dou, Kui Yang, Yingzhang Liang, Haijiang Ren, Weijia Jia, Jiangang Wang, Yuguo Zhang, Canbiao Du, Yuchang He, and Yiping Yin

Tsinghua Primary School takes the personalized diagnosis of students' academic quality as the starting point, and is guided by education, and the data analysis of students' physical health performance is not specific, the diagnosis suggestions are not comprehensive, and the precise intervention guidance is lagging. Based on data such as student physical fitness data and real-time monitoring of smart playground, a scientific and generalizable series of personalized diagnosis and feedback results of physical health has been formed.

21.1 Research Process

Phase 1: Content design research stage of personalized diagnosis and feedback report (September 2020~February 2021).

First of all, the school and out-of-school, in-class and extracurricular, school and family form a joint force, from grade to class to individual students, from horizontal to vertical, based on big data tracking, to achieve personalized and accurate services such as content, form, method and platform. Secondly, personalized attribution diagnosis was carried out for students in the class, including "students with excellent physical fitness, students with short constitution, students with physical difficulties, students with body fat problems, students with technical problems, students with

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environmental problems, and students with other problems"; Class teacher coordination, physical education teachers, clubs and X class teachers to help different types of students find the "nearest development area" and provide structural supply; Linking inside and outside the school, with the help of smart bracelets, all-weather tracking and recording, forming data analysis, process diagnosis and feedback on key indicators such as obesity rate and exercise habits. Finally, a class-based "personalized diagnosis and feedback class report framework" was formed, including tracking and comparative analysis of class physical test data over the years, hierarchical attribution by physical fitness, classification diagnosis by project, smart bracelet monitoring, and improvement strategies.

The second stage: model development and promotion stage of personalized diagnosis and feedback report (March 2021~August 2021).

According to the diagnostic goals and measurement results, select valuable data, try to develop operable and batch application intelligent models, and further collect opinions and suggestions in experimental research, optimize and improve the analysis system, and finally form a feasible report model. Since the attribution analysis of students involves all aspects of student development, such as interests, habits, family, and volitional qualities, attribution diagnosis requires physical education teachers to work with class teachers and parents to creatively develop a diagnostic model combining "system + labor" in cooperation with third-party companies (错误!未找到引用源。). SunfitLink Sunshine Sports Load Monitoring System is selected for exercise load monitoring, and the main components include: heart rate armband meter, data receiver, display terminal equipment, etc.

The third stage: the practical application stage of personalized diagnosis and feedback report (September 2021~February 2022).

According to the batch application and practice of intelligent models, continue to collect opinions and suggestions from class teachers, students, parents and experts, and rely on the "smart sports playground" to continuously optimize and upgrade from physical education classrooms, large class breaks, after-school services, and students' independent exercise.

The fourth stage: comprehensive research and achievement improvement stage (March 2022~June 2022).

Sort out and refine the process results of research to form high-quality research papers and reports; Anticipate and extend the topic to lay the foundation for deeper research. For example, "Research on the Practice of Personalized Diagnosis and Feedback of Primary School Students' Studies" (Tang Weihong et al.) won the first prize of the "13th Five-Year Plan" Excellent Education and Scientific Research Achievements Evaluation Award of Haidian District in April 2021.

21.2 Conclusion

The content of the personalized diagnosis and feedback report is reasonably designed and effectively implements the function of sports people. The high-quality personalized diagnosis and feedback report of physical health takes the national physical health test data and smart bracelet monitoring data as the starting point, focuses on sports habits, interest cultivation, will quality and other educational elements, breaks the single logic of physical fitness improvement, and explores the content design ideas of "accurate data analysis + scientific attribution diagnosis + personalized feedback guidance". And in practice and improvement, constantly optimize the framework structure and presentation methods.

The model development of personalized diagnosis and feedback report is practical, giving full play to the role of smart sports. Personalized and accurate diagnostic reports require complex data testing, analysis and diagnosis, and the focus of the batch application is to develop intelligent and operable report models, so on the basis of all-round and whole-process collaborative improvement of teachers, students and parents, third-party evaluation companies are introduced to give full play to the intelligent and accurate advantages of the bracelet, reduce labor costs, improve the efficiency of diagnosis and feedback.

The application and promotion of personalized diagnosis and feedback report is feasible, and a series of research results have basically been formed. Through the intelligent reporting model, the batch application of personalized diagnosis and feedback reports is efficiently realized, such as 1 "class diagnosis report" per class, 1 "personalized physical fitness feedback sheet" per person, and 1 "bracelet monitoring report" once a month, etc., and continues to promote science and technology to help the practice and exploration of physical education, and gradually form successful experiences that can be promoted, and then influence the whole country.

Chapter 22
Efficient Classroom in the Context of Data Intelligence and Educational Intelligence

Zhenqi Li, Hongxu Chu, Yulei Han, and Xiaoqing Li

Taking high school chemistry "Iron and Its Compounds" as a teaching case, under the premise of using data feedback and trying new teaching modes, the focus of teachers' teaching design has changed from pure knowledge teaching to ability teaching, and through the effective use of online resources, accurate grasp of learning conditions, and careful design of teaching activities combining theory and practice, students can comprehensively cultivate their chemistry ability.

22.1 Research Background of Precision Teaching Based on the "Smart Learning Partner Platform"

"Smart Learning Partner Platform" is an intelligent big data public service platform developed by the Advanced Innovation Center for Future Education of Beijing Normal University, which can realize "the collection of data in the whole learning process, the modeling of knowledge and ability structure, and the diagnosis and improvement of learning problems". Discovery and enhancement of disciplinary advantages". The Fangshan District Education Commission has cooperated with the Advanced Innovation Center for Future Education of Beijing Normal University for many years, and teachers of various disciplines have actively participated in front-line practice, striving to explore teaching improvement models with the characteristics of Fangshan, school-based, discipline and academic situation through the "Smart Learning Partner Platform". The "Smart Learning Companion" platform

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provides three necessary conditions for the realization of precision teaching: First, the process-based aggregation of students' learning data provides a prerequisite for accurate diagnosis of learning conditions. The second is the organic integration of subject ability and teaching content to promote teachers' overall grasp of curriculum standards. Third, rich learning resources make it possible for teachers to optimize teaching design.

22.2 Research Methods for Precision Teaching Classroom Improvement

The research adopts the precise teaching theory pointing to the development of subject ability as the support, according to the learning process of students' mastery of subject knowledge to gradually improve their ability to solve problems, that is, the simple input of subject knowledge and experience–the simple output of knowledge and experience after processing input information–the high-order output after deep processing of information, the ability level of chemistry discipline can be divided into A. learning understanding B. Application practice, C. transfer innovation three capability levels. Among them, learning comprehension includes A1. recognition memory, A2. generalization association, and A3. explanatory argumentation. The application practice includes B1. analysis and interpretation, B2. inference prediction, and B3. simple design of three children. Transfer innovation includes three sub-levels: C1. complex reasoning, C2. system exploration, and C3. innovative thinking.

22.3 Analysis and Research Conclusions of Classroom Teaching

"Iron and Its Compounds" is the first time that high school students are exposed to more complex elemental compounds, which is very important for students to form an understanding of elemental compounds and master the general idea of exploring elemental compounds. Based on the development of students' subject ability, the accurate diagnosis of learning situations based on the data of the "Smart Learning Partner Platform" can help teachers select teaching goals, clarify teaching difficulties, and design "evidence-based-problem-oriented-ability development" teaching.

22.3.1 Self-Study in Pre-Class Micro-Lessons to Diagnose Learning Conditions Based on Data

Before teaching, teachers first arranged the micro-course resources of "Trace Elements–Fe" on "Smart Learning Companion" for students to learn by themselves, consolidate old knowledge, infiltrate new knowledge, and let students achieve learning performance indicators through self-study. When the resource self-study reached the A1 "recognition and memory" ability level, the teacher designed the pre-test paper according to the teaching objectives of the new course, covering the A1–C3 ability level, and accurately diagnosed the students' weak knowledge points and ability to be improved before class, laying the foundation for targeted teaching design. The teaching focus of this course is on the properties and tests of iron salt and ferrous salt, and the mutual conversion of Fe^{3+} and Fe^{2+}; The difficulty lies in enabling students to independently complete the experimental exploration of Fe^{3+} and Fe^{2+} conversion from the perspective of material category and valence, and cultivate students' ability to compare ideas and control variables in experimental inquiry.

22.3.2 In-Class Problem Design to Guide Students to Improve Their Subject Ability

Based on the key and difficult points of teaching, teachers cultivate and improve their abilities in generalizing associations, analyzing and explaining, inference and prediction, and Systematic Exploration has designed 4 teaching links, each of which is designed with corresponding key questions to guide and inspire students to complete teaching goals. First, the situation is introduced, and a two-dimensional map is drawn to understand iron-containing substances. Based on the valence state of the element and the category of the substance, the chemical formula of the iron-containing substance is written in a complete and orderly manner, and the chemical formula of the iron-containing substance is summarized by combining the two-dimensional perspective of the substance category and valence based on the knowledge learned, leading the students to summarize the correlation, and make inferences and predictions on the transformation between different substances. Second, the valence of iron in iron supplements is guessed and verified. Predict the reducibility of unknown objects from the perspective of valence and prove it experimentally, so as to broaden students' perspective of looking at matter and improve their experimental exploration ability. After the experiment, the teacher and the students sorted out the general ideas and methods for solving the task of testing elemental compounds, broadened the perspective of students' analysis of substances, and realized the effective improvement of students' ability to summarize and correlate with them. Third, realize the conversion of Fe^{3+} to Fe^{2+}. To enable students to conduct further experimental exploration on the basis of the established general ideas and methods of elemental

compound testing tasks. Fourth, students further summarized and improved the chemical properties and conversion relationship between iron salt and ferrous salt, and improved the learning and understanding ability of the correlation profile by sorting out the conversion relationship between the two.

22.3.3 After-Class Achievement Detection, the Effect of Target Ability Improvement is Remarkable

In order to test the effectiveness of the classroom, teachers also arranged the "Smart Learning Companion" micro-test question to test students' subject ability, involving the ability level of iron and its compound core concepts A to C, which was compared with the pre-test. It can be seen that after the teacher's targeted teaching based on the support of data, the students' ability performance has been greatly improved compared with the pre-test, and the application practice ability has been greatly improved: among them, the analytical comprehension ability has increased by 0. 38, the ability to infer prediction has improved by 0 36; The ability to migrate innovation is also determined by 0 16 increased to 0 41. Although the ability to learn and understand has decreased, the ability to generalize and relate to the focus of this course has also increased from 0 67 to 0 73. These data strongly show that the effective teaching design supported by teachers using data has achieved teaching goals and effectively improved students' subject ability at the overall level of the class. It can be seen that the cultivation and monitoring of students' subject ability supported by data is expected to become a high-reliability scale to measure the effectiveness of classroom teaching.

Chapter 23
Data-Driven Large-Scale Teaching Model Construction and Implementation

Bangqi Liu, Junsheng Liu, Dongze Cui, and Xinyi Li

With the core goal of "data-driven large-scale teaching according to aptitude", Bengbu City has built a data-driven large-scale teaching model implementation framework through UGBS collaborative innovation and comprehensive use of theoretical deduction and practical induction, and has produced good results and influence in local promotion and practice. The development of regional smart education provides experience and reference.

23.1 Research Process

Through the combination of theoretical deduction and practical induction, the research on the teaching mode according to aptitude is mainly divided into three stages:

The first stage is the construction of model prototypes, focusing on the connotation and characteristics of teaching according to aptitude, analyzing the technical points supporting teaching according to aptitude from the three levels of "material recognition-teaching-development", combined with the excellent cases of Bengbu smart classroom, summarizing and extracting a number of typical scenarios that can reflect teaching according to aptitude.

The second stage is the iterative improvement of the model, and the three schools in Bengbu City were selected to carry out the pilot application of the model, and face-to-face interviews were conducted with the pilot teachers, and the framework

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of the teaching model according to aptitude was optimized and improved according to the feedback of teachers.

The third stage is the practice of model application, which will be promoted and applied throughout Bengbu City, and constantly play an important role in the reform of teaching methods.

23.2 Key Content

Teaching according to aptitude is aimed at the different physical, psychological and social differences of learners, through different educational methods and teaching activities, and ultimately promotes the comprehensive personality development of learners, including three levels: first, "material", educators should understand the physical, psychological and social differences and characteristics of students, and grasp the students' cognitive methods and cognitive foundations related to the implementation of teaching; The second is "teaching", educators should combine social needs and teaching content, and adopt different educational methods according to the different situations of students; The third is "development", the teaching process should be oriented to each student, to achieve "comprehensive and individual development".

Based on three levels, the intelligent technologies that support individualized teaching are divided into three categories: learning situation analysis and diagnosis technology, personalized teaching and learning technology, and multiple evaluation technology. At the level of "material recognition", intelligent technology is mainly used in the analysis of learners' differences, including student digital portrait technology, multi-dimensional data collection and analysis technology, and data mining and dynamic modeling technology. At the level of "teaching", intelligent technology is mainly used in teaching activities, including automatic generation technology of teaching design, classroom recording and analysis technology, intelligent recommendation technology of teaching resources, learning analysis technology and intelligent interaction technology. At the "development" level, intelligent technology is mainly used in multiple assessments, including homework intelligent marking technology, oral assessment technology and adaptive question bank technology.

After prototype construction, iterative refinement and application practice, the framework of the teaching model according to aptitude is finally formed.

Objectives: The ultimate goal of the aptitude-based teaching model is to promote the comprehensive and individual development of students, enhance students' core literacy, and enable students to acquire the necessary character and key abilities that can adapt to the needs of lifelong development and social development.

Environment: The smart classroom information platform provides teaching resource services, teaching interaction, process evaluation and other functions, with the classroom intelligent platform as the core, with intelligent education cloud

services, combined with various intelligent teaching terminals and intelligent environmental terminals, to provide resource services, interactive services and teaching tools.

Technology: Combined with the practical needs of the implementation of teaching according to aptitude, corresponding to the three levels of teaching according to aptitude, the smart classroom information platform helps scientific material recognition, accurate teaching and development evaluation.

Session: Pre-class scientific materials can accurately grasp the commonality and different characteristics of students' physiology, psychology and society with the help of intelligent technology, and the main teaching scenario is accurate chemical analysis; Precise teaching in the course combines curriculum standards and students' needs, adopts different teaching methods, and realizes learning to teach, learn first and teach later, and develop wisely, and the main teaching scenarios are flexible teaching presets and intelligent classroom implementation; After-school development evaluation monitors students' learning in real time, analyzes students' learning effects in multiple dimensions, and conducts comprehensive evaluation, and the main teaching scenarios are personalized homework guidance and diversified learning evaluation.

Scenario: The unique teaching scene of each teaching link is the embodiment of the operability of the teaching mode according to aptitude, which provides guidance for teachers to implement the concept of teaching according to aptitude in the three links before, during and after class.

23.3 Experience

The implementation of the data-driven large-scale teaching model has opened a new situation of information teaching in Bengbu City in the intelligent era, injected new impetus into educational reform, and gained some experience in innovative mechanisms and policy guidance.

The first is to innovate mechanisms and collaborative construction, give full play to the value of the practice community of the coordinated participation of universities, governments, enterprises and schools, build a collaborative research mechanism of UGBS, and ensure that the constructed teaching model according to aptitude is scientific and accurate.

The second is policy guidance and overall promotion, which is regarded as an important content in the planning plan of the demonstration area, the annual work plan of the demonstration area, and the key training program at the municipal level to promote the promotion and application of the model.

The third is to promote the use of competitions, gather cases, and continue to give full play to the practical effect of the model. The survey found that the teaching model based on smart classroom improved the pertinence of teachers' teaching, among which, in terms of mastery of learning situation, the number of teachers who believed that "they can fully grasp students' learning situation" increased by 25 42%,

in terms of homework evaluation, the number of teachers who think that "homework evaluation is targeted" has increased 33 31%。

The fourth is to help topics and conduct special research, and constantly expand the breadth and depth of the model. For example, Bengbu No. 6 Middle School carried out data-supported stratified operation design and application research for the assignment link in the teaching mode according to aptitude, and arranged layered homework every week in the experimental class for data collection, and gradually formed the application strategy of hierarchical operation.

Chapter 24
Research on the Application of Big Data in School Sports

Min Zhang, Zhiwen Mao, and Ting Qiu

Based on the physical health monitoring data of primary schools in Donghu High-tech Zone from 2017 to 2019, this study focuses on exploring the dynamic changes and prominent problems of the physical health status of primary school students in Donghu High-tech Zone based on the physical health test results, to provide suggestions for schools to promote students' physical health.

24.1 Research Methods

Taking the urban–rural ratio of primary schools in Donghu High-tech Zone as the basis for stratified sampling, combined with random sampling, 8 urban primary schools and 3 township primary schools were finally selected, with a total of more than 20,000 primary school students, which is a regional representative. Six basic indicators of height, weight, lung capacity, 50 m running, sitting forward flexion and one-minute skipping rope were selected for research from the first to the sixth grade of primary school, and the original data included BMI value and the scoring scale of all the contents of the physical fitness test. Among them, the BMI value was divided according to 4 grades: overweight, obesity, low weight and normal, and the lung capacity, 50 m running, sitting forward flexion and one-minute skipping rope were all divided into fail, pass, good, and excellent There are four levels and correspond to different grading standards for grades 1 to 6 of primary school (refer to the National Standards for Student Physical Health).

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24.2 Data and Analysis

The statistical analysis of the data shows that there are significant differences in gender, urban and rural areas, grades and school years in the physical health monitoring results of primary schools in Donghu High-tech Zone from 2017 to 2019.

In primary school, boys and girls are in the stage of rapid growth and development, but the overall level of physical health of girls is significantly better than that of boys, and boys are more likely to have obesity, overweight, or low body weight. In the 21,475 samples, 7.2% were obese, 11.8% were overweight, and 4.8% were low-weight students, of which 8.5% were obese among boys, low weight is 4.6%, female students have an obesity rate of 5.4%, and low-weight rate is 4.9%; Boys' BMI scores declined over the three years, indicating an increase in the number of boys who were overweight, obese or underweight in primary school, while girls' BMI scores remained relatively stable.

The scores of urban students in lung capacity, 50 m running and one-minute skipping rope were significantly higher than those of rural students, while the measured scores of rural students in the sitting forward flexion event were significantly higher than those of urban students, which may be affected by the uneven development of physical education resources between urban and rural areas. However, from the overall trend, the overall physical health data of rural primary school students is growing, indicating that the gap between urban and rural physical education resources is gradually narrowing.

BMI and lung capacity are constantly changing in primary school, grade and school year differences focus on students' BMI index and lung capacity values increase with grade level, and BMI index and lung capacity in upper grades are generally higher than in lower grades, so schools can effectively intervene in health for students' sports participation in response to this growth characteristic. It is beneficial to reduce obesity rate, improve BMI index, improve students' cardiopulmonary function, etc.

From the development trend of physical health data in the past three years, the overall physical test score excellent rate and good rate showed an upward trend in the past three years, while the failure rate and pass rate showed a downward trend.

24.3 Recommendations

The first is to continue to maintain the trend of developing students' physical health test results in a good direction, and adhere to the promotion of "one increase, one reduction and one guarantee" as the focus of primary and secondary school health promotion actions.

Second, the school should achieve "one publicity, two training, and three development" for the promotion of physical health, and always teachers and students and

parents publicize the importance of physical health and obtain the support and cooperation of various groups and departments; 2. Formulate special training programs, strengthen the strict control of physical education classes, recess exercises, extracurricular exercise activities and other courses, and incorporate the physical health and sports skill levels into the school assessment system; Third, under the condition of ensuring the normal, orderly and scientific development of daily physical exercise, attention should be paid to the development of students' physical and mental health and the all-round development of moral, intellectual, physical and aesthetic.

Third, in view of the imbalance of sports resources in urban and rural schools, the quality of the school's curriculum can be fundamentally improved by hiring excellent teachers from other schools and one-on-one assistance from brother schools, and the teaching environment and teaching resources can be improved; Use existing resources to actively carry out as many forms of physical activities as possible, create special courses for school sports, strengthen students' participation in sports, and cultivate students' exercise habits from an early age.

Fourth, it is recommended that each school establish its own functional database or student physical health management system, which is convenient to log in to view, download, and immediately analyze the data of physical health results at any time, so as to help physical education teachers fully understand students, so as to discover the physical health test results and existing problems of students in their school or class, and help students thrive.

Chapter 25
Research on Big Data Helps the Physical Development of Rural Students

Aiping Zhang, Fenghua Liu, Hongbo Zhu, and Yujuan Zhang

Focusing on how big data can help small-scale rural schools carry out off-campus sports activities, 122 students from Zhenrenqiao Primary School in Changsha High-tech Zone were used as research objects to carry out a long winter and summer vacation 78 days of follow-up research found that with the support of intelligent technology such as big data, the development and supervision of off-campus sports activities of rural students were solved. The interest of rural primary school students in sports has increased, and the overall level of physical health has improved significantly.

25.1 Research Process

In order to improve the development level of the physical fitness system of rural students and solve the problem of physical exercise supervision during the winter and summer vacations, Zhenrenqiao Primary School of Changsha High-tech Zone relies on the platform for primary and secondary school students in the city to introduce intelligent skipping rope (one for each student). Supervise students' skipping physical exercise during winter and summer vacations.

The researchers started with the "1-min skipping rope" in the National Physical Health Test Project, and let students during the winter and summer vacation in the form of assigning winter and summer vacation physical exercise homework Jump

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rope for 3 min or 500 times a day. Smart skipping rope can upload the generated real-time data to the integrated database server through Bluetooth and Internet technology, and the background can monitor and analyze the relevant data of students at a certain time, day, month and year, parents and teachers see your child's activity for the day on your phone.

In order to monitor the effect of intelligent skipping rope application, the school conducts a round of one-minute skipping rope performance tests for all students before and after the winter vacation and summer vacation, and gives four grades of excellent, good, qualified and unqualified evaluations with reference to the "National Student Physical Health Standards", and compares the changes of the number of one-minute skipping rope jumps before and after the winter vacation and summer vacation. Compare the changes in exercise data of the whole school before and after the winter and summer vacations. In order to encourage students to keep skipping rope every day, the school has adopted relevant incentive measures, such as issuing certificates to students who complete tasks and awarding prizes to students with excellent grades, etc., to increase students' interest and participation rate in sports.

25.2 Effect of Implementation

Through monitoring, it was found that the smart skipping application improved the students' skipping exercise level and physical health. After the implementation of the 28-day winter vacation rope skipping sports activity, the excellent rate of 1-min skipping rope among all students in the school increased from 7.38 to 63.93%. After the implementation of 50 days of summer rope skipping physical activity, the excellent rate increased from 57.55 to 93.40%; In September 2021, the school's students participated in the national physical health test for primary school students, and the excellent rate was 28.8%, exceeding the average of the whole district; In the same period of 2020, the excellent rate of physical fitness tests for all students in the school was 0%.

As a small-scale rural school, Zhenrenqiao Primary School won 4th place in the overall score of the city's group in the 2021 winter and summer rope skipping competition of primary and secondary schools in Changsha, which improved the school's influence. It provides an excellent experience for big data technology to promote the reform of physical education teaching. Practice has proved that the appropriate and effective use of intelligent technology can effectively narrow the gap between urban and rural education, and the quality of education in small-scale rural schools can even exceed that of urban schools.

25.3 Research Conclusions and Reflections

The study found that under the background of the implementation of the "double reduction" policy, assigning appropriate and appropriate off-campus physical exercise homework to students is a useful measure and very necessary to promote the healthy development of students' physical fitness, which can urge children to come out of the heavy homework pile and reduce the incidence of myopia, obesity and mental illness.

Students' extracurricular sports activities still need to be supervised and evaluated by teachers, students have limited time in school, with the support of smart devices and big data technology, teachers can check students' exercise every day through mobile phones, instantly summary, feedback, evaluation, process evaluation to promote students' daily persistence, encourage students to progress, and take appropriate incentive measures to enhance students' interest in sports and improve the effect of physical exercise activities.

The school organically combines the application of intelligent skipping rope with the platform of everyone in the city's primary and secondary schools, which effectively improves the participation rate of students in physical exercise activities during the holidays, improves the physical health level of students, and is a typical application of intelligent technology in physical education. Through practice, it has been proved that intelligent technology and big data have been able to help rural primary school students carry out extracurricular sports activities, so it is easier to achieve in urban schools.

The data transmission path between smart devices is relatively limited, and the strengthening of cooperation between governments, schools, families and enterprises may further promote data sharing between sports equipment such as smart jump rope and smart sports wearing bracelets, generating more and more valuable data, and comprehensively improve the sports interest and sports efficiency of primary and secondary school students. Accurately improve the physical health level of each student and a school, and promote the balanced development of urban and rural education.

Chapter 26
Holistic Governance of Education in Subliminaria from the Perspective of Artificial Intelligence

Lu Zhang and Haoxiang Hou

Exploring the inherent coupling of intelligent technology and regional education holistic governance has important theoretical and practical significance for eliminating increasingly complex regional education problems, avoiding cross-departmental policy conflicts, activating cohesion in governance network structure, and providing seamless public services for the public.

26.1 The Practical Dilemma of the Overall Governance of Regional Education Under the Perspective of Artificial Intelligence

Subject obstacles: Data barriers hinder the formation of related education governance subjects, and the platforms and systems of government functional departments and schools generate massive amounts of redundant and incompatible data, causing the dilemma of "separate" governance between information systems, unable to form a closed loop of data, and restricting internal data sharing and external data openness in education.

Ways to shackle: The smart divide weakens the collaborative and shared education governance pattern. Government departments are dedicated to specialized operations and can't think holistically at a level of future development direction, region/school. The information foundation of education governance entities is different, and there

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are funding and capacity bottlenecks in the research and development of educational intelligent products and platform operation and maintenance.

Behavioral fragmentation: The limited application of artificial intelligence leads to the disorder of the educational decision-making process, and the information collection with automated decision-making as the path requires all-round coverage of decision-making affairs by data sources, and the automated decision-making process tends to be correlation analysis, which is difficult to capture the tacit knowledge of human experts and encompass simple algorithms. Educational decisions derived from complex human social activities are questionable.

Technical threats: Ethical errors in algorithm education induce privacy and security issues for teachers and students, the individual behavior data generated by each link of education is huge and sensitive, and the bias from the data source will be iteratively aggravated in the inference of the algorithm itself, and the recording of teachers' and students' teaching behavior and personal preferences may have hidden dangers in the application of algorithms such as sensitive information exposure and family privacy information being mined.

26.2 The Transformation of the Overall Governance of Regional Education Under the Perspective of Artificial Intelligence

Value co-creation: Data flow leads to changes in organizational relations and power structure, the popularization of intelligent products makes it easy to obtain education data, massive data flow constructs an information space that transcends the real structure, and information penetration reorganizes organizational structure, subject relationship and resource allocation, shifting from "government supply-centered" to "public demand-oriented". Gradually form an atmosphere of data altruism, ecological and educational value co-creation.

Holistic intelligent governance: Intelligent technology and high-performance computing power have driven the positive growth of regional education overall governance innovation, and the government, schools and social enterprises have in-depth cooperation based on the open source environment, and the governance pressure formed by diversified participation is transmitted to the government level through policy networks and intelligent interactive channels, reshaping the pattern of regional education co-governance.

Coordination and integration: The government coordinates all departments to jointly build indicator data around education demand scenarios, coordinates and integrates cross-departmental professional content, embeds it in the scenario decision-making framework, and relies on the integrated intelligent platform to reconstruct scenario-centric working groups to replace the original organizational structure divided by functions, and improve the decision-making efficiency of cross-domain issues.

Technical rectification: As the user of machine algorithms, human beings need to have corresponding algorithm knowledge and literacy, be able to distinguish the scope of algorithm capabilities and clarify the division of labor between man and machine, and transform the subjective status in the moral, political and legal sense of artificial intelligence.

26.3 The Action Path of the Overall Governance of Regional Education Under the Perspective of Artificial Intelligence

First, based on the "holistic" top-level design, connect the flow channels of regional education data. The overall governance of regional education needs to break the data fragmentation between levels, departments, schools and society, build an open organizational mechanism and standard system, break through the data barriers between existing business systems based on business collaboration, and standardize the ownership relationship and call mechanism of various education data. Promote sustainable development of data trading and sharing.

The second is to promote the upgrading of "holistic" joint forces and create a "cloud-edge-end" collaborative structure for regional education. The government distributes governance resources and computing services through the cloud center, fully respects the co-governance status of schools and society on the basis of overall planning, expands campus edge computing applications, and stimulates their respective forces to form a governance synergy.

The third is to integrate "holistic" collaborative decision-making and build an intelligent system with brain-like functions. Carry out data mining and service generation with education service requirements as the core, provide support for cross-subject domain access, magnitude data labeling, multi-threaded concurrent processing of data of education data, etc., rely on online technology to instantly combine virtual departments, and feedback processing results online to the public, forming a fast and convenient regional education service demand response mode.

The fourth is to gain insight into the "holistic" technical logic and strengthen the ethical supervision and regulation of algorithm embedding. Balance the power of algorithms with data power, and carry out value correction in the data input stage of algorithms. Follow the differences in the application scenarios of specific educational algorithms, implement targeted regulatory regulations, continue to study and predict the potential risks of more advanced artificial intelligence in the future, and create a future environment suitable for human–machine symbiosis.

Part IV
Solutions

Chapter 27
Teaching Resource Construction and Application Solution Based on Knowledge Graph

Chao Liu, Hongyu Wang, and Huijie Li

Based on the teaching resource construction project in key areas of the Ministry of Education, we use new technologies such as artificial intelligence, big data, and blockchain, explore new paths, new mechanisms and new models for the construction and application of professional resources based on knowledge graph, in order to provide resource construction and application solutions for the training of professionals in emerging fields and key core fields.

27.1 The Overall Construction and Basic Functions

The framework of the teaching resource-sharing service platform in key areas mainly includes six aspects: knowledge graph tools, resource construction, curriculum construction, teaching application, experimental training and statistical analysis. The intelligent processing tool of a human–machine collaborative knowledge map mainly realizes the construction of a knowledge graph through data collection, knowledge extraction, knowledge fusion, knowledge processing and other processes. The integration of practical training projects is connected with third-party training project platforms to provide teachers and students with rich experimental training project cases, data sets and computing power resources to meet the industry training needs of related majors in key fields. In the construction and sharing application of resources, relying on blockchain technology to establish an educational resource ecosystem, with a trusted timestamp and chain stamp double authentication, generate copyright DNA for resources uploaded to the resource platform, bind and record information

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such as the content, version, author, and formation time of the resource on the chain, and clarify the ownership of copyright.

27.2 Application Cases and Results

In terms of the construction of teaching resources in the field of artificial intelligence, based on the knowledge system of seven major fields: introduction to artificial intelligence, basic cognitive science, machine learning, pattern recognition, deep learning, knowledge engineering, and artificial intelligence experiment, 2,757 online resources covering 398 knowledge points and nearly 2,000 high-quality practical training projects have been built, and the coverage rate of knowledge points has reached 99%; The core curriculum system of majors in the field of artificial intelligence has been constructed, covering 7 directions, and the construction results formed have promoted the overall improvement of the quality of project construction in the field of artificial intelligence from the aspects of platform construction, resource construction, curriculum reform, and technology application. By the end of 2021, the number of course candidates in the course resources built by the project had exceeded 1,000, and 90 teaching resource-sharing service platforms in the field of artificial intelligence had been opened for trial. To a certain extent, it promotes the convergence of teaching resources of artificial intelligence majors, effectively solves the shortage of teaching resources in the early stage of professional construction, and will help improve the training level of artificial intelligence professionals, which has high promotion and application value.

In the field of heavy-duty gas turbines, the construction of relevant knowledge systems has been completed, and the "Teaching Resource Sharing Service Platform in the Field of Heavy-duty Gas Turbines" has been built, and it is planned to introduce virtual simulation technology to build an experimental teaching system combining online and offline in combination with the characteristics of the field. We plan to jointly carry out the co-construction and sharing mode of virtual simulation large-scale comprehensive experiments with universities and enterprises to strongly support the construction of related majors and talent training. In the field of virology, the "Teaching Resource Sharing Service Platform in the Field of Virology" has been built to meet the online teaching application needs of some professional core courses, and plans to carry out research on issues of high social concern such as virology, epidemic prevention and control, epidemic prevention and health care, and jointly promote the development of the project to socialized services.

27.3 Technical Characteristics and Application Prospects

In the process of constructing the map, artificial intelligence technology is integrated to realize the functions of intelligent recognition, knowledge mining, automatic extraction, relationship matching and other functions of uploaded text content. Its main features are: support multi-view editing page, clear structure and easy operation; Support crowdsourcing annotation and hierarchical review, making team collaboration authoritative and efficient; Support human–machine collaborative work mode to achieve intelligent knowledge mining. In terms of intelligent segmentation and processing of resources, technical means such as speech recognition, image recognition and text recognition are used to realize the structured processing of multi-source data such as videos and documents, and realize intelligent segmentation and labeling of teaching resources. At the same time, based on Baidu's blockchain deposit system and network-wide copyright monitoring system, it provides technical support for resource copyright protection.

The use of a knowledge graph for knowledge system expression can reflect the multi-dimensional relationship between the definition, structure and level of knowledge, and support the visual presentation of knowledge system, so that knowledge becomes a "visible" architecture. Based on this, the knowledge system will show new characteristics of "panoramic ecology, knowledge orientation, rapid iteration, flexible application". The knowledge map is used for the construction of a teaching resource library, so that the granularity of teaching resources is associated with knowledge points, and the granularity of teaching resources can be standardized by relying on the knowledge map, so as to realize the intelligent segmentation of teaching resources and effectively avoid the difference in resources uploaded by teachers. The content of teaching resources is closely bound to knowledge points and their relationships, so that all teaching resources have the foundation of intelligent deduction, and the intelligent teaching resource library based on the knowledge graph will become the foundation of digital teaching ecology. The intelligent teaching resource library is used for course teaching, and the course will have its own map image, compared with the professional knowledge map, and the course will clearly show the position and role in the professional course system. Since resources are associated with the knowledge graph, all learning behaviors and their results will be associated with knowledge points, the learning path is intuitively visible, and the learner portrait is simple and easy. The introduction of a knowledge map in the teaching process can outline the learning path and knowledge defects of each learner, which is convenient for personalized analysis and guidance. Learners can visualize the position and value of each knowledge point in the entire professional knowledge system, fully understand the hierarchy of the knowledge system, and facilitate the clarification of learning goals and paths.

Chapter 28
Smart Education F5G All-Optical Network Solution

Jun Zhang, Ruili Zhang, Xiang Zhang, Peng Luo, and Lin Jia

28.1 Application of Huawei F 5G All-Optical Campus in Digital Campus

F5G empowers everything perception and web applications. Huawei F5G all-light park mainly adopts F5G passive optical local area network (POL) technology, with single-mode optical fiber as the medium, using 10G GPON (compatible with GPON), Wi-Fi 6 fifth generation fixed access technology to build park network, including optical line terminal OLT, passive optical distribution network ODN, optical network unit ONU, etc., can unify carrying data, voice, video, with simple architecture, easy evolution, intelligence and high-reliability characteristics. The F5G All-light Park in the digital campus application mainly includes several application scenarios, such as smart classroom, smart classroom, smart office, all-light dormitory, safe and wireless campus, and so on.

Smart classroom: The F5G all-optical campus supports fiber-to-the-classroom, and PON technology can use time slot isolation or wavelength isolation to isolate services, matching the latency and bandwidth requirements of different services, and effectively supporting it Interactive classroom, VR/AR classroom, holographic classroom and other applications.

Smart office: In the F5G all-optical network, ONU devices can provide multiple service interfaces to meet different office scenarios. For the access requirements of service terminals, ONU products can be selected according to the requirements to provide high-speed and secure network connection functions.

All-optical dormitory: F5G all-optical network builds an ultra-wide campus dormitory network with wired and wireless convergence, providing students in the

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dormitory area with an Internet network, education network, intranet, online class, etc., and providing multi-service and IoT integration bearer.

Safe campus: In the campus security technology prevention network of the F5G all-optical network, ONU can provide standard Ethernet interfaces (10GE/GE, etc.) to access security equipment such as surveillance cameras and access control The function of POE to power security equipment; The F5G all-optical network supports enhanced media transmission quality index (eMDI) detection and camera blackhead detection, which can quickly locate the flower screen and black screen that appear in video surveillance, and efficiently carry the video security monitoring system service.

Wireless campus: F5G provides converged "one network", and each IoT terminal is carried through the F5G all-optical network, fundamentally reconstructing the data framework and achieving the resource-sharing goal of "one school, one database, one number and one source, one multi-purpose, and dynamic update".

All in all, the simple architecture, intelligent O&M, and high reliability of the all-optical campus will meet the requirements of the digital campus and provide a new teaching experience for teachers and students.

28.2 Application Cases and Results of Huawei's Smart Education F5G All-Optical Network Solution

Central South University grasps the opportunity of digital transformation in education, and plans to use "three gigabit" networks (gigabit optical network, 5G, Wi-Fi 6) as the carrier and "F5G + 5G + Internet of Things" as the core technology to complete the construction of a fully connected, fully perceiving, and fully intelligent smart campus network by 2023, so as to achieve the goal of ubiquitous smart education for everyone, all the time, and everywhere. College teaching and life scenarios are intertwined, school administrators, teachers, and students have continuously improved requirements for network quality, and a large number of Internet of Things terminals such as teaching equipment, all-in-one cards, and charging piles urgently need network resource integration. Huawei's F5G all-optical campus solution provides ultra-long-distance transmission to meet the rail-transit laboratory's multi-kilometer rail network deployment, real-time data control, and large bandwidth to realize ultra-clear distance teaching of clinical trials in Xiangya College. Proceeding from the usage needs of school administrators, teachers, and students, Huawei comprehensively connects campus data and applications, consolidates the foundation for smart campus construction, and plans to build Central South University into the first all-optical university model site in Hunan Province.

In order to promote the high-quality development of education in Yiwu, the Municipal Education Bureau proposed to promote the comprehensive reform of smart teaching with an F5G all-optical network, and build a Yiwu education metro network with the characteristics of ultimate experience, streamlined operation and

maintenance. We formed "one network, one cloud, one platform, and N applications" to achieve basic environment improvement, multi-field application development and teaching information literacy improvement. Huawei has launched network upgrading and transformation projects in batches, combined with the Internet of Things + platform, adopted existing mainstream GPON technology, and implemented the solution construction involving classrooms, public areas, high-density venues, offices, and other places. Huawei fully meets the needs of high concurrency and high traffic, and comprehensively completes wireless coverage, helping Yiwu Education Network achieve service requirements and ensuring the safe and stable operation of the information equipment system in the network. Through this, data access is secure, risks are controllable, and the status of IT assets such as terminals of each unit is visible, convenient and efficient. Until now, more than 100 primary and secondary schools and kindergartens in Yiwu have adopted the all-optical education metro network solution to complete the campus network transformation, significantly expanding the coverage of high-quality educational resources. Based on the successful construction of the education metropolitan area network, the Education Bureau of Yiwu has built and renovated a large number of synchronous classroom distribution schools, forming the "Internet + Yiwu Education" experimental zone in Zhejiang Province, effectively strengthening the growth and inclusiveness of local high-quality basic education resources.

Chapter 29
"Teaching According to Aptitude" Smart Education Solution Under the Background of "Double Reduction"

Jiafeng Zhou, Bo Yang, Dong Guan, Kai Pan, and Meng Han

Under the background of "double reduction", iFLYTEK effectively combines the general technology of artificial intelligence and data in the education process, converts various scenarios of information of the education process into big data that can support education services in the future, builds a new model of people-oriented digital learning, and forms two smart education theme solutions of "teaching according to aptitude" and "smart double reduction".

29.1 Artificial Intelligence Helps "Teach According to Aptitude" Solutions

The "teaching according to aptitude" solution takes "artificial intelligence helps education, teaching according to aptitude achieves dreams" as the core concept, relies on artificial intelligence, big data, teaching and research and other core capabilities, focuses on classroom teaching, five education teaching, student evaluation, teacher development, education governance and other educational scenarios, to solve the problem of modern education "not only to reduce the burden of teachers and students, but also to improve the quality of teaching; It is necessary to reduce daily examinations and evaluate the effectiveness of teaching; It is necessary not only to strengthen the main position of the school, but also to take into account the burden of teachers". The scheme includes four projects and multiple application systems of "Internet + Education" platform, teaching burden reduction and efficiency increase, "five education" demonstrations, and data evaluation-driven education: through the

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construction of the "Internet + Education" platform, consolidate the digital foundation of regional education and strengthen technical support for the high-quality development of regional education. Through the implementation of teaching burden reduction and efficiency enhancement projects, we realize strengthening the main position of school education and the main scene of classroom teaching, creating a new classroom teaching environment, and expanding the temporal and spatial scope of teaching by relying on artificial intelligence technology and intelligent terminal equipment. On the basis of high-level burden reduction and efficiency improvement, we build artificial intelligence innovative education, smart sports, and mental health education systems to provide support for the integration of educating five domains into normal teaching. The comprehensive evaluation-driven education project includes an evaluation index system, evaluation tools, evaluation reports, student portraits, and data-based evaluation to drive the reform of education methods.

At present, the solution has been applied in 32 provincial-level administrative regions across the country, serving more than 38,000 schools and more than 100 million teachers and students, and has achieved remarkable results in artificial intelligence in helping the high-quality and balanced development of regional compulsory education, reducing the burden of teaching and improving quality, and the all-round development of students, and has achieved large-scale application in Bengbu City, the Qingdao West Coast New Area, Changzhi City, Kunming Wuhua District and other places.

29.2 Artificial Intelligence Helps High-Quality "Double Reduction" Solutions

Focusing on the core requirements of the "double reduction" task, the comprehensive solution focuses on two scenarios accordingly: after-school services and homework testing, and relies on iFLYTEK's big data recommendation algorithm, class scheduling engine algorithm, natural language understanding, biometric authentication and other advantageous technologies to help the introduction, review and application of high-quality five-education courses. They can also help with the hierarchical design and accurate push of homework, and improve the quality of after-school services and reduce the homework burden of teachers and students. The plan adopts the "cloud + end" architecture design, including smart "double reduction" platform, curriculum resource service and smart operation system. The smart "double reduction" platform includes a basic support platform, an after-school service management system, and an assignment resource library, providing basic support for two types of systems: after-school service course application and primary and secondary school homework application. Course resources cover moral, intellectual, physical, aesthetic and special courses; The intelligent operation system mainly solves the problems of difficult data collection and inefficient homework in traditional homework paper, realizes intelligent identification and intelligent collection of learning data through

intelligent scanners. It helps teachers prepare for lessons and lectures, recommends learning content by systematically analyzing the weak knowledge points of classes and students, and reduces students' homework burden by reducing invalid homework.

Through the implementation of the layered operation teaching and research and application project under the "double reduction" policy in Hangzhou, a smart operation system is built. At the same time, a platform for the construction of the homework question bank is provided, and a layered homework teaching and research platform is provided for the school, so as to realize the closed-loop of multi-link processes such as homework teaching and research, layered arrangement, data recovery, homework evaluation, and homework supervision, and plan to build a hierarchical homework teaching, research and application demonstration area under the "double reduction" policy.

29.3 The Technical Characteristics of Smart Education Solutions

iFLYTEK's smart education solution has made breakthroughs in three key technology dimensions to effectively ensure the application effectiveness of multiple educational scenarios such as classroom teaching, homework testing, five-education teaching, education governance, and education evaluation. First, based on continuous breakthroughs in perception and cognitive AI capabilities, intelligent analysis of complex unstructured data in multiple scenarios is carried out to realize the transformation from raw data to structured data and knowledge; Second, we identify the recent development area of learning, give dynamic learning path planning, and build a systematic knowledge map of all disciplines, and recommend personalized learning plans for students. Third, we carry out full life cycle management of all teaching process data, which can break through several big data platform technologies such as real-time computing platform and data security-related privacy computing, and realize data connection, interconnection, and intelligent application.

Chapter 30
Build a Digital Base for Education and Build a High-Quality Education Support System

Hai Zhang, Wenbo Shi, and Rui Hu

Alibaba Cloud Digital Base Solution for Education is an educational infrastructure operating system and ecological base designed and developed according to the characteristics of the educational public service industry. It is applied to build a new educational infrastructure system with an optimized structure by perfecting the organization, enriching the application. By building an educational public service industry cloud as a whole, and unifying the authoritative organization user system, it has built an application development platform, a unified education workbench, an exclusive application market for education, and a data exchange platform for collection and sharing, etc., to solve the problems of inconsistent accounts, impassability of data, and low application efficiency in the process of decentralized construction of education systems, and help regional education develop with high quality.

30.1 The Overall Structure and Functions

The Alibaba Cloud Digital Base Solution includes infrastructure system, pedestal support system, business application system and multi-terminal docking system, which leads the construction of new infrastructure in the education industry such as industry cloud, application support system, digital campus and education big data warehouse. The cloud infrastructure capacity of the public service industry in education is constructed according to the "3 + 1 + 1" model, including three resource zones, one management and control module and one operation module. The platform builds an education big data warehouse based on the education industry cloud, realizes the integration and convergence of all kinds of education data resources,

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promotes the penetration and sharing of education data between different regions and different levels. The organization center provides unified and centralized organization management and identity authority service capabilities for education systems at all levels, connecting organizations, members and applications. Application Center is an educational application management system for unified examination, unified distribution and multi-end, which mainly includes application development platform, application market and unified workbench. Data center provides the ability of the whole process of educational data from collection, storage, processing to analysis, and realizes the sharing of educational data among provinces, cities, counties and schools.

30.2 Application Cases and Results

Alibaba Cloud Digital Base Solution for Education has been widely used in Zhejiang, Shanghai and other places. By 2022, it will have provided digital education services to 2,100 educational institutions and 210,000 schools.

Relying on Alibaba Cloud Education Digital Base and Zhejiang's integrated intelligent public data service platform, Zhejiang Education Rubik's Cube designs and develops a basic support system for all schools and education-related departments in the province to support education data perception, data sharing and data calculation. The system focuses on core application scenarios such as "education brain", "smart school" and "future community", and based on gathering personal learning data and establishing e-learning files, it realizes education big data services for related users in the education industry in the whole province, forming an "innovation in one place". Through one year's construction and operation, "Education Rubik's Cube" has made some phased achievements in provincial offices, education bureaus of cities, districts and counties, schools at all levels and in the field of civic learning: a map of five levels of education intelligence management in province-city-district-county-school has been built, and 15,094 education bureaus in the province have been covered and connected, serving 629,629 teachers and 8,899,115 students in the province, and all kinds of education have been managed. It has built the application market and operation platform of the educational Rubik's Cube, built 36 kinds of applications such as precise teaching, intelligent management and communication between home and school, and completed 578 ecological applications. Meanwhile, it empowers the regional education administrative department, which has completed the coverage and access of 93 district and county education bureaus in 11 cities of the province, and supported the provincial education bureaus to optimize resource allocation. In addition, it empowers all kinds of schools at all levels, and focuses on solving the technical problems of unification, mutual integration and data convergence of each application portal in the digital construction of schools. At present, 3,000 schools in the province have access to the educational Rubik's Cube service.

30.3 Application Environment and Technical Characteristics

The deployment architecture of this solution is flexible, such as the deployment architecture based on the Alibaba Cloud customer's exclusive account (the core application hub, organization hub and data hub are uniformly deployed to the exclusive Alibaba Cloud environment of customer's account) or the deployment version based on customer's local environment (the customer's local computer room needs to deploy the infrastructure of Alibaba Cloud). The scheme has efficient customization and expansion ability, and because it faces more local customers, each local customer may make personalized demands. As well as high-performance big data retrieval and processing capabilities, it can ensure the rapid summary and analysis of multi-party data, form consistency standards, and solve the problems of inaccurate and inconsistent organizational data to the greatest extent. At the same time, it provides a completely open platform capability, which can help customers quickly build their own safe, efficient and personalized open platform.

Chapter 31
Building a Regional Efficient Operation Management Platform

Jun Wang, Xi Jiang, Yanshuang Bai, Yu Cui, Yuandong Lin, Shujun Gao, and Shuang Yang

Shanxue Online is an intelligent application service complex, providing customized technology research and development services and resource content expansion services according to the individual needs of regions and schools. This platform helps promote school homework management from traditional to informatization and intelligence with technology empowerment, transforming teachers' traditional teaching and homework marking mode, helping teachers carry out differentiated teaching, providing guidance for students' personalized learning. It has opened a window for home-school community linkage, and helped the region to build a high-quality intelligent operation management system with characteristics.

31.1 Cases and Results

Based on its own advantages in intelligent technology, Chisheng joined forces with the teaching and research department of Erdao District of Changchun to build the "Erdao District Good Learning and Intelligent Operation Management Platform of Changchun City", with a view to forming a regional scientific, reasonable, sustained and long-lasting operation management mechanism through the application of the platform. With the help of the big data collection in the whole scene of the platform, the value of process data is recorded and mined, and the student-centered learning

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situation analysis is formed, thus serving teachers' more accurate education and teaching, and providing all-round operation data supervision information for regional managers.

Supported by the platform of Good Learning Online, Erdao District of Changchun has built a regional unified homework management platform, which makes use of the flexible and efficient function of Good Learning Online to record questions and generate test papers to manage the homework content and learning resources of all schools, sections and disciplines in the region. Teachers in regional schools make overall plans to estimate students' daily homework subjects and the corresponding homework duration, give early warning and remind for abnormal homework duration, and uniformly supervise whether the daily homework of each subject is in compliance and reasonable, thus realizing efficient and coordinated assignment of all subjects. The platform intelligent marking technology is applied to realize all-round data collection. Teachers only need to take photos or scan homework content to judge papers. The platform can automatically score objective questions and simple subjective questions. On the one hand, it greatly reduces the labor intensity and practice of teachers' marking homework, on the other hand, it can summarize, analyze and mine students' homework data and record students' process evaluation in detail. According to the students' historical homework and study profile, we make a fine portrait for each student, effectively supporting the push of students' personalized homework content and hierarchical teaching in schools. Personalized homework effectively reduces students' academic burden, and hierarchical teaching helps schools form a benign teaching closed loop. The platform has opened up the connection between classroom teaching and students' homework, and the intelligently-marked data linkage test explanation system helps teachers accurately understand the class homework, and make accurate and efficient comments in class during the short classroom teaching time, helping the classroom to reduce the burden and increase efficiency. It provides a "big data cockpit" for the regional education authorities of the platform. Through the visual map board, the workload of each school and subject and the development of after-school services can be visually displayed, and the quantification of homework contents and reports can be realized. The platform provides a "parent side", which supports parents to know the students' learning situation anytime and anywhere, and through the platform's feedback from time to time, realizes the cooperative education of home, school and society; With the help of Shanxue Online, the operation management in Erdao District has gradually embarked on a benign development model of "reducing, increasing quality and improving efficiency".

31.2 Technological Innovation and Characteristics

Learning online deeply integrates intelligent big data processing technology, and combines key artificial intelligence technologies such as intelligent speech recognition, TTS speech synthesis, K12 knowledge map, OpenCV (cross-platform computer

vision library), OCR (optical character recognition), etc. Through intelligent scanning recognition and artificial intelligent marking, it realizes batch uploading, batch marking and intelligent statistical report generation of daily paperwork. Learning Online is based on the individual needs of students' development, proceeding from the educational reality, optimizing and upgrading platform technology through continuous intelligent marking and iterative upgrading, and continuously accumulating practical and service experience in the deep integration of technology and education and teaching. It is compatible with the intelligent marking of more test questions, and has been applied a new generation of emerging technologies to help the balanced development of regional education with high quality.

Chapter 32
Digital Resource Supply Solution: Create a Regional "New Learning Engine"

Hong Ge, Nianzhi Xiao, Qiurong Tao, Hui Zhao, and Shuang Zhang

Suzhou Industrial Park (hereinafter referred to as the "Park") is based on the "Easy Plus" platform. From the perspective of resource services, it focuses on systematic construction, structured presentation and scene application, providing effective support for teachers' teaching and students' learning, improving teaching quality and efficiency, and igniting a "new engine" of intelligent learning.

32.1 The Systematic Construction of Resources

Adhering to the concept of "being built according to needs, being excellent in use, and being innovative in research", the park is planned by subject teaching and research staff, demonstrated by key teachers, and fully participated by subject teachers to comprehensively promote the co-construction and sharing of regional high-quality teaching resources:

First, build resources according to the content of textbooks to meet the needs of students' flexible and independent selection: based on subject textbooks, it has built regional shared high-quality resources according to chapter system, knowledge point system and core literacy system, and realize full coverage of synchronous resources, weiyun course resources and question bank resources;

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The second is to build resources according to the needs of the curriculum to meet the needs of students' systematic thinking: based on a single lesson, it has also built learning resources such as learning objectives, learning contents, discipline tools, testing and training, and curriculum package resources of the whole curriculum with formative evaluation;

Third, follow the characteristics of the project to build resources to meet the needs of all-round development of students' abilities: the platform is guided by the project and characteristics to build special resources, and to build special school activities resources for primary school Chinese, mathematics and English, as well as map resources for middle school entrance examination.

32.2 Structured Resources

The resource library is mainly "micro-video", with more than 60,000 video resources, realizing the full coverage of chapters and knowledge points of all years, all disciplines and all national courses and textbooks. The park serves users' usage habits, making the layout of resources more reasonable and the presentation of resources more scientific:

First, the resources are presented in the form of subject atlas, covering key ability atlas, knowledge system atlas, and literacy system atlas, like a learning tree, so that students can know the "branches" that they should grow up after their past studies. Students can learn independently by clicking on the "branches" to obtain the resources pushed intelligently, and find the precise point of their own growth;

Second, resources are built and filled according to the learning road network (here "the learning road network" refers to the subject knowledge, which is built with the help of information technology. It is a collection of learning paths that meet the characteristics of different students' original knowledge level, cognitive ability and learning style, and supports students' knowledge learning and ability cultivation). In the building of the learning road network, the road network is enriched with resources such as teaching and learning application tools, simulation laboratories, famous teachers' cloud lessons, excellent students' learning experience sharing videos and works, etc. Teachers can effectively help students to deeply understand knowledge, experience inquiry knowledge and systematically learn knowledge, so that students can get effective learning support according to their actual needs and suitable learning methods;

The third is to make resources provide an engine driven by data. The platform establishes complete learning big data for each student, teaching big data for each teacher and class, and helps teachers accurately locate students' knowledge. The data-driven intelligent recommendation engine for personalized learning provides teachers, resource providers and learners with accurate and appropriate resource organization forms and access ways, and empowers "individuality" and "smart education".

32.3 The Scene Application Resources

Based on the resources in the platform and the big data beneath them, the park explores the innovation of a "curriculum, after-class, after-class" learning path relying on high-quality resources, giving birth to a deep revolution in learning;

First, curriculum learning is more intelligent: students in the park can use the curriculum resources closest to the nearest development area in the platform to "flip" before class, and complete the preview task of basic knowledge before class. With the help of subject tools, virtual simulation experiments and other learning materials, students can internalize subject knowledge and experience the generation of knowledge in independent inquiry. After class, according to the students' own learning process, the resources can be scanned anytime and anywhere, and the learning data can be automatically summarized to realize the follow-up and companionship of the whole learning process.

Second, the learning process after class is more diverse: teachers design diversified homework such as reading homework, video homework for oral communication, homework for virtual scene operation training, etc. They can also expand the curriculum resources and implementation ways of labor, art and other characteristic disciplines, develop students' interest, and enable students to get comprehensive development. By using the map resources of NMET to study the special content of NMET, students are able to deepen the knowledge and construct their own learning system.

Third, extra-curricular development is more independent: based on the resource library and curriculum library, every student in the park can learn at this time and everywhere. Teachers issue learning tasks around the project, guide students to discover, analyze and solve problems by comprehensively using subject knowledge in the process of project activities, and share the results of activities in various forms such as research reports, posters and videos. The platform provides a resource system for the whole people. Everyone in the park can enjoy the personal space, curriculum library and study circle provided by the platform, and build their own learning ecosystem, so that every learner can have a sense of gain.

Chapter 33
Light Practical Smart Experiment Classroom and Smart Education Application Solutions in Popular Science Corner

Xiang Gao, Ying Wang, and Zhaorui Cao

Jingle Magic is based on a new generation of emerging key technologies such as AI, AR, XR and 5G. With the joint operator and The Qingdao West Coast New Area, we have carried out the "5G+ Smart Education Application-Experimental Classroom and Popular Science Corner Project", which is mainly applied to the experimental teaching of physics and chemistry students in middle schools. The project covers 65 schools on the west coast of Qingdao, benefiting 140,000 teachers, students, parents and education administrators, and promoting high-quality development such as subject education, quality education and popular science education.

33.1 Plan Structure and Technical Characteristics

Intelligent experimental classroom and popular science corner apply a new generation of emerging key technologies to help experimental teaching. With the help of virtual and real teaching equipment and artificial intelligence teaching management platform, classroom management and control, permission granting, data statistics, teaching and learning evaluation are carried out. Through process interaction, optical recognition, voice guidance, etc., the whole process of experimental teaching is from digitalization, light practice, to multi-modal and complete WEB3.0 virtual and real seamless connection, which brings an inspiring interest to the school.

Intelligent experimental classroom and popular science corner change the traditional laboratory mode, which is mainly based on hardware configuration. Intelligent

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experimental equipment can change the combined spatial layout. The connection and combination between AR intelligent experimental desks are more flexible and open, which is convenient for students to carry out cooperative learning and inquiry learning, and for teachers to carry out group guidance. The virtual and virtual laboratory space has changed students' learning style. Students explore and learn in the virtual scene from the first perspective, analyze, modify and perfect the experimental model in the virtual space, and store, process and share the experimental information with the help of cloud storage, digitalization and the Internet, so as to realize the combination of real objects and virtual operations, and truly master the initiative of learning. At the same time, it supports the construction of an instant new dynamic learning diagnosis and evaluation system. By collecting and analyzing experimental process data, experimental result data, classroom participation data and interactive discussion data, it can construct multi-dimensional portraits of teachers and students, reconstruct intelligent evaluation and management of experimental teaching quality, and maximize the effect of course experiment and management. In addition, the virtual laboratory is not limited by the inherent experimental equipment, and there is no need to estimate the experimental consumables and costs. The same experiment can test hundreds of results, and each step of operation and result-orientation can give equations and analysis of experimental principles. One laboratory supports the integration of multi-disciplinary and whole-course experimental courses, which improves the reuse efficiency of single laboratory and saves redundant laboratory construction costs.

33.2 Application Scenarios and Methods

It is applied to the experimental teaching of physical and chemical students. A classroom has the functions of extracurricular science popularization, teaching and practice of general experiments for physics and chemistry students in class, etc. The curriculum resources are synchronized with teaching materials to meet the needs of all experiments and extracurricular science popularization subjects for physics and chemistry students in junior high school. A low-cost, high-safety, multi-disciplinary and high-intelligence experimental classroom is constructed to solve the teaching problems of traditional laboratories in one stop.

Applied to the scene of popular science courses in primary schools. Based on the safety and operability of the AR intelligent experimental desk in Jingle Magic, an open demonstration area and operation area are set up, so that students can experience the effect of scene demonstration and practice interaction in science class. Jingle Magic has landed in 14 schools in the Qingdao West Coast New Area, effectively helping the diversified development of quality education and teaching.

It can be applied to the upgrading of traditional laboratories. Before that, we need to construct an experimental scene that is familiar with the experimental process first, and then practice. Students can get familiar with the experimental process through

desks and check for leaks and fill in gaps through data feedback, so as to avoid errors and risky operations and improve the safety of the experiment.

It is applied to areas where teachers, teaching conditions and teaching resources are relatively scarce. Through smart classrooms and 5G holographic teaching, large-scale teaching such as synchronous classroom, interactive teaching and research can be carried out, which can solve the problems of "lack of teachers and less education" and "uneven curriculum offering" in areas where educational resources are scarce, and effectively promote the balanced development of urban and rural educational resources.

Chapter 34
Smart Teaching Assistants Empower Teachers to Do Well in Every Class

Bin Wang

The smart teaching assistants of Onion Academy are mainly supported by powerful digital educational resources and personalized teaching applications. Among them, the number of digital educational resources exceeds 5,000 micro-lesson videos, with a total duration of about 45,000 min, covering most subjects in elementary school, junior high school, senior high school and secondary vocational school. At the same time, combined with technologies such as cloud computing, big data and artificial intelligence, mobile Internet applications and Web products deployed in the cloud that are suitable for multiple terminals have been launched to meet the normal application of teachers under various circumstances. The learning system collects students' "human–computer interaction" learning behavior data in real time, makes statistics and analysis, and feeds it back to teachers immediately, helping teachers understand students' learning situation and push learning tasks individually, thus realizing data-driven precise teaching.

34.1 The Features of the Program

The essence of smart teaching assistants is to simulate the teaching process that mostly accords with the cognitive competence of students. The program aims to solve students' individualized problems accurately and timely. Digital resources enable high-quality education to be scaled and replicated through human–computer interaction and the empowerment of big data.

Features of digital educational resources: In terms of the effectiveness of resources, full consideration should be given to combine scientificalness, with

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psychological needs as well as cognitive competence of students, so as to enhance the active participation of students. In the form of resource presentation, animation and multimedia special effects are mostly used, and abstract knowledge points are refined into 5–8 min of visual content, which is visually and vividly displayed to students. In the adaptation of resources, it is arranged according to the catalogue order of different editions of textbooks nationwide, corresponding to each knowledge point of disciplines and chapters, which is convenient for teachers and students to use. As for the use of resources, it takes full consideration of the actual needs of teachers. Teachers are supported to choose important and difficult segments according to knowledge slices in classroom teaching, which greatly enhances teaching efficiency.

Features of personalized teaching application: Smart teaching assistants empower teachers to improve those problems that are difficult to solve by themselves, such as the accuracy of knowledge and the individualized needs of students. Smart teaching assistants can make appropriate data burying points in advance, support the collection of valuable key data that can reflect students' learning behaviors, and push accurate and effective resources through accurate analysis to realize accurate teaching. The application of smart teaching assistants requires that the closed-loop teaching should be completed, and resources should be pushed immediately after the analyses of the learning situation, so as to help students fill in knowledge gaps in time. Through the matching of knowledge maps and learning situation data, the great value of self-research resources can be brought into play, and teachers can help students accurately check for leaks and fill vacancies. The application of smart assistants starts from the actual conditions of the school and the actual needs of teachers, and gradually improves classroom teaching.

34.2 Cases and Effects

Photosynthesis New Knowledge (Beijing) Technology is committed to building a personalized learning system of human–computer interaction, and forming a learning closed loop in the context of digitalization. From the perspective of classroom teaching, the digital education application solution of Onion Academy has accumulated more than 2 million registered teachers and 70 million registered students. It has been applied in more than 2,000 schools across the country, and 65% of them are distributed in third-tier cities and rural areas below. The smart teaching assistant program has been applied on a large scale in Shizuishan City, Ningxia. It has served more than 200 junior high school teachers and more than 18,000 students in normalization education and teaching, and promoted classroom reconstruction and teaching quality improvement in schools in the central and western areas. In the Huis School in Huinong District, through the in-depth application of Onion Academy to carry out normalized smart teaching, the role and educational concept of school teachers have imperceptibly changed. Teachers gradually realize that they are no longer the only source of knowledge, and students can obtain knowledge and information through

the Internet. Teachers ought to guide students to correctly obtain and process information. Ad hoc, students gradually adapt to the blended learning mode with the help of digital resources, and their ability to understand, share, display and apply complex knowledge is gradually improved. Their interest in learning is gradually enhanced with the improvement of their academic ability. At the same time, with the help of Onion Academy, remote rural schools can use the same resources as urban schools and schools in developed areas to carry out teaching, and the application of normalized teaching can boost the overall education quality of schools steadily.

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