Chapter 2
ICT Supported Instructional Innovative Practice and Diffusion Mechanism of K-12 in China

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Abstract With the rapid development of technology and society, each country has emerged more innovative instructional practices in K-12 using new Information Communications and Technologies (ICTs). As an important representative, China has a long history of exploring and reforming the instruction. In recent years, there are lots of innovative instructional practices emerging with the development of ICT in education in China. The experiences of innovative practice, including the approach of innovation and diffusion model are important for every country. In this chapter, we analyze some typical instructional practices and relative models in China from eight approaches of instructional innovations which can be classified as three main missions: to realize education equality, to promote teaching quality, and to cultivate creative ability. It can be found that all these innovative instructional practices are combined with characteristics of the educational organization system of China and there are several influence factors for these innovative instructional practices, including government-supported educational institutions and enterprise, experimental team in school, technological innovation and educational needs, etc. Therefore, this chapter extracts typical educational innovative diffusion mechanism in China, which can be used as reference of ideas and inspiration in practice for other countries.

Keywords Instructional innovation · Innovation practice · Diffusion mechanism

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R. Huang et al. (eds.), *ICT in Education in Global Context*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-47956-8_2

2.1 Introduction

For now, after several years of development, the technology has been widely applied in the instructional process in schools at all levels, and greatly promoted the teaching efficiency and to a certain extent, promoted the innovation and development of instruction. Considering the ponderous pace of change in formal education, it is a formidable task of shifting toward learning that fosters creativity and innovation, dislodging it from the "factory model" that moves students along the conveyor belt of schooling through successive grades of prescribed content. On a practical level, trying to infuse creativity, innovation, and entrepreneurship into existing education structures that favors conformity is destined to mute the potential positive impact of doing so. Ultimately, as Michael Fullan (2013) has suggested, what is required is an extensive makeover of education systems. One element of that makeover process, he proposes, is the use of "new pedagogies." This makes sense if we are to learn from the great hopes and expectations associated with updating education through greater use of technology—applied to conventional teaching practices. Simply adding technology to existing practice has not been nearly as transformative as expected. Rather, Information Communications and Technologies (ICTs) will be more effective when utilized with "new pedagogies". Moreover, the new pedagogies and makeover need to be associated with a coherent vision of education that has challenged outdated assumptions about the real purpose of education.

In order to cater to the development of technology and education, the Chinese government and educational institutions have explored a series of instructional innovation for regional and school practice. The Ministry of Education, P.R.C. has released the *National Plan for Medium and Long-term Education Reform and Development (2010−2020)*, which contains a number of strategies for education development and also proposes development goals for all levels of Chinese education. The Ministry of Education and the Ministry of Finance, in November 2012, jointly launched the implementation of the "digital educational resources cover all teaching sites" project (MOE 2013). The so-called teaching site is the school where is remote, small scale, and lack of teachers and infrastructure. All the teaching sites had been equipped with digital educational resources, receiving, and playback devices. Meanwhile, this project helps teachers to offer national curriculum, so that school-age children in rural and remote areas can be well-educated (Wei 2015). Innovative practices of education not only achieve success in the regional level of resource construction, but also in school level. In 2014, the initiative of *teaching with co-creations* launched by the National Center for Educational Technology for nationwide school teachers. All teaching materials created by teachers including real-time recorded video will be shared online, commented by other teachers, and finally conducted the competition. The excellent courses are used for reference by other teachers, which is beneficial in sharing of quality resources and improve teaching quality (Fu 2014). Faced with the uneven distribution of infrastructure, educational resources, and teachers in urban and rural school, the synchronous

classroom is an effective mechanism of high-quality resources in rural areas covering a wide range of teaching sites and is essential to achieve sharing of high-quality education resources among schools by synchronizing activities of high-quality school's classroom through two-way video conference system (Yan et al. 2014). For example, No. 1 Middle School in Zhengzhou and No. 7 Secondary School in Chengdu are both using satellite to share quality teacher resources. Through satellite communication technology, high-quality resources are transmitted to schools in poor areas. For many rural students, it provides the highest quality education resources (Wang 2014). Some schools also actively explore ICT supported instructional innovative practice, such as *Flipped Classroom Teaching* in Changle No. 1 Middle School, which is a new trial to integrate ICT with teaching. It enables ICT to fully penetrate into all aspects of curriculum such as learning goals, teaching resources, curriculum structure, and instructional evaluation, so that ICT supported teaching and learning has become conscious activity for teachers and students (Dong 2014). No.2 Middle School in Zhengzhou exploring education transformation, takes advantage of mobile terminal and changes the way of teaching and students' learning to let students carry out self-regulated learning anytime and anywhere (Chen 2014). The maker education in Wenzhou Middle School successfully meets the needs of encouraging, sparking and developing student's creativity and practical ability, and makes students transforming from consumers to creators easier (Xie 2014). Luochuan Middle School in Shanghai carries on project-based learning, setting their teaching goal as improving students' twenty-first century skills by integrating subject knowledge, subject tools, Web 2.0 technology, and other resources (Jiang 2009). All the above literatures are based on the practice of educational innovation, but mainly concentrated on studying special innovative teaching mode or analyzing certain case, ignore the effect and internal affective factors of educational innovation from a macro perspective. The theoretical research on these problems can enrich the knowledge of innovative education.

Diffusion of Innovations is a theory that seeks to explain how, why, and at what rate new ideas and technology spread through cultures (Roger 1995). It has been used to systematically analyze thousands of innovative diffusion cases. Rogers proposes that four main elements influence the spread of a new idea: the innovation itself, communication channels, time, and a social system. Ely (1999) identified the following eight conditions that appeared to facilitate the implementation of education technology innovations: (1) dissatisfaction with the status quo; (2) existence of knowledge and skills; (3) availability of resources; (4) availability of time; (5) rewards or incentives exist; (6) participation; (7) commitment; and (8) leadership. Michael Fullan's change describes features of professional learning communities that promote change and how to embed change in practice (Sparks 2003). Fullan and Stiegelbauer (1991) identified three areas of the major factors affecting implementation: characteristics of change, local characteristics, and external factors (government and other agencies). After that, based on the angle of the process, the process model (C-R-E-A-T-E-R Model) clearly embarked upon the change process in The Change Agent's Guide (Havelock and Zlotolow 1995). This model includes six periods: Care, Relate, Examine, Acquire, Try, Extend, and Renew.

This model also explains the example of each stage and the focus of the specific work. The *Concerns-Based Adoption Model* (Hall and Hord 1987) provides tools to "keep a finger on the pulse" of change and to collect the information needed. The model's guidelines help readers to understand the different concerns that stakeholders experience as change progresses. This, in turn, will help readers to design and enact interventions when they will be most effective. Tumeniene (2002) conducted research on the research of innovative activities features of Lithuanian secondary school teachers. In the aspect of classification on the teachers' innovative activities, based on S-curve innovative diffusion theory, Vitalija Tumeniene came up with a more comprehensive model of teacher innovation process. By examining the results of survey assessments of the eBook project, Martinez-Estrada and Conaway (2012) analyzed how the eBook supported student learning and course outcomes. Panagiotis etc. (2013) analyzed seven cases of ICT-enabled innovation for learning from Europe, Denmark, Hong Kong SAR, Japan, Singapore and South Korea, covering aspects such as scale and nature of innovation, learning outcomes targeted, the role of technology in the innovation, and the implementation strategies. The lessons learnt about the necessary conditions for sustainability, scalability and impact at the system level are also discussed. Zhang (2013) argued that the research on innovative diffusion mechanism of educational technology is to abstract internal logic mechanism in a complex system. Technical diffusion research should concern the process by which an innovation is communicated through certain channels over time among the participants in a social system.

Overall, up to now, the innovation and development of education, from a practical and theoretical research has made great progress, but still lack of macro understanding about instructional innovation. Educational innovation is a systematic process, requires in-depth analysis and research. Therefore, based on previous research and theory, this chapter tries to refine innovative features and innovative diffusion mechanism from a macro perspective, by studying innovative practice a typical case of China, which has great influence on contemporary educational innovation.

This chapter includes five parts. First part introduces general development of ICT supported instructional practice in China. Second part is on research design, including the research framework and research methods. Third part introduces current innovative instructional models and practice in the K12 mainland of China. Based on the study of typical cases, the fourth part analysis the main characteristic of innovative instruction in China. The last part discusses the focus point of government, scientific research institutions, and practitioners in the diffusion process of innovative instruction, and typical model of education innovative diffusion in China. This chapter not only analyzes and summarizes the nature of Chinese education philosophy and innovative diffusion strategies based on case study, but also analyze instructional innovation from a macro view, which has certain reference and enlightenment in instructional innovation for each country.

2.2 Development of ICT Supported Instructional Practice in China

Along with the process of social transition, educational transformation, and spreading of ICT in society, the development of ICT in education in China mirrors its international development. If we consider the proclamation that "computer education should start from children" by Deng Hsiao-ping as the starting point of ICT in education in China, it can be divided into four phases: (1) *Instruction of computing as a discipline* starting from the end of 1970s, (2) *Computer assisted instruction and management* starting from the middle and late 1980s, (3) national initiatives focused on *ICT construction of infrastructure in education* since late 1990s, (4) national projects of ICT in education focused on *improving capacity of using ICT* since 2005 (Huang et al. 2006).

Since 1970s, a series of national projects and policies of ICT in education have been implemented, laying a solid foundation for its sustained development (Meifeng et al. 2009). From the changing process of education technology infrastructure in primary and secondary schools, China has experienced the development process of countries to promote the building of audio-visual education facilities to the computer and network-based modern education technology facilities. After the year of 2000, ICT in education in China has entered the phase of comprehensive and rapid development. Due to the implementation of national policy and the follow-up of government special fund, the launch of "school-to-school" project inspired a flood of the construction of ICT-based education in primary and secondary schools and the investments of ICT-based education also bullish all the way. For the clear and specific time requirements, a large number of schools began to speed up the purchase of equipment, build computer lab and construct the campus network and metropolitan area network (Huang et al. 2007).

In 2012, the Ministry of Education of the People's Republic of China issued "*National Development Plan for ICT in Education (2011–2020).*" This plan makes an overall design and comprehensive deployment for the next 10 years of ICT-based education work. Its basic objective is to build an ICT-based education system which covers all levels of urban and rural schools, promote the deeply integration of ICT and instruction to realize the comprehensive innovation of education thought, idea, method, and means by improving the quality of education, promoting educational equity and building a learning society (MOE of P.R.C 2012). By the end of 2014, the proportion of learning terminals ownership is 10 %, funding of ICT in education accounts for 11 % of total education funding. Nearly 30 % of primary and secondary schools have school-based digital repository, about 70 % of schools can share resources through the campus network. 80.6 % of primary and secondary schools realized Internet access, 59.6 % of ordinary classrooms have been equipped with multimedia teaching equipment in the whole country.

As for the great improvement, China is strengthening international exchanges and dissemination. There are also many innovative instruction practices emerged. In May 2015, UNESCO's *Conference on ICT and Post-2015 Education* was held in Qingdao.

The conference seeks to create an interface between education and ICT sectors to debate on how ICT can be leveraged at scale to support the achievement of post-2015 education targets. Under the core theme of leveraging ICT to support the achievement of post-2015 education targets, the conference looks forward to debates, shares the cutting-edge knowledge and ICT solutions, and devoted deliberation on sector strategies. In order to showcase the recent development and achievements of ICT in education, most of the Chinese provinces and Municipalities recruit and select some typical representatives of innovative instruction practice and demonstrate all these cases during this conference.

The authors collect all those cases as object of study in order to make sure the characteristics and diffusion mechanism of Chinese innovative instruction practice in K12. Before this chapter, a preliminary study indication has been done. According to the diffusion scale, all the educational innovations can be divided into three categories: (1) *large scale of diffusion* includes innovation and transformation of teaching resources and teaching processes; (2) *medium scale of diffusion* includes motivate educational approach, curriculum provision, and alterative learning environment; (3) *small scale of diffusion* includes systematic instructional design, learning evaluation, social learning activities, etc. It is also obvious that large scope refers to the innovations that can be carried out in most schools, the medium scale refers to those that can be conducted in one part of schools, and the small scale refers to those that can be conducted in some high quality schools. Although there are obviously differences, all these educational innovation practices make great effect and diffusion in these three different levels. There is more in-deep research to be done to make sure the rules of innovation and diffusion mechanisms.

2.3 Research Design

2.3.1 Research Framework

The needs for innovative education coming from economic and social development become increasingly urgent, and require suitable measures of reforming from the aspect of instructional process, teaching mode, instructional structure, teaching method, learning content, etc. As the influence of ICT in education has become increasingly obvious, it also has different levels of influence on the educational innovation at the same time. Innovative instruction practice is the core of education reform; the traditional education is mainly about teachers' knowledge transformation while the new teaching mode is given priority in the learning process.

In fact, there is no sole or single innovative way. According to the previous analysis, we can find all the innovative practices that can be categorized into eight dimensions. In order to analyze the main characteristics of variety innovation, this study defines eight types of educational innovation as Dimensions of Innovation listed in Table 2.1.

Table 2.1 Analysis dimensions of educational innovation

Diffusion scale of innovation	Dimension number	Dimensions of innovative instruction
Large	D1	High quality digital learning resources
	D2	New teaching and learning process
Medium	D3	High motivative educational approach
	D4	Multi-optional curriculum
	D5	New learning environment
Small	D6	Systemic instructional design
	D7	New evaluation and assessment
	D8	Social learning interaction and activity

2.3.2 Research Methods

There are many factors related to implement successfully an innovative instruction. According to the framework with eight dimensions of innovative instruction, this paper choose some typical representative cases from the excellent cases which are collected with reliable information during *UNESCO's Conference on ICT and Post-2015 Education*. General information of eight cases is listed in Table 2.2.

Table 2.2 General information of selected cases in the study

Dimension	Name of school	Instructional features	Typical of school	Innovation diffusion area
D1	Case1: Chengdu No. 7 Secondary School, Sichuan Province	High quality schools live satellite synchronous classroom	High school	West China
D2	Case2: Changle No. 1 Middle School, Shandong Province	Flipped classroom teaching	High school	Southwest China
D3	Case3: Jingshan School in Beijing	Intelligent robot activity	Full school (grade 1 −12)	East China
D4	Case4: Wenzhou middle school of Zhejiang Province	Maker space	High school	East China
D5	Case5: Zhengzhou No. 2 Middle School, Henan Province	Teaching by tablet computer	High school	North China
D6	Case6: Harbin Xiangbin primary school, Heilongjiang Province	Competency-based learning supported by ICT	Primary school	Northeast China
D7	Case7: Network evaluation system of Tsinghua University	Self-enrollment and selection of personnel evaluation system	High School	East China
D8	Case8: Zongbei primary school in Chengdu, Sichuan Province	Collaborative computer-supported learning	Primary school	Southwest China

We summarize lots of theoretical knowledge-books which have guiding significances on the research through sorting, analysis, inductive thinking, and summary. The literatures help us understand the perspectives and ideas of the related researches in domestic and foreign countries.

In this chapter, we collect sufficient information of the cases through various channels. Through the analysis of the model and effect of different types of cases, we try to reveal the characteristics, unique value, and internal rules of innovation and diffusion by using qualitative analysis method to sum up and reveal the new instruction practice.

2.4 Current Innovative Instructional Models and Practice in K12 in Mainland of China

2.4.1 High Quality Digital Learning Resources

At present, China has more than 10 million teachers, but the teachers' shortage is still critical. Thus, the share of teachers becomes a necessary and vital issue in China. The way of long distance live-transmission turns teaching resources into high-quality digital resources to share for a larger scale. In China, the model of long distance live-transmission classroom has been widely recognized, which makes schools share qualified teachers to solve the teachers' shortage.

(1) Scenario

In China, teachers' level and education level has a large gap between different areas. In order to take high-quality resources to rural and remote areas, the school of case 1, as a high-quality school, through the use of long distance live-transmission classroom to share good teacher resources to substandard school, where mainly concentrated in Yunnan, Guizhou, Shanxi, Sichuan, etc.

The whole teaching processes are delivered by Chengdu No. 7 Secondary School including the teachers' interactive white board, video, and voice. Moreover, Chengdu No. 7 Secondary School can have live interactive lecturing conference with these schools and teaching, lesson preparing, practicing, and testing are all synchronous in schools. To guarantee the quality of teaching, every lesson should be a collaborative work by monitors, instructors, subject teachers, and technical assistants.

(2) Model

Depending on specific teaching aims, live-transmission and synchronous classroom teaching usually have two different ways to implement about individual themes of collaboration and regular classroom collaboration. The main process is as follows:

First, setting up essential facilities is needed. In order to achieve real-time interactivity, the designated classroom should be equipped with computer network broadcast systems, camera, microphone, speakers, and other facilities.

Second, making synchronous teaching plan is oriented by center school. The remote school would carry out synchronous classroom according to the teaching plan. During synchronous classroom, the course is taught by teachers of center school and other schools' classroom connected to the center schools' classroom via live system, which can achieve interactivity.

Finally, based on their actual situation, the remote school raises issues and communicates with central school to facilitate remote synchronization teaching to reach optimal effect.

(3) Benefit

- Reducing the gaps of education resources between urban and rural areas.
  Sending high quality of teaching to distal school narrows the gap of education level between urban and rural areas, such as Chengdu No. 7 Secondary School uses regional fiber optic network, satellite network to provide services of classroom synchronization to nearly 20,000 students, 142 schools, including Yunnan, Guizhou, Tibet, Gansu, Shanxi and Sichuan Province countryside, etc.
- Improving teachers' professional level and promote teachers' professional development.
  To make remote synchronization carried out smoothly in the classroom, teachers need to work closely with both sides to share resources, experience, ideas, and promote each other jointly. In order to have a more in-depth understanding, the ICT application should be concerned.

2.4.2 New Teaching and Learning Process

The teaching and learning process is an important part to achieve the goal of education and it is also an important way to improve the quality of teaching. The traditional teaching process in general is as follows: the organizations of teaching, review inspection, teaching new courses, consolidation exercises and assignments. With the deepening reform of new curriculum, this teaching process gradually revealed its limitations. Appearance of flipped classroom subverts the traditional teaching process, which makes students to be the masters of learning and promote the development of students' practical ability and creative consciousness. In case 2, the teaching practice has changed based on the original process of flipped classroom, which is more indigenization.

(1) Scenario

With the depth development of ICT in education, "flipped classroom" as a new teaching model has become a hot topic of research and it has a significant impact on teaching reform of education.

The school of case two has 146 classes in 7–12th grades where flipped teaching has been implemented for all subjects. In their flipped teaching implementation, there are two stages: self-questioning and training-demonstrating. The self-questioning

stage consists of five segments, namely guiding the goals, self-learning the materials, assisted by micro video, cooperative learning, and online evaluation. The training-demonstrating stage also consists of five segments, which are breaking through the difficulty, training how to demonstration, promoting the cooperation, coaching the evaluation, and summarizing the reflection. Teachers have built a course resources system called "Studies the document + Micro-class + Instructional design." They have also created a teaching research system which includes curriculum establishment, school-based research, teacher and student training, and development of learning plan. An interactive digital learning platform has been developed for tracking students' learning process of recording, feedback, analysis, and evaluation (Fig. 2.1).

(2) Model

Pre-class, teachers need to design for self-learning resources according to the characteristics of knowledge such as video recording teaching by themselves or other teaching resources. Teachers based on their teaching experience record multiple versions of content to adapt to different needs of students. Before class, the teacher can use the network to support students' learning. Students can communicate with fellow students through message boards, chat rooms, and other Internet communication tools, which can promote understanding and learning between each other.

In-class, there is more time for teacher−student interaction, so teachers should take advantage of the situation, cooperation, conversation, and other factors to bring students' initiative into full play through designed activities. For example, teacher can carry out teaching activity to guide students to ask questions, analyze problems, collaborate, start brainstorming ideas, and share the product and feedback. Compared with traditional classroom teaching, in this session, the role and position of teachers has undergone great changes. Teachers need to increase the depth of discussion among students, which need to give more targeted guidance based on teacher–student interaction.

Fig. 2.1 Flipped classroom in Changle No. 1 Middle School

Post-class, students deal with learning contents and control learning progress by themselves. Teachers adopt the guidance and collaboration to meet the learning needs of students and personalized learning process.

(3) Benefit

- Improve academic performance
  Flipped teaching improves students' initiative. This knowledge construction strategy reduces the difficulty of knowledge and increases interaction between teacher and student, which can improve students' academic performance.
- Promote learning occurrence
  After class, student should learn by themselves according to high quality resources provided by teachers, which can complete the transfer learning process of knowledge. It enables students to follow their own pace to learn, and achieve one-to-one personalized guidance. When students need help, the teachers and other students would help them. Students can get instant feedback and correction. It enhances students' interest in learning and promotion in learning happens.

2.4.3 High Motivated Educational Approach

With the development of computer technology, bio-technology, mechanical technology, electronic technology, and other fields of knowledge, the intelligent robot research has become a hot issue. The purpose of robot course is to motivate students to take part in competitions. It stimulates students to pursue knowledge, which is an extremely effective educational approach to improve students' motivation. At present, China has emerged a group case of robots education practice as activity curriculum and organized many competitions to improve the students' enthusiasm to participate in them. The practice of case three has been widely recognized.

(1) Scenario

With the rapid development of communications technology, virtual reality technology, science and technology, and cognitive learning theory, robots have been developed to promote students' learning. The case three is a specialized education test in a primary and secondary school. In 2000, teachers participated in the training course on intelligent robots. After the training, they started to carry out scientific and technological activities using intelligent robots. Intelligent robots give students a panoramic view of ICT, and students can give full play to the imagination to develop a variety of intelligent product, which can cultivate their scientific and technical development ability.

After students finish working, they can participate in various scientific and technological activities, vehicle model competition, science and technology production competition, science and technology class meetings, computer robotics competition, etc. Students who win the competition will be given material rewards and honors, which can inspire other students to learn.

(2) Model

Students acquire knowledge through hands-on practice. They are like real engineers to select research themes for the project, plan, design, assembly, and test. The small groups use blocks, sensors, motors, and gear components to design their own robots, and write a program to control the product. The main flow is as follows: concept and analysis, and pay attention to their legitimacy; plan and design, students should conceive it based on design and use a pencil to draw up a draft and the teacher should explain the method during the process. Then the group works together to finish the task and then tested and commented under the guidance of teachers.

(3) Benefit

- Motivate student interest
  In robot teaching, the robot is just a carrier through which teaching and competition are carried out to effectively promote students' learning and motivation.
- Expand students' scope of knowledge
  Robots' teaching is not merely related to the content in the class, but also involves blended knowledge in other general curriculum, including energy, materials, tools, and design. Robot technology covers the basics of ICT and general technology, which can broaden students' knowledge.

2.4.4 Multi-Optional Curriculum

With the development of economy, science, and technology creative thinking and design ability in education gets more attention. Design-based learning is used to help learner acquire the knowledge and skills in various fields through integrating education-related aspects of innovation and professional knowledge. The traditional course can no longer meet the demands of students, and a multi-optional curriculum should be designed to find and satisfy demand. The instructional practice of case four creates Maker Educational courses, which can be described as a successful case and has been widely recognized.

(1) Scenario

With the 3D technology, open-source hardware platform has become more popular, the trend started to focus on the capability for personalization in recent years. In case 4, the school integrates design-based learning in the group activity to conduct the creative education. It provides a place for students to create, and a multi-optional curriculum to choose for students. The Maker Space was created by this school in October 2013. This space uses Arduino as the platform for the courses of Maker, which is suitable for large class teaching. Different hardware, such as Raspberry Pi, Banana Pi, pc Duino is used for the group learning demonstrations. 3D printers and laser engraving machines are also used for printing out students' works. The Maker Space provides students a place to transfer their creativity into real world objects as well as transforming Maker Education from theory to practice (Fig. 2.2).

Fig. 2.2 Maker space in Wenzhou Middle School

(2) Model

Design-based learning includes three basic components: (1) Conceptualization of the task: learners accept to the challenge from teachers, clearing tasks of project by brainstorming ideas, and possible solutions to solve the problem (2) Establishments and tests of the solution: learners choose a feasible method to design and create; forming models; learner show their products to others, redesign and modify the products according to others' proposal; retest. Learners continue to find the techniques and methods to modify the products. (3) Sharing and gaining the knowledge: through research, learners share solutions and discuss with others, which can acquire more knowledge. In this model, teachers ask students to design a material object by themselves, such as a car model, in order to inspire students to have their own knowledge and skills for designing and implementing their design plans. In the process of implementation, students can keep learning new knowledge and skills through the continued modification and redesign of their design plans.

(3) Benefit

- Be conducive to individualization development
  Multi-optional curriculum encourages students to follow their own interests to choose. It helps students develop their interest and promote the individualization development.
- Improve students' interest
  Maker Education breaks the way of traditional teaching, by a series of experience and achievement, so that students can learn in a more active learning environment, which enhances the students' interest.

2.4.5 New Learning Environment

The emergence of printing greatly contributes to the development of human culture, since people could record the practice or skill and develop some technical knowledge preserved in the form of text. In the Information Technology Environment, intelligent multimedia educational software has good interaction. Presenting teaching content by sound, animation, high-quality video, audio can be more dynamic, and visualization. For example, new learning environment like tablet PC, not only makes learning more self-directed, but also more free and diverse. Learning behaviors can be more individual and cooperative. In case 5, the tablet PC has been used as a normal tool in the new learning environment and have won initial success.

(1) Scenario

Currently, it has been tens of thousands of classes using iPad and other mobile devices to teach in China. These types of classes could access to networking, digital learning resources and students have high participation.

Experimental educational innovation of ICT in the school is the fundamental method to promote changes in teaching concepts and teaching methods. In case 5, the school received special attention and support from Apple (China), and established a strategic partnership with Henan Normal University, East China Normal University and other research institutions. With the support of researchers, this school has implemented a self-regulated learning model by using ICT. Nearly 78 classes, 217 teachers, and 5000 students have already started using that in this school. The school has set up ICT innovation experimental classes, in which each student is provided with a free tablet to build e-learning environment. The resources of instructional design, courseware, teaching cases, and reflection have been integrated in a platform to facilitate mobile self-regulated learning. Students regulate their own learning and the teacher can track students' learning processes and performance. The school provides "four types of lessons" which include prerequisite lessons, feedback lessons, reflection lessons, and practice lessons. This new type of learning environment enables students to learn more independently.

(2) Model

First, the teacher should define the teaching topic, construct the teaching situation and teaching content, and develop digital teaching resources based on mobile devices. Second, the teacher defines the appropriate learning tasks for each study group. Moreover, providing students with learning resources, organizing students to carry out inquiry-based learning and discussion. The last thing is to provide concentrated guidance comment on the results of the discussion for students and form evaluation reflection.

(3) Benefit

- Improve academic performance
  By using tablet PCs, teachers can convey the resources to students in advance. It can also take advantage of audio and video tool to record students' oral and situational dialogue, and presentations allow students to complete work and

display their outcomes. It improves students' cognitive competence and enhances teaching efficiency. Meanwhile, the tablet enables students have individual learning and evaluation, which makes teaching more targeted.

- The transformation of roles between teachers and students
  Mobile devices increase the level of independent learning. Teachers start to guide students to learn, and students, as masters of learning, strengthened their learning initiative, which are transforming the role of teachers and students effectively.

2.4.6 Systemic Instructional Design

Systemic instructional design is important in instructional innovation, which highly requires the teachers' teamwork. Instructional system design is mainly to promote learners as the fundamental purpose. It can apply teaching theory into the teaching objectives, teaching content, teaching methods, teaching strategies, teaching evaluation and create an effective "process" or "procedure." Systematic instructional design can improve teaching efficiency in classroom, and promote students' understanding and application. In case 6, the school summarizes the systemic instructional design for their school, which has achieved certain results and drawn greater attention.

(1) Scenario

Case six has sorted out the knowledge system of various disciplines based on the development rules for the discipline competency. The individual learning activities are supported by ICT to design systemic instruction and develop the competency-based learning for improving the core literacy of students in the twenty-first century. The school has developed successful models of competency-based learning for the disciplines of natural science and social science through many years of practice. Students have been trained to have the abilities of independent observation, active thinking, good communication skills, and knowledge building collaboration through the implementation of ICT. In classroom teaching, the five teaching activities, namely the problem-driven, the idea discovery, the experience exploration, the sharing outcome, and the comprehensive implementation, guide students to gain the above abilities. The experience of this school's success in using ICT in education can be illustrated as phase-by-phase promotion of ICT in education, as shown in Fig. 2.3.

(2) Model

Problem-driven: Design learning problem or task helps to stimulate students' interest. The task should not be fully resolved with prior knowledge, and require a structured multidisciplinary knowledge.

Idea discovery: Supporting students to discover the application of existing knowledge and complete the task during the process, students find some unsolved

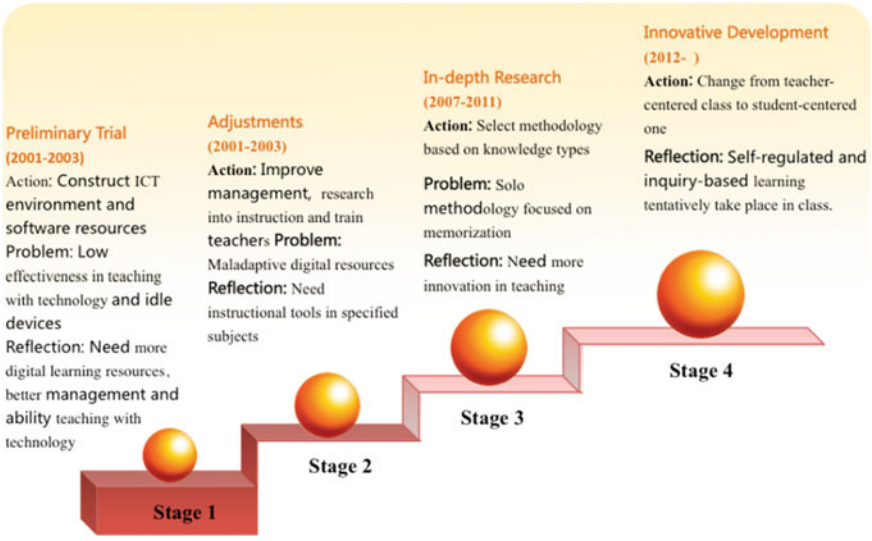

Fig. 2.3 Phase-by-phase promotion of ICT in education in Xiangbin Primary School

questions and they explore and summarize what knowledge can be used to solve the questions under the guidance of teacher.

Exploration and experience: Providing appropriate environment and tools or the resources contribute to the understanding of knowledge, which can help students complete the construction of knowledge.

Achievement sharing: Sharing individual learning outcomes and promoting the growth of collective intelligence.

Comprehensive application: Training students to master knowledge by the complex issues and help them to be proficient.

(3) Benefit

- Promote students' understanding and application
  Systemic instructional designs give students the challenge to acquire systematic knowledge which improve their academic performance and enhance the interest. And students could have a deeper understanding of knowledge and facilitate to apply what they learn into practice.
- Develop students' capabilities
  This mode pays close attention to the competency-based learning which is essential to the development of students. It can solve common scarcity of learning ability, creative ability and practice ability to meet the need of social and employment market.

2.4.7 New Evaluation and Assessment

With the development of education, educational evaluation has got widespread attention. Traditional evaluation and assessment is mostly focused on the results instead of the learning process. A new evaluation method promoting students' sustainable development has become an urgent need to improve the quality of education. Therefore, we should establish a new evaluation and assessment of education, building students' development evaluation system. It not only promotes students' well-around development, but also enables evaluation more objective and fair. Practice of case seven makes college enrollment become more equitable and effective.

(1) Scenario

China's college entrance examination has many limitations, and the lack of comprehensive and process evaluation comes first. Supreme mark aggravates the unfairness of the competition of the entrance examination. And teachers teach for the sake of the students' high scores and neglect the needs of students and the function of testing. Tsinghua network evaluation system sends profiles to the college admission office and the profiles are reviewed by the network evaluation committee experts, which can be used for the students' enrollment. Network evaluation is divided into two main levels, including "basic knowledge and basic skills assessment" and "online research." The online research encourages students to choose the subjects by themselves, especially combine with the technology research activities, computer activities, essays of arts activities, which was carried out by the university. The "network evaluation" truly becomes an evaluation system, which combine high school teacher with experts working together to guide the process of education. The evaluation results will be an important reference for Tsinghua University to enroll the students. Currently, Tsinghua University has invited four science experiment schools, including Tsinghua University High School, Peking University High School, Beijing Normal University Affiliated Experimental High School, and Huadong Normal University Affiliated 2nd High School to join in the comprehensive quality assessment project.

(2) Model

Network evaluation system uses servo recommendation. First, the submitted students' work will be recommended by an assistant professor. Then a professor will give further recommendation. In the end of the academic activities, professors give comprehensive performance evaluation and recommendation according to the students' behavior during the event.

At the end of the whole event, the file which acquired comprehensive recommendation access to a number of professors' summative assessment. The final qualified files will be sent to the University Admissions, which is used for selection of talents for university.

(3) Benefit

- Ensure the scientific selection
  This new evaluation tool greatly reduces the complexity of the process evaluation, which increases the efficiency. It is more focused on the learning process, making evaluation more objective and scientific. What's more, the assessment of process betters the teaching through consistent feedback possessing and all-sided characteristic.
- Benefit the students' all-round developments
  In the process of industrialization, the education reform of China must implement competency-based education, and this evaluation method is not only focused on students' knowledge, but also paying close attention to their comprehensive quality ability. It makes it possible to combine the process evaluation with formative evaluation and measure cultivation of the students' all-round development.

2.4.8 Social Learning Interaction and Activity

With the progress and development of society, the cultivation of twenty-first skills has become a key point. Social learning activities improve the communication between people and acquirement of new knowledge. The plan of collaboration and establishment guides students to actively construct learning, and cross-discipline knowledge building expands students' learning experience to develop twenty-first century skill. Practice of case eight describes that the school builds a collaborative knowledge construction platform, to support social learning interaction and activity.

(1) Scenario

Since August 2010, the school of case eight has provided a collaborative computer-supported platform, called Knowledge Forum. In this forum, students are guided to collaborate and interact in groups for co-creating group knowledge. For example, in geography classroom of 5th grade, a student proposed a question, "If I was running faster than the speed of earth's rotation, what would happen?" The teacher then guided students to expand this question in this forum for launching conversations and discovery activities. Students post their own ideas and opinions in this forum publicly and share their comments, questions, improvements, and summaries, and then achieve the goal of knowledge sharing. The philosophy adopted here is that learning should be "posting your own ideas" and that teachers are not only ones who teach in the classroom.

(2) Model

Collaborative knowledge construction teaching process generally includes five steps: ① Students grouping: the teacher divide students in different study groups according to gender, interests, learning standards, communication skills, a sense of discipline, etc.; ② Goal determination: teachers and student jointly develop learning

goals for each lesson according to the outline of requirements and the practice in the book; ③ Methods teaching: teachers should provide students with the transitional bridge from the known to the unknown and students learn to think the teaching content independently; ④ Cooperative learning of groups: teachers take part in group learning and make the necessary guidance and regulation in the group learning process; ⑤ Comments and conclusions: after every group present their outcomes, the teacher should give guidance and reflection about the learning performance.

(3) Benefit

- Promote exchange, learn from each other and develop twenty-first century skills
  Collaborative knowledge building can promote students to communicate with other learners, and learn to absorb the useful perspectives of others to enrich the knowledge, thus inspires the learners' emotion and involvement in the learning process. Knowledge accumulation and sharing in collaborative learning are the core capability in the digital life, through which the positive teaching effect is achieved.
- Changing traditional roles of teachers and students
  Taking part in cooperation, students have a greater sense of responsibility and obligation to finish their task and they are more concerned over each other. Students have the initiative to study, which transforms the teacher's role to be an organizer.

2.5 Main Characteristics of Innovative Instruction in China

By further analyzing the content of these eight cases above, we summarize some key points of education practices, which mainly include Change Facilitator, Intention of Change, Instructional Model, Instructional Process, Learning Outcomes Targeted, and Benefit. These points of each case are shown in the following table (Table 2.3).

The theory of Innovation Diffusion is associated with the aspects of change facilitator, intention of change, instructional model, instructional process, learning outcomes targeted and benefit which are mentioned above in different degrees. Different change facilitator makes different impact on the corresponding purpose and the innovative diffusion scopes and effects. Different intentions of change also make different impacts on the instructional models and benefits of educational innovative diffusion. It will be analyzed in detail in "Influence Factors of Innovative Diffusion" part and "Typical Diffusion Model of Education Innovation in China" part.

Table 2.3 Main characters of innovative instruction

# of case	Change facilitator	Intention of change	Instructional models	Instructional process	Learning outcomes targeted	Benefit
Case 1	Practitioner	Educational demands	Live-transmission and synchronous classroom of high quality schools	(1) Setting up essential facilities	Acquirement of knowledge	Reducing the gaps of education resources between urban and rural areas, improving teachers' professional level
				(2) Making synchronous teaching plan		
				(3) Developing synchronous classroom		
				(4) Sharing high-quality resources of examinations and lesson preparations		
Case 2	Practitioner	Educational demands	Flipped teaching	(1) Pre-class: teachers record micro-lectures in advance and students learn these micro-lectures by themselves	Acquirement of knowledge, basic capability	Improving academic performance, promotion in learning happens
				(2) In-class: teacher and students communicate and interact to consolidate knowledge		
				(3) Post-class: students deal with learning contents and control learning progress by themselves		
Case 3	Practitioner	Development of new technology	Intelligent robot activity	(1) Drawing the draft through design and analysis	Innovative capability	Developing students' innovative capabilities, expanding students' scope of knowledge
				(2) Assembling robots by group cooperative learning		
				(3) Testing and making comments		

(continued)

Table 2.3 (continued)

# of case	Change facilitator	Intention of change	Instructional models	Instructional process	Learning outcomes targeted	Benefit
Case 4	Practitioner	Development of new technology	Design-based learning	(1) Conceptualization of the task	Development of personal capability and interest	Improving students' interests, developing students' innovative capabilities
				(2) Establishments and tests of the solution		
				(3) Sharing and Gaining the knowledge		
Case 5	Research institute	Educational demands	Teaching by tablet computer	(1) Defining the teaching topic and developing digital resources	Acquirement of knowledge, basic capabilities	Improving academic performance, transforming roles between teachers and students
				(2) Refining the detail of learning tasks and providing learning resources		
				(3) Organizing inquiry-based learning and discussion		
				(4) Provide concentrated guidance		
Case 6	Research institute	Educational demands	Competency-based learning supported by ICT	(1) Problem-driven	Promoting the understanding of knowledge, application, and migration	Improving students' interest, developing students' capabilities
				(2) Idea discovery		
				(3) Exploration and experience		
				(4) Achievement sharing		
				(5) Comprehensive application		

(continued)

Table 2.3 (continued)

# of case	Change facilitator	Intention of change	Instructional models	Instructional process	Learning outcomes targeted	Benefit
Case 7	Research institute	Educational demands	Self-enrollment and selection of personnel evaluation system	(1) Reviewing works of students	Basic capabilities	Scientifically selecting talents, leading students developments all-round
				(2) Recommending by an assistant professor		
				(3) Recommending by a professor		
				(4) Comprehensive assessments, the final assessments of comprehensiveness recommended by many professors		
Case 8	Research institute	Educational demands	Collaborative computer-supported platform	(1) Arranging students in group	Acquirement of knowledge, basic capabilities	Promoting the communication, developing twenty-first century skills, changing roles between teachers and students
				(2) Determining the goals		
				(3) Teaching relative methods		
				(4) Cooperative learning in group		
				(5) Making Comments and drawing conclusions		

2.5.1 Impact of Innovative Instruction

From the perspective of sociology, the core concept of research is through the symbol of writing materials such as slogans, regulations, documents or even literatures to explore practical behaviors, and then reflect the core idea or notion by these, as shown in Fig. 2.4. In this chapter, we summarized the behaviors' effects and influence of different cases from the characteristics above, it will help to promote the development of practices of innovative instruction in macro level.

(1) Promoting Educational Equity

Promoting educational equity is the foundation of innovative instructional. Currently, the problem of unbalanced social and economic development in different regions and between rural and urban areas still stands out in our country even in the world. More than 30 % primary and secondary schools are distributed in rural areas; because of the restrictions of the geographical position, school conditions and teachers' level in those rural schools, there are huge gaps of educational quality between urban schools and rural schools. Therefore, promoting the balanced development in regional or urban-rural areas disparities is the focus of basic education policies of the government. The innovation of districts' management system is not the average allocation of educational resources simply; it is to improve school-running standards and education quality synchronously. Normally, the college entrance examination system in China only pays more attention to students' scores and ignores their performance of learning. So the innovative instructional practice such as long distance live-transmission classroom and online evaluation enrollment system are all welcome.

- Long distance live-transmission classroom
  Through the ways such as long distance live-transmission classroom or online classroom high quality resources can be shared to rural students and teachers. In

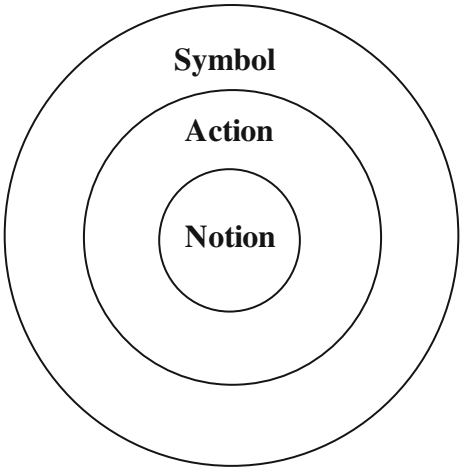

Fig. 2.4 Three layers of study on theory of sociology

these ways it can narrow the educational gap of different regions, urban and rural or different schools and promote educational equity.

- Online evaluation enrollment system
  By the online evaluation and enrollment, educators can have a comprehensive understanding of student's performance. It is the selection of combining formative evaluation and summative evaluation that pays more attention to the students' ability and comprehensive quality and helps to keep equity in the process of selection.

(2) Improving Educational Quality

In order to drive the development of society, it is the necessary to improve the overall quality of laborers. Many changes and characteristics of laborer's quality are presented along with social transition and economy development. With the development of ICT, practices of innovative instruction began to emerge constantly, which aim to enhance education quality. Those practices include Flipped Teaching and Knowledge Construction with mobile devices such as tablet computer, etc. These new teaching methods not only promote students' learning and understanding but also improve qualities of instruction.

- Flipped teaching
  Flipped teaching transforms the teaching process of traditional classroom. Students study after class, and teachers make full use of time in class to provide guidance to every student. It improves the efficiency of class for the videos of before class are the essences limited in 5–7 min. It also promotes teacher paying more attention to students, improving their professional development as well as improving the quality of teaching.
- Teaching by tablet computer
  Teaching by tablet computer not only enables students to learn at anytime and anywhere, but also improves learning efficiency and exercises the students' ability of self-regulated learning. Embedded resources to students' tablets can reduce preparing time and improve students' learning interest, thus improve the teaching quality.
- ICT-based knowledge construction
  ICT-based knowledge construction can enhance the classroom efficiency. It makes each student can raise their own views and opinions online and have more interaction between the students. Teachers can also provide the targeted guidance to the problem and it can help to improve the efficiency of the courses and the teaching quality.

(3) Cultivating Creative Ability

Cultivating creative ability is the most urgent task of education in the social transformation. Social transformation is the transition process from traditional to modern in which social economic structure, people's behavior and value system may change obviously. Education as a social activity aimed to cultivate people should meet with the requirements of the society and promote the socialization of people. As China transformed from a planned economy to market economy, the

transformation of economic structure caused the transformation of social structure. The cultivation of creative ability has become the most urgent task in twenty-first century in China. In the aspect of basic education, the teaching goals of some innovative instruction practice had already begun to transform from imparting knowledge to cultivating ability in China, for instance, Maker Education, robot activity, competency-based learning, problem-based learning, etc. Through the cultivation of creative ability, we can arouse students' creative consciousness, cultivate students' creative spirits and improve students' creative ability. It can also make students become the creative talents in the twenty-first century and promote education reform and social transformation.

- Maker Education
  The Maker Movement is a technological and creative revolution underway around the world. Maker Education is a new way of cultivating creative ability. Under the guidance of teachers, students find problems in daily life and do some designs, creations and hands-on operations. Students can solve the problems by completing works. In this way, it not only improves students' learning interest, cultivates students' abilities of finding and solving problems, and the most important is that it can cultivate students' creativity.
- Motivate Educational Approach
  Motivate Educational Approach such as Robot teaching activity is a kind of education activity which based on ICT and higher than the ability of ICT. It can come into contact with a panoramic view of ICT. Through the completion of works and the organization of competition, it improves students' interest effectively and boosts students' learning motivation.
- Competency-based Learning
  Competency-based learning develops knowledge-connected teaching model by integrating multidisciplinary contents. It is helpful to cultivate students' comprehensive abilities systematically. According to development rules of student, it analyzes the inner link of multidisciplinary knowledge system and provides learning activities which needed the application of advanced cognitive thinking for students in problem-solving mode to promote the development of students' innovative ability.

2.5.2 Influence Factors of Innovative Diffusion

Innovation is the focus of education. The development process of innovative instruction may be affected by many factors. Such as education institutions or enterprises supported by government, the school itself, technical innovation and the education demand, etc. Due to the particularity of China's national conditions, government plays an important promoting role in educational innovation. But the cooperation between education research institutions and enterprises can make a big

influence on educational innovative diffusion. In schools, the experiment teams need to consider their own school equipment's technical conditions and education needs, and should ask external forces for help actively. The influence factors of educational innovation diffusion also include innovation of technologies and educational demands. It affects the government's policy orientation and provides the direction of researchers and experiment teams, as shown in the Fig. 2.5.

(1) Government-supported Educational Institutions and Enterprise

Government-supported educational institutions cooperate with enterprises to promote the development of educational equity. ICT in education is an effective means to promote educational equity and improve educational quality. ICT in education can spread high-quality digital educational resources to rural and remote areas quickly and easily at lower cost and achieve the sharing of high-quality educational resources quickly. Supplemented by the corresponding management measures, it can improve teaching standards in rural areas in a short time at a low investment. And it can narrow the educational gap of different regions, urban and rural or different schools and promote educational equity and improve educational quality.

Government plays different roles in the educational innovation, including acting as policymaker, facilitator and coordinator. Government plays an important role in innovative instruction system. It is an important organizer of educational innovation.

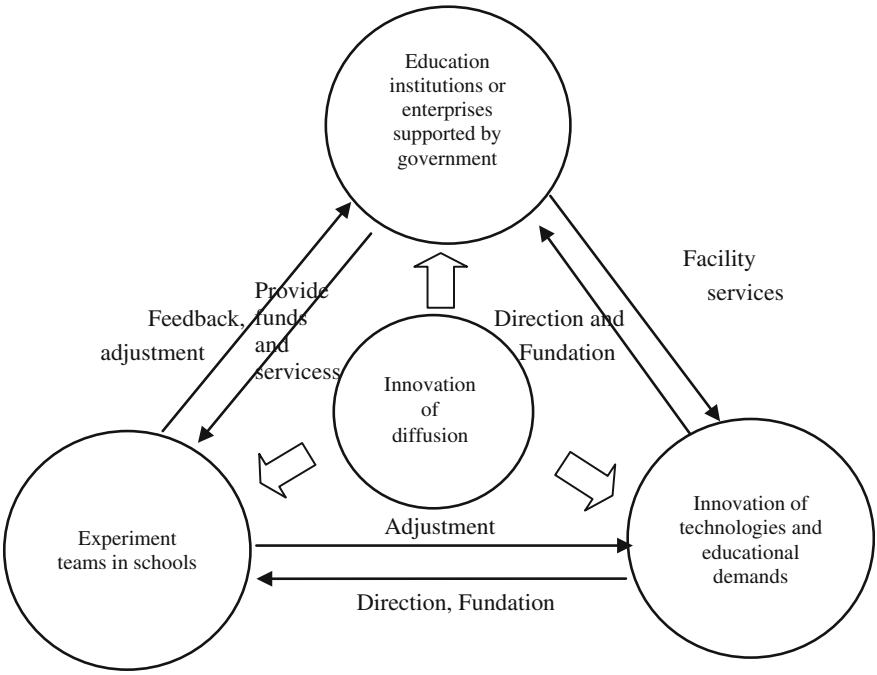

Fig. 2.5 Influence factors of innovative diffusion

There are fundamental assurances of the successful implementation of educational innovation in world's leading innovative countries and regions such as clarifying main responsibilities of government in the implementation of educational innovation, establishing the leading role of government and developing policies, regulations and institutions in order to ensure the well operation of the educational innovation.

It is important to provide educational services and learning support services, which is the key to the successful implementation of distance education in elementary and secondary schools and even more crucial than the learning support services for higher education. Therefore, the operation of model requires specialized agencies or organizations to provide teaching and learning support services. The enterprise has some abilities to provide the teaching services and can take the advantages of their provision of user services and management of customer relationships.

The live-transmission classroom of case one is mainly advanced by Chengdu No. 7 Secondary School, remote schools and Oriental Scent Company trilateral cooperation. Chengdu No. 7 Secondary School is mainly responsible for providing instruction and resources, Oriental Scent Company is mainly responsible for the market and supportive services, and remote schools are mainly responsible for running of live-transmission classroom in their schools and management of students and they are also providing the support for students' learning. In the service of live-transmission teaching, the school is responsible for teaching input, teaching activities and management and Oriental Scent Company is responsible for the investment of equipment and technology and the management activities. The main functions of remote schools' teachers in the "four-in-one" mode are: preparing lessons earnestly and make full preparation for teaching; cooperating with the teacher actively in the class, managing classroom and assisting teaching to show the specific "double-teachers effect" of the teaching in network by multimedia demonstration class; completing the homework correction and after-school tutoring for students. This model can achieve the construction of teachers' community of practice and it can take their own advantages of the three parties of cooperation. It also combines with their respective needs closely. This kind of cooperation model can motivate participants' abilities and improve the effect of cooperation.

Now only a few schools' conditions can support the implementation of flipped teaching, a lot of schools' teaching conditions such as technology, funds, management are not enough to support the implementation of a large-scale flipped teaching. So the large-scale promotion of flipped teaching needs to wait for the right time, thus we should strengthen cooperation with the third-party companies. The flipped teaching of case two cooperates with a third-party company to develop the "Sunshine Micro-lecture" platform based on network environment. In this case, the company freely provides 240 customized tablet computers according to the experiment and then students use their own portable terminals for self-directed learning. This not only achieves the implementation of platform for the flipped teaching, and it also provides technical supports and service guarantee continually.

This kind of cooperation is the foundation of schools to carry out flipped teaching smoothly.

So, departments of government should establish a management mechanism of collaboration and schools should strengthen the cooperation with companies. In the aspect of organization and management, government departments should take the responsibility for clearing the development direction and promoting overall plan and coordination. It is necessary to establish a "multi-stakeholder" operation mechanism of ICT-based the construction of education. The government should explore and form the arrangement of social parties to participate in education ICT-based system, arouse the enthusiasm of participation in education ICT-based and take advantage of market allocation and professional services of some institutions. The resources and funds of schools are limited, the government and enterprises should provide appropriate supports and help them.

(2) The Experimental Team in School

The experimental teams in school with external forces for help actively is one of the influence factors of educational innovative diffusion. Promoting an innovative activity in a school without any experiments is a risky behavior. Through the establishment of experimental teams, school can conduct teaching experiments in some subjects or some classes. In this way, the school can try ICT-based teaching innovations and make comparison with traditional teaching modes and experiencing the advantages of ICT-based teaching.

The experimental team should be guided by the leader teachers who should play the role of opinion leaders. Interpersonal relationship channels are more effective to form and change the innovative concept of individual and it will affect individual adoption or reject innovation decisions. Most individuals do not evaluate an innovative activity by the conclusions which are drawn from the experts' scientific researches, but evaluate the activity according to the subjective evaluations of their companions who adopted it. This is because that these companions played an exemplary role, other members will imitate their innovative behavior. Although the opinion leaders in innovative diffusion are not the people who own the right for decisions such as school leaders, they have high prestige in fellow teachers. If the models lead well, it will be conductive to the rapid diffusion of innovation.

School experimental team also needs to get the help of external forces on scientific and effective supports. For instance, schools can cooperate with colleges and research teams. In the case 6, the school cooperates with the information and technology institution of Northeast Normal University in 2005. In their cooperation, they experienced three phase, namely: initial attempts, reflection and adjustment, and innovation and development. The school uses resources to explore effective application methods of instruction and get scientific and effective support by this institution. Supported by the institution, the school established a leader group and had taken on national and provincial instructional research projects. They had cooperated by introducing synchronous classroom teaching resources, teaching training, experiment guides. In case 8, the school conducted an educational scientific research under the guidance of Dr. Chen Jingping who graduated from State University of New York in the United States in the autumn of 2010 (Li 2014).

The research required students to use the "knowledge forum" and conduct constructive knowledge learning and assessment in order to form a knowledge forum community where students can share and grow together. In this case, the scientific guidance promotes the innovative teaching methods conducted in the school smoothly. In the case 2, from summer vacation of 2013, the school organized some outstanding teachers into lead-organization team to make teaching plans. They worked out all teaching plans for different grades and made them become teaching resources in order to prepare for the implement of flipped teaching. In the case of Maker Education, for the limit of the documents and measures in the aspect of government and policies, the school of case four gathered a group of front-line teachers who are interested in conducting Maker Education set up the Maker Space. They explored how to build the Maker Space and conduct Maker Education in the existing conditions and search for help and develop positively in national scale.

Therefore, in order to generalize new ICT-based teaching methods we need to form experiment teams and through the core team to explore teaching organizational methods and efficient teaching models under different conditions of ICT and get external help actively. Research institutions can provide academic help and support, and enterprises can help the achievements in the direction of technology. Through the core team and external forces, it can explore the ICT-based education formation and application way with characteristics of the school itself and popularize it gradually.

(3) Technological Innovation and Educational Needs

- Technology drives the application

The continuous development of ICT and the emergency of new technologies expand the teaching and learning methods and scope, teachers and students have equal status to access information and it helps to build the new educational model which teachers and students interact actively. The depth and extensive use of ICT will change teaching mode and study style in existence. It makes the education transformed from teacher-centered to student-centered, from knowledge-transfer to ability and quality training and transformed from classroom study to learn from a variety of ways. Education will meet the demand of students and even the diverse and personal requirements of teachers better. Education will be more likely to reflect the basic requirement of morality education and achieve cultivation-orientation, priority of moral education, focus on ability and comprehensive development and it will try to provide appropriate education for each student and enable every child to be a useful person. In the case 5, the headmaster Wangrui thinks that mobile Internet technology breakthroughs constantly and tablets will be widely used; we should make full use of the ICT-based advantage, solve the problem that students' schoolwork are too much in current and change the traditional classroom mode. In September 2011, the school started to establish the ICT-based innovation class. They use mobile and tablet technology, explore the personalized teaching and reduce the burden of learning to promote students' innovative thinking and quality cultivating. The robot course of the school in case three uses robots at the ICT ideal teaching tools. The content of robot course covers

sense and control technology. Through teaching practice of intelligent robots, teachers have a new understanding of the connotation of ICT education and it drives the application of ICT-based equipment in teaching.

The progress of ICT causes a major reform in education and the traditional education and management ways are impacted a lot. The emergency of ICT leads educational model in modern transformed from the traditional educational model of classroom teaching to networked open educational mode and improves creative ability of students and teachers with the ICT in teaching innovation. The application of ICT in education is never-ending, the continually innovation of technology provides new methods of application and the new demand of education reforms and developments will also create new applications.

- Demands drive the application

Demand-drives application is the vitality of the development of ICT-based education. For transition of cultivation of talents in the twenty-first century and transition of demand, as well as the problem of our country's resources distribution inequality in currently, governments and schools have adopted a series of measures to improve the quality of teaching, which changed the traditional teaching model. Starting from the goals of teaching and demand of learners we can achieve them through the reform of teaching mode and learning ways. First, we should focus on solving problems in education reform and development and building applications in the field of teaching and learning. This application should be daily activities in teaching and learning which were widely participate by teachers and students, it should provide service of the whole process of teaching activities and it should transform and improve the existing teaching methods. Second, we should put forward and achieve new applications in the process of education reform and development continually. The remote schools in the case one have relatively small number of high-quality education resources due to the lack of teachers, and these schools need more and better education resources. Through the use of advanced ICT means, they cooperated with the school and built synchronous classroom. In this way, they achieve the sharing of high-quality resources and boost the development of education in the poor areas. The emergence of network-based evaluation system in case seven is because of low efficiencies and high cost of process including traditional academic lectures weeks, problems feedback, submissions and guidance of small thesis, interview activities and team cooperation examinations. Therefore, developing this network-based evaluation system to realize the automation of the process above not only reduce the cost, but also improve the efficiency of the evaluation at the same time.

Because of the particularity of China's national conditions, government plays the most important role in organization and implementation. In modern society, the primary responsibility for holding and initiating social welfare undertakings and public undertakings lies with the government. But even the government has its own holdbacks and it is often powerless to deal with many problems. Including research institutions and practitioners play different roles in educational innovative diffusion.

2.6 Discussion

Owing to the particularity of Chinese national conditions, government plays the most important role in organization and implementation. In modern society, the primary responsibility for holding and initiating social welfare undertakings and public undertakings lies with the government. But even the government has its own holdbacks and it is often powerless to deal with many problems. Including research institutions and practitioners, play different roles in educational innovation diffusion.

2.6.1 The Focus Point of Government, Scientific Research Institutions, and Practitioners in Education

Government, scientific research institutions, and practitioners play different roles in educational innovation diffusion. By the informatization of education, the government can quickly and easily disseminate high-quality digital education resources to rural and remote areas at a lower cost and can achieve the goal of sharing high quality education resource in a short time, combing with the corresponding management measures. Teaching standard of school in rural areas can be improved in a short period of time with a small amount of financial investment. The educational gap between urban and rural areas and between different schools can be narrowed, even promote education equity and quality. Research institutions promote the further application of new theory and technology and play a supporting role in schools, which can develop students' creative ability. Practitioners can effectively promote the improvement of the quality of education, because practitioners are the real workers. Schools and teachers should take effort to help student to acquire knowledge, develop moral ability, etc., and by means of original and scientific teaching methods and various teaching modes the students can learn how to communicate, make dialogues and cooperate in interactive practice. Education quality needs to be improved by optimizing the management system or training teachers. As mentioned above, the problems about education fairness, education quality, and student's creative ability can be solved by these eight innovative instruction practices. Because of the different goals, the main focus of government, research institutions, and practitioners in the problems of education fairness, education quality, and student's creative ability are different (Table 2.4).

Table 2.4 The focus level of government, research institutions and practitioners in the problems of teaching fairness, teaching quality, and student's creative ability

	Education fairness	Education quality	Student's creative ability
Government	High	Medium	Low
Research institutions	Low	Medium	High
Practitioners	Medium	High	Low

The perspective government focuses more on educational equality and also pays attention to educational quality. Increasing government educational investment is an important prerequisite for narrowing the gap between regions and schools, and is the key to promote educational equality. In longer term, if education investment is not increased, only changing the distribution model of the existing educational resources results in sacrificing the quality of local schools to achieve education equality. Or in the way to industrialization, the government is responsible for weak schools' education development and market is responsible for quality schools' education development, which cannot achieve the goal of education fairness development. Increasing government investment in education, especially in rural areas, less developed areas, K12 schools, to help them afford teacher's salary and let every child go to school and enjoy equal opportunities and educational conditions. Chinese government should keep disseminating public educational resources to rural areas, the central and western regions, the frontier regions and the minority regions. The government should gradually narrow the education development gap between urban and rural areas and between different regions, coordinating the pace of the development of public education. The education funding system and the education management system should be improved and the allocation of high quality education resources should be balanced. The government should take effort to optimize the allocation model to avoid the education gap caused by the differences in regional development. As to the educational opportunities, the government should provide the compulsory education opportunity to everyone, pay attention to the unbalanced development of regional education, and reveal individual equality and education fairness.

Research institutions are mainly focused on the cultivation of students' ability. The instruction under research institution's support is based on the idea of adapting to the new curriculum, innovative education model. The teaching suggestions are raised from the perspective of theoretical to promote students' comprehensive and sustainable development. Meanwhile, scientific researchers pay more attention to the cultivation of students' learning ability to meet the needs of their own and social development. Under the background of basic educational curriculum reform and student subjectivity's importance being increasingly advocated, the research institutions explore pertinently the practical patterns to bring students' subjectivity into full play, and embody students' individuality to make them actively and widely acquire knowledge.

Practitioner's main focus is the improvement of education quality, which is an important guarantee for the development of education requiring the efforts of all stakeholder including both teachers and leaders. The teaching quality means everything to a school, and improving the education quality is the main reason and final goal to each school's development. School management, moral education, and education teaching research, or building teachers' team, all need to focus on how to improve education quality. Teachers should combine their own development with social requirements, constantly update their knowledge structure, and arme themselves with new educational ideas to meet the requirements of the new curriculum reform. A solid foundation of the teachers is the prerequisite to improve their

ability, especially the ability to control the comprehensive problems and open questions. During daily teaching process, the teachers should be accordant with the requirements of the new curriculum standards, tamp foundation, and strengthen application. The teacher's idea of cultivating students' awareness and initiative need to be guided, while students' questioning ability and consciousness of participation need to be motivated. Through rigorous training, let student form a habits of hardworking, meticulosity, and elaborate, and enhance students' participation consciousness and questioning ability.

2.6.2 *Typical Model of Education Innovative Diffusion in China*

Governments can take different roles in innovation, from creating favorable conditions to foster leaders of innovation. They often take several roles at the same time, depending on their needs and the political interest in promoting innovation in the area in question. The policy recommendations cover all of these potential roles.

National policy documents that support the use of innovative teaching and learning exist in all countries and most countries reported some national-level program support for innovative teaching and learning.

The promotion of the Chinese government is an important driving force of the development of ICT in education. In the centralization model, the national government leads and guides the development process of ICT in education in Mainland China by providing financial support, policy guidance, project monitoring, management, evaluation, and other measures. From the perspective of effective implementation, the most distinguished characteristics of the state-driven approach are the speed, the broad coverage, and the operation by the administrative system.

Since the late 1970s, the modernization drive, the reform, and opening up to the outside world have transformed China's highly centralized planning economy into a market-oriented and a more dynamic economy. Acknowledging that over-centralization and stringent rules would kill the initiatives and enthusiasm of local education institutions, the national central government called for resolute steps in streamline administration and to devolve powers to units at lower levels so as to allow them more flexibily to provide education. Nowadays, the socialist state in China is transforming into an accelerationist state, with a neo mercantilist character, since the government is heavily involved in "market creation" and officials actively use their policy capacities to create, enhance, and maintain the "governed market" or "state-guided market" in China (Mok 2005).

The Diffusion of Innovation model of Rogers (1995) is concerned about planning and guiding organizational change processes to promote the adoption of new innovations. Understanding how early adopters will push organizational uptake of new products and processes, or how entrenched resistors or "persistent skeptics" can stonewall change, is important for change managers and will help to scale-up the innovation of ICT in education.

There are two diffusion systems (models) in society: centralized and decentralized models (Rogers 1995). The former is a classical diffusion model, spreading from a central source of innovation to the adopters; the latter, by contrast, means that innovation may not come from the formal research and development system, but often emerges at the operational level within the system through invention by some major users of the system. The decentralized diffusion model is constant with recent literature on diffusion of educational innovations (Developmental Education Task Force 2008; Bye et al. 2013). In the scale-up of innovative ICT in education, those two types of diffusion system are in co-existence. We call the centralized model as Researcher-Led Diffusion of ICT in Education (shown in Fig. 2.6), and the decentralized model as Practitioner-Led Diffusion of ICT in Education (Zhang 2009a)

The centralization diffusion system (Researcher-Led Diffusion of ICT in Education) is based on relatively linear, top down, and one-way communication. Due to the long-term effects of the traditional educational model, the high pressure of enrollment and academic performance and the generally poor learning environments of the schools, educators including teachers, administrators of school, or regional education organization have no time to work on the new methods, technology, and applications. Therefore, Chinese educational organizations highly rely on researchers as experts to design and develop the innovations. The source of innovation is derived from the technical or educational experts in the field of ICT in education. In the research community, through multiple channels, researchers create or recognize the innovations that are worth promoting and proliferating to the practitioners. Acting as innovation agents, researchers inform the policymakers and practitioners. Policymakers evaluate the value of the innovation, judge the feasibility of diffusion, control the funding (increased or reduced) by monitoring the diffusion process once they make the decision to promote, guide research community activities, or release new policy and regulations (such as incentive policies)

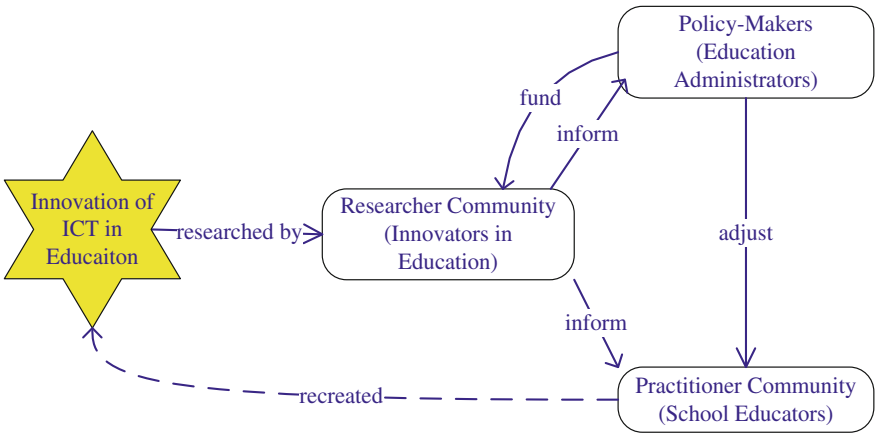

Fig. 2.6 Researcher-led diffusion of ICT in education

guiding practitioners' participation. In the process of adopting, implementing, and spreading the innovations, practitioners can also recreate or improve the innovation, thereby looping back to inform the next cycle of research.

The innovative diffusion in the perspective of practitioners, on one hand is the school level; on the other hand is the teacher level. There are two main types of school education innovation, one of them is the educational technology diffusion project mode that school actively seek external help, it is a typical "problem-solving mode." In this mode, the initiator of technology diffusion is school; after the assessment of what they need, the problem that urgently need to be solved is identified, get support from innovative institutions through seeking help from outside. Innovative institutions analysis the needs of schools, develop or select a certain innovative educational technology products for schools, achieve promotion in a large scale after a small scale of trial and modification; during the period of trial, innovation institutions may also provide support (Fig. 2.7).

In the process of the promotion, schools should establish innovative diffusion promotion team and put a key person in charge, this team should include a director in teaching and research section, technical support personnel, experiment teacher, etc. Continuously promote internal experimental activities and the relationship with external through frequently internal communication. The team has a strong spontaneity and autonomy, therefore can do a great job in promoting the project. First, the innovative diffusion promotion team gets support from the school by regularly reporting to the school leaders; second, when facing the problems in the experiment, the director in teaching and research section should seek help from innovation institutions; third, advertising and providing support to other teachers (Fig. 2.8).

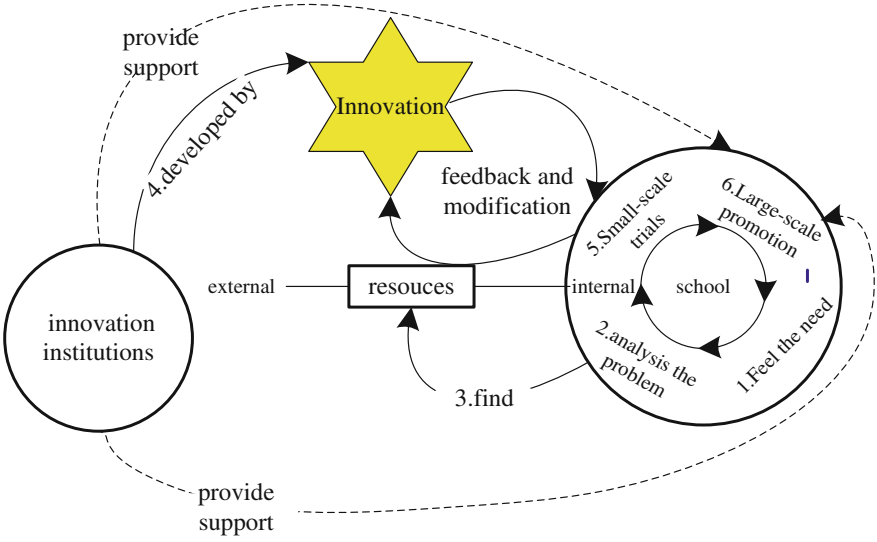

Fig. 2.7 School actively seek external help in the educational technology diffusion project mode

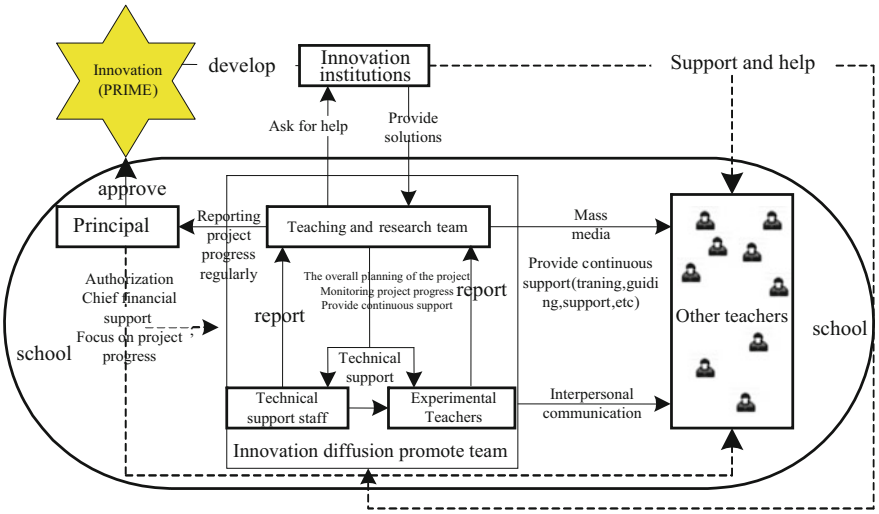

Fig. 2.8 The basic mode of innovation diffusion promotion team in promoting educational technology experiment

Innovative teaching happens more in environments where teachers have access to strong programs of professional development. In professional development, both intensity and design make a difference. Survey data show that innovative instructional practices tend to be reported more frequently by teachers whose recent professional development has been longer term and included more hand-on activities, such as practicing teaching methods and conducting research rather than observing demonstrations and listening to lectures.

The decentralized model as practitioner-led diffusion of ICT in Education (shown in Fig. 2.9). Compared with the centralization diffusion system (Research-Led Diffusion of ICT in Education), the decentralization system of innovation can better meet the needs of users, and help address their problems. In this decentralization system, users are able to feel the sense of ownership and

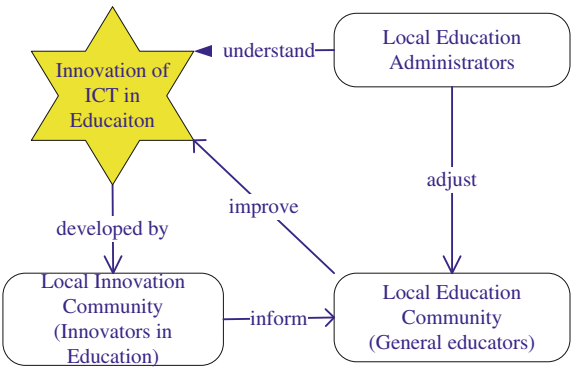

Fig. 2.9 Practitioner-led diffusion of ICT in education

control of the innovation, because they are in the center of the key decisions. For example, educators can decide which problems should be paid prioritiy for attention and be resolved, what innovation can best meet their needs, from where and how to obtain the relevant information, and how to make appropriate amendments once implementing innovations in specific circumstances.

2.7 Conclusions

In the twenty-first century, the position of the job is more inclined to the talented person who has more creative, critical thinking, ability of solving the problems, and the ability of taking decisions. Furthermore, the workers in the twenty-first century should adopt the way of communication and cooperation. The workers must possess the information literacy. Therefore, teaching practice need to continue exploring and studying to transform the traditional teaching mode to break through the education barriers. There are already a bunch of good samples in instructional innovation practice in China, but the experience and the diffusion mechanism need to be summed up in order to achieve educational innovation on a larger scale. To promote educational innovation, government, schools, and practitioner need to promote the education and teaching innovation mechanism. Education reform is a systematic work, which needs a better communication between governments, fields in education, business community, and social groups. And the goal of education should meet demand of both personal and social development, by using social resources effectively, and pursuing reforms under a circumstance of coordination. It also needs a series of concrete steps to conduct, such as reform standards and evaluation, curriculum and teaching, teacher professional development and learning environment, etc. These factors constitute a guaranteed system; and the relationship between them is indivisible and interdependent, which means the neglect of any one can restrict the integral effect. Therefore, the consistency and synchronization between the various segments must be guaranteed in order to make contribution to the development of education innovation in China.

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http://www.springer.com/978-3-662-47955-1

ICT in Education in Global Context
Comparative Reports of Innovations in K-12 Education
Huang, R.; Kinshuk; Price, J.K. (Eds.)
2016, XII, 293 p. 40 illus., 12 illus. in color., Hardcover
ISBN: 978-3-662-47955-1