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Comparative Research of ICT in Elementary Education Development Strategy in Developed and DevelopingCountries

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Abstract:ICT in education development strategy is an important part of educational strategy plan, which promotes the development of ICT in education.Scientific and rational planning of ICT inEducation play an important role in promoting sustainable development of ICT in Education and exerting functional benefit of ICT in education. ICT in Elementary Education is an essential part of construction of ICT in Education, which is the core area that reflects the revolutionary impact of ICT on educational development. The paper, taking China, United States and Singapore as examples of developing country and developed countries, discussed the NETP2010 which was launched by U.S. Department of Education, the Master Plan 3 by Singapore Department of Education, and the Elementary Education part of "Ten-year development plan of ICT in Education(2010-2020)" by China Ministry of Education. Combined with the development demands and basic conditions of China, United States and Singapore, the paper compared and analyzed the features, similarities and differences of the three strategic plan of ICT in Elementary Education, and explored the difference of their construction background and development ideas.Finally, the paper proposed several suggestions for the developing countries like China to enhance the construction of ICT in Elementary Education.

Keywords: ICT in education, development strategy of ICT in education, ICT inElementary Education, comparative research

1. Introduction

ICT can play a particularly important role in supporting education reform and transformation (Means & Olson, 1995; Means, et al., 2004).Faced with increasingly fierce competition, countries around the world regarded ICT in education strategy as a forward-looking choice to promote innovation and development of education, and enhance countries' comprehensive competitiveness. U.S. Department of Education(2010) launched the forth National Educational Technology Plan (Hereinafter refer to as"NETP2010")in 2010, which is a typical and influential strategy plan in the field of ICT in Elementary Education. British Joint Information Systems Committee (2010) published the "JISC Strategy 2010-2012". JapanMinistry of Education, Culture, Sports, Science and Technology (2011) published the "The vision for ICT in Education"in 2010, and Singapore (2008) released the "Master plan 3"in 2008.To deal with the fierce competition of integration of ICT and educational development, meet the actual needs of educational reform and development, and achieve the requirements of "National Long-term Educational Reform and Development Plan (2010-2020)", China Ministry of Education (2012) released the "Ten-year development plan of ICT in Education(2010-2020)" (Hereinafter refer to as "Ten years' Plan"). The "Ten-year Plan" noted that ICT in Elementary Education is the cornerstone of improving national information literacy, and the top priority of ICT in Education(Ministry of Education, 2012). This paper selected the United States and Singapore as the two representativedevelopedcountries from Europe and Asia to compare withdeveloping country of China, and analyzed the strategic objectives, core contentand main projectsof the three countries strategy plan of ICT in Elementary Education, which can not only figure out the developmentcharacteristics of ICT in Elementary Education in United States and Singapore, but also compare the differences of the overall development objectives and future development tasks among the two countries and China, and thus provide reference for the subsequent deployment and implementation of China "Ten-Year Plan".

2. U.S. Strategy Plan of ICT in Elementary Education

NETP2010 called for revolutionary transformation of the educational system, and proposed the “A 21st Century Model of Learning Powered by Technology”, which presented five essential componentsincluding learning, assessment, teaching, infrastructure and productivity. The model identified goals in each area, which are thestrategic goals of NETP2010.

- Learning: All learners will have engaging and empowering learning experiences both in and outside of school that prepare them to be active, creative, knowledgeable, and ethical participants in our globally networked society.
  - Revise, create, and adopt standards and learning objectives for all content areas to improve learning.
  - Develop and adopt learning resources that exploit the flexibility and power of technology to reach all learners anytime and anywhere.
  - Use advances in the learning sciences and technology to enhance STEM learning.
- Assessment:Our education system at all levels will leverage the power of technology to measure what matters and use assessment data for continuous improvement.
  - Give timely and actionable feedback about student learning.
  - Build the capacity to use technology to improve assessment materials and processes for both formative and summative uses.
  - Explore how gaming technology, simulations, collaboration environments, and virtual worlds can be used to assess complex skills and performances embedded in standards.
  - Ensure privacy and information protection while enabling a model of assessment that includes ongoing student learning data.
- Teaching: Professional educators will be supported individually and in teams by technology that connects them to data, content, resources, expertise, and learning experiences that enable and inspire more effective teaching for all learners.
  - Design, develop, and adopt technology-based content, resources, and online learning communities.
  - Provide pre-service and in-service educators with preparation and professional learning experiences powered by technology.
  - Leveraging technology to create career-long personal learning networks within and across schools, pre-service preparation and in-service educational institutions.
  - Use technology to provide access to the most effective teaching and learning resources, and to provide more options for all learners at all levels.
  - Develop a teaching force skilled in online instruction.
- Infrastructure: All students and educators will have access to a comprehensive infrastructure for learning when and where they need it.

- Ensure that students and educators have adequate broadband access to the Internet and adequate wireless connectivity both inside and outside school.
- Ensure that every student and educator has at least one Internet access device and software and resources.
- Leverage open educational resources to promote innovative and creative opportunities for all learners and accelerate the development and adoption of new learning tools and courses.
- Build state and local education agency capacity for evolving an infrastructure for learning.
- Support “meaningful use” of educational and information technology in states and districts by establishing definitions, goals, and metrics.

- Productivity: Our education system at all levels will redesign processes and structures to take advantage of the power of technology to improve learning outcomes while making more efficient use of time, money, and staff.
  - Develop and adopt a common definition of productivity in education and more relevant and meaningful measures of learning outcomes and costs.
  - Improve policies and use technology to manage costs including those for procurement.
  - Fund the development and use of interoperability standards for content, student learning data, and financial data to enable collecting, sharing, and analyzing data.
  - Rethink basic assumptions in our education system that inhibits leveraging technology to improve learning.
  - Design, implement, and evaluate technology-powered programs and interventions.

There are four influential projects on ICT in Elementary Education implemented in the U.S., as the Table 1shown.

Table 15 Main projects on ICT in Elementary Education

No.	Project	Supporter
1	Technology Innovation Challenge Grants	Office of Innovation and Improvement
2	E-rate program	Federal Communications Commission
4	PT3（Preparing Tomorrow’s Teachers to Use Technology）	Teacher and Student Development Programs Service

Technology Innovation Challenge Grants was funded by the Office of Innovation and Improvement of U.S. During the five years of 2000 to 2004, the project had funded a total of 100 sub-projects, which covers curriculum standards, teacher professional development, network resources, computer-assisted instruction, educational technology impact assessment and other aspects.

In order to achieve the goal that each classroom can connect to the Internet in 2000, Clinton signed the "Telecommunications Act" and established the E-rate program in 1996, providing low-cost telecommunication fees to ensure each school and library can afford the advanced communications services.

The Department of Education's Preparing Tomorrow's Teachers to Use Technology (PT3) grant program addresses a growing challenge in modern education: nearly all elementary and secondary

schools are now "wired" to the Internet, but most teachers still feel uncomfortable using technology in their teaching. Since 1999, PT3 has awarded over 400 grants to education consortia to help address this challenge. These grants include projects designed to transform teaching and learning through:Faculty development, Course restructuring, Certification policy changes, Online teacher preparation, Enriched-Networked-Virtual, Video case studies, Electronic portfolios, Mentoring triads, Embedded assessments.

3. SingaporeStrategy Plan of ICT in Elementary Education

Master Plan 3 (MP3) emphasized the use of information technology to enhance students' self-learning. MP3 proposed four major goals and corresponding content:

- Students develop competencies for self-directed and collaborative learning through the effective use of ICT as well as become discerning and responsible ICT users.
  - Self-Directed Learning: Ownership of Learning, Management and Monitoring of Own Learning, Extension of Own Learning.
  - Collaborative Learning: Effective Group Processes, Individual and Group Accountability of Learning.
- School leaders provide the direction and create the conditions to harness ICT for learning and teaching.
  - Develop and communicate shared ICT vision and goals that are aligned to the school’s strategic thrusts and mp3 vision and goals
  - Establish targets and communicate expectations of the effective use of ICT in learning and teaching
  - Support the continuous professional learning and development of all teachers; align school resource management with student learning needs; engage stakeholders and industry to enhance support for student learning
- Teachers have the capacity to plan and deliver ICT-enriched learning experiences for students to become self-directed and collaborative learners, as well as nurture students to become discerning and responsible ICT users.
  - Establish Student-teacher learning partnership, promote students’ self-management and monitoring of their learning, extend students’ learning experiences, in order to promote self-directed learning.
  - Create multiple and appropriate platforms and networks to generate and promote collaboration among students; provide feedback on individual learning and group learning and performance
- ICT infrastructure supports learning anytime, anywhere.
  - ICT infrastructure has the capacity to respond to changing curriculum needs and the needs of individual schools based on their programmes and curriculum needs.
  - Provides full ICT capabilities and easy access to computing devices to support a range of learning and teaching needs.

- ICT infrastructure keeps pace with technological developments with minimum obsolescence.
- A range of technical support services is readily available to meet schools' needs.
- Every student will have access to a computing device with the necessary software, internet connection and learning resources to enable learning to take place from home.

There are six influential projects on ICT in Elementary Education implemented in Singapore, as the Table 2shown.

Table 16 Main projects on ICT in Elementary Education

No.	Project	Topic
1	Program for Rebuilding and Improving Existing Schools	Infrastructure
2	FastTrack@School	Educational resources
3	LEAD ICT@Schools	ICT integration
4	Edvantage	Innovative ICT application
5	Cyber Wellness Student Ambassador Programme	Cyber wellness
6	The ICT Mentor Programme	Teachers' professional development

Program for Rebuilding and Improving Existing Schools was launched by the Singapore Ministry of Education to update and improve the hardware and IT equipment of old schools, and the program had invested 450 million dollors.

The FastTrack@School project encourages businesses and schools collaborate to develop online education resources, during the MP1 implementation period, the project had funded more than 300 interactive multimedia software and services projects.

Both the LEAD ICT@Schoolsproject and Edvantageproject were funded to support and promote schools' creative application of information technology at a higher level.

Cyber Wellness Student Ambassador Programme and The ICT Mentor Programme focused on cyber wellness and teachers' professional development respectively, which were implemented during the MP3.

4. China Strategy Plan of ICT in Elementary Education

The "Ten-year Plan" presented three goals in the field of ICT in Elementary Education. 1) Bridge the digital gap. 2) Promote the integration of ICT and teaching. 3) Cultivate students' learning abilities in ICT supported environment.

To achieve the three goals of ICT in Elementary Education, the "Ten-year Plan" put forward corresponding content. Core contents of ICT in Elementary Education of the "Ten-year Plan":

- Bridge the digital gap
  - Improve school's basic configuration level in infrastructure, teaching resources and software tools.
  - Promote teachers and students' use of digital teaching resources, open enough curriculum standard based courses, and enhance bilingual education in ethnic minority area.
  - Focus on supporting rural areas, remote and poor areas, ethnic minority areas' school information and public service system.
- Promote the integration of ICT and teaching
  - Build intelligent learning environment, provide high-quality digital educational resources and software tools.
  - Carry out heuristic, inquiry, discussion and participatory teaching using ICT.

- Encourage development evaluation, explore the establishment of learner- centered teaching mode.
- Advocate online interscholastic collaborative learning, improve the teaching level with ICT.
- Gradually spread network teaching research led by experts, improve teachers' learning relevance and effectiveness, and promote teachers professional development.

- Cultivate students' learning abilities in ICT supported environment
  - Continue to popularize and improve information technology education, carry out various ICT application activities, and create green, safe, and civilized application environment.
  - Encourage students to use information tools for active learning, independent learning and cooperative learning.
  - Cultivate students' good habits of using ICT to learn, develop interests and specialties, and improve learning quality.
  - Enhance students' abilities of asking and analyzing questions, and problem-solving skills in the network environment.

Furthermore, for the three goals, the"Ten-year Plan" proposed the "Development Frameworks of ICT in Elementary Education 2020".

- Improve school's basic configuration and application level of ICT construction
  - Availability of various ICT infrastructure and resources. Schools' leadership, teachers' application ability of educational technology, professionals' supportive ability.
  - Teachers, students and parents' satisfaction of ICT application.
- Schools' innovation of educational and teaching methods make breakthrough.
  - Teachers' habit of teaching with ICT.
  - Changes in Knowledge presentation, teaching evaluation, and organizational differentiated instruction.
  - Changes in student diversity and personalized learning.
- Enhance students' self-learning ability in ICT supported environment
  - Willingness to use ICT in learning.
  - Ability of using ICT to discover, analyze and solve problems.
  - Self-discipline to use ICT healthily.

There are three main projects on ICT in Elementary Education implemented in China, as theTable 3 shown.

Table 17 Main projects on ICT in Elementary Education

No.	Project	Topic
1	School-to-School project	Infrastructure
2	Class-to-Class project	Educational resources
3	People-to-People project	Personalized learning

In order to quicken the pace of the popularizing ICT in education in elementary and middle schools, China's Ministry of Education promulgated "thenotification on implementation School-To-School Project in elementary and middle schools" and decided to organize and implement this project in 2000. It intends to make90% of elementary and middle schools connect to the Interact to promote the balanceddevelopment of education within 5 to10 year. The establishment of theSchool-to-School Project gives a firm protection to promote the balanced development ofeducation caused by the historical, economic and political factors.

"Class-to-Class" is a project following the "School-to-School" project, which is a comprehensive program that blends infrastructure, software resources and ICT integration with

educational content. The goal of "Class-to-Class" is to realize the sharing of high-quality educational resources among classes.

"People-to-People" is a new project proposed based on the first two projects, which was launched by the "Ten-year Plan", and the aim of "People-to-People" project is to achieve personalized learning, that is, each student will have their own learning space which can connect with others.

5. Comparison of ICT in Elementary Education Development Strategy of China, United States and Singapore

After comparing the goals and core content of NETP2010, Master Plan 3 and "Ten-year Plan", it is easy to find out the similarities and differences of the ICT in Elementary Education strategy focus, as shown inTable 4.

Table 18ICT in Elementary Education strategy focus of China, U.S. and Singapore

	"Ten-year Plan"	NETP2010	Master Plan 3
ICT infrastructure	√	√	√
Digital teaching resources	√	√	√
Learning assessment with ICT	√	√	
Application of ICT in teaching	√	√	√
Students learning ability with ICT	√	√	√
Educational productivity		√	

5.1 Similarities

In the above table, we can see that the ICT in Elementary Educationstrategy goals of U.S.,Singapore and China have significant differences. However, there are three common features of the countries' goals: focusing on ICT infrastructure construction, emphasizing the application of ICT in teaching, paying attention to cultivate students' learning ability in ICT supported environment.

5.2 Differences

Firstly, the strategic goals of the NETP2010 is based on the systematic view, proposed the 21st Century Model of Learning Powered by Technology, and set the goals from the aspects of educational system including learning, assessment, teaching, infrastructure and productivity. Especially, the NETP2010 involved the educational productivity, which is not included in the Master Plan 3 and "Ten-year Plan".

Secondly, the Master Plan 3 embodied the educational idea of "Just for students' development". The four goals in theMaster Plan 3 all served for developing students' competencies for self - directed and collaborative learning from the perspectives of students, teachers, schools and infrastructure.The outcome goal of the Master Plan 3 is for students to "develop competencies for self - directed and collaborative learning through the effective use of ICT and to become discerning and responsible ICT users" with a focus on anytime- anywhere learning (ICT Connection website). The three key enablers are: school leadership for providing direction, communicating that vision and creating a conducive environment with systematic support; teacher capacity to guide students and provide structures that allow for such experiences; and infrastructure, including Internet connectivity, within the school and at the Ministry level with opportunities for extension to the home for every student (Office of Educational Technology U.S. Department of Education, 2009).

Singapore has made a conscious choice to leverage ICT to enhance and enrich the learning experience of students in its education system. As the technologies advance, their use in education has become increasingly more pervasive and effective. The continual success in the use of ICT for teaching and learning will necessarily depend on a committed government that has the tenacity to see through the implementation of various ICT Master Plans in Education as well as the foresight to chart out future needs in this area (UNESCO, 2011).

Thirdly, goals of the “Ten-year Plan” reflected the special conditions and educational status of China. Uneven development of Elementary Education is a significant problem in Chinese education system, therefore, the “Ten-year Plan” emphasized on narrowing the digital gap between developed areasand underdeveloped areas in China ICT in Elementary Education. Furthermore, as thestagesof ICT in Education of China isbetweenthe “emerging” and “applying”, integration of ICT and teaching is an important goal of the “Ten-year Plan”. However, as the U.S. and Singapore’ development level of ICT in education is much higher than China, the NETP2010 and Master Plan 3 pay more attention to the innovative application of ICT in teaching.

6. Discussion and Conclusion

Drawing upon the experiences of the NETP2010 and Master Plan 3, we may lead to the following lessons on developing ICT in Elementary Education, which may be also helpful for the countries like China that is investing more on ICT in education and lacking of enough experiences.

6.1 Political Support

Some educational policies are conceived at the highest level of the government. Often, these policies are presented as a national initiative that transcends educational goals, aiming, in the first place, to produce social and/or economic transformations and in a second place, to have an impact in students’ educational outcomes(UNESCO, 2011). Both countries of the U.S. and Singapore have strong political support on the development of ICT inElementary Education, and the governments invested a lot money and resources to enhance the construction of ICT in Elementary Education.

6.2 Implementation Strategy

There are different strategies that can be used to implement ICT in education policies, they can differ in the way they are planned and managed, the structure used for its implementation and stages that countries follow to implement them. For example, Singapore, developed a very well structured, progressive approach to the implementation of its ICT in education policy, defining the phases, activities, products and responsible party for each step of the implementation. By implementing a feedback loop, results of each ICT master plan were analyzed in order to incorporate the lessons learned into the design of the subsequent one (UNESCO, 2011).

6.3 Teacher Professional Development

One of the key challenges in the successful implementation of the ICT master plan for education is ensuring teachers’ readiness in changing their classroom practices to integrate ICT into the curriculum in a meaningful manner. To succeed in the implementation, attention must be paid to the cultural or people dimension. Before most teachers will be willing to change their classroom practices, they need to be persuaded by realistic models of ICT-based pedagogies that demonstrate some transformation of the educational experiences of their students. As there may be a steep learning curve in the integration of ICT into the curriculum, most teachers will not be convinced to change their classroom practices if the application of ICT were to merely allow them to go about their teaching faster or to do more of the same. It is important to change teachers’ beliefs through the use of success stories that clearly demonstrate the value-adding impact of the use of ICT in teaching and learning (The International Bank for Reconstruction and Development, 2008).The pedagogical role of teachers is to structure and support these practices by providing resources and explicitly modeling cognitive and social processes and prompting students to take up these practices (Bransford, Brown, & Cocking, 2000; Blumenfeld, Kempler, &Krajcik, 2006; Krajcik&Blumenfeld, 2006).

6.4 Investment on ICT in Elementary Education

Adequate financial support is essential to the steady development of ICT in Education. The United States provided financial support through a number of policies and regulations, and establishing different levels of funding methods according to their national conditions. Singapore also invested a lot to ensure the construction of ICT in education, especially in the aspects of infrastructure, digital educational resources and teachers' professional development. During MP1 to MP3, Singapore had implemented a lot of projects to ensure the development of ICT in education. For the developing countries, adequate investment on ICT in Elementary Education is a more important thing, for the infrastructure in developing countries should be the priority, and it takes more money to equip enough ICT devices for schools, classrooms, teachers and students. In addition, educational resources and teachers' professional development are both important for the developing countries, which need large investments. So the author suggested that government should encourage the collaboration with private enterprises and stimulate their investment on the development of ICT in Education by policy support.

The breadth and depth of these ICT-supported emerging practices suggest that these trends will persist, if not accelerate and expand, in the coming decade. For ICT to play a supportive, beneficial role in improving education in the future, the most critical factor is whether or not educational leadership, at all levels, continues to address the policy issues as they emerge, including the need to develop the capacity for schools to be ICT-supportive learning organizations (International Association for the Evaluation of Educational Achievement, 2001.)

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