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Using ICT to Prepare Learners for the 21st Century: The Perspectives of the Eastern APEC Economies

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Abstract

Based on a proposed framework for using ICT to transform education, this article depicts an overview of the development of ICT in schools in Eastern APEC economies, including the perspectives of planning and management, hardware infrastructures, resources and services, staff development, and the practices of educationally using ICT. The cultural impacts and directions for the future development are also discussed focusing on the widespread uses and integrations of ICT in education that can enhance sustainable innovations.

Studying alone without friends results in a shallow and narrow mind.
(□□□□□□□□□□□□□)
(Confucius, 551–479 BC)

During the past decade, there has been a flood in the applications of information and communication technologies (ICT) in the whole society. It is thus not surprising to see the increasing interests and investments being put into the uses of ICT in education throughout the world. Access to and use of ICT are of primary concern for educators in all APEC economies. There is a clear consensus that culture must have a definite and very strong influence on the design and use of information, communication and learning systems, as well as on their management (Wild, 1999). This article is dedicated to depict a picture of the applications of ICT in schools in China as well as other Eastern APEC economies, reflect over the successes and failures during the development, and figure out the challenges that need to be addressed in the future.

The Impacts of Eastern Pedagogical Culture on ICT Uses

A culture is a manifestation of ways in which an identifiable group adapts to its changing environment (Scheel and Branch, 1993). The twenty-one members of the APEC are separated by the Pacific Ocean but also by a cultural divide between distinct Eastern and Western cultural traditions. These two traditions have had a

significant effect on educational practices and systems in the APEC region.

Rooted in Aristotelian philosophy, the Western culture holds an analytic and mechanistic view of the world, positing the human beings are divided from the state of nature by instruments of their own making, i.e., language, philosophy, theology, and science. Hence Western culture sees humans as separated from both nature and the spiritual, and divided within themselves into mind, body, and spirit. Based on such ontology and epistemology, the Western societies are governed by a belief of individualism that must subdue and control nature, rewarding competitive successes in this pursuit, valuing personal achievement and independence, positing that the "good life" to be a future based upon the rational and analytical use of science and technology within an ever-expanding "new frontier" (Hyun & Gilder, 1998).

Rooted in Confucian philosophy, the Eastern culture is based upon a synthetic and holistic view of the world, perceiving the human being and the nature as one unified entity, taking into consideration the interdependent relationship of living things and the environment, the natural and human elements, and their mutual shaping in the construction of meaning (Chen et al., 1999). The Eastern culture tradition seeks the harmony human order and well-being in a society by emphasizing the social roles of all individuals and classes, who should behave according to the social expectations defined by their social roles spanning from senior family members to young children, from governors to common citizens, from male to female. Hence the Eastern culture holds a view of collectivism, urging individuals to surrender their own genuine interests for the sake of the well-being of a collectivity, whether that is the family or the state (Huang, 2002). This cultural tradition, functioning together with other social factors such as the population pressure, economical and political systems, helps shape a group-based, teacher-dominated, and highly structured pedagogical culture (see Figure 1). Teachers are habituated to conduct expositive teaching in large classes. However, this doesn't mean that they merely "feed" knowledge to learners passively, but rather, qualified Eastern teachers tend to guide learners' active reflections by asking thought-provoking questions, and use a variety of teaching strategies to adapt to the needs of different learners during teaching processes. Learners' self-engaged learning is conceived as the core of good education (Stevenson & Stigler, 1992; Lee et al., 2003).

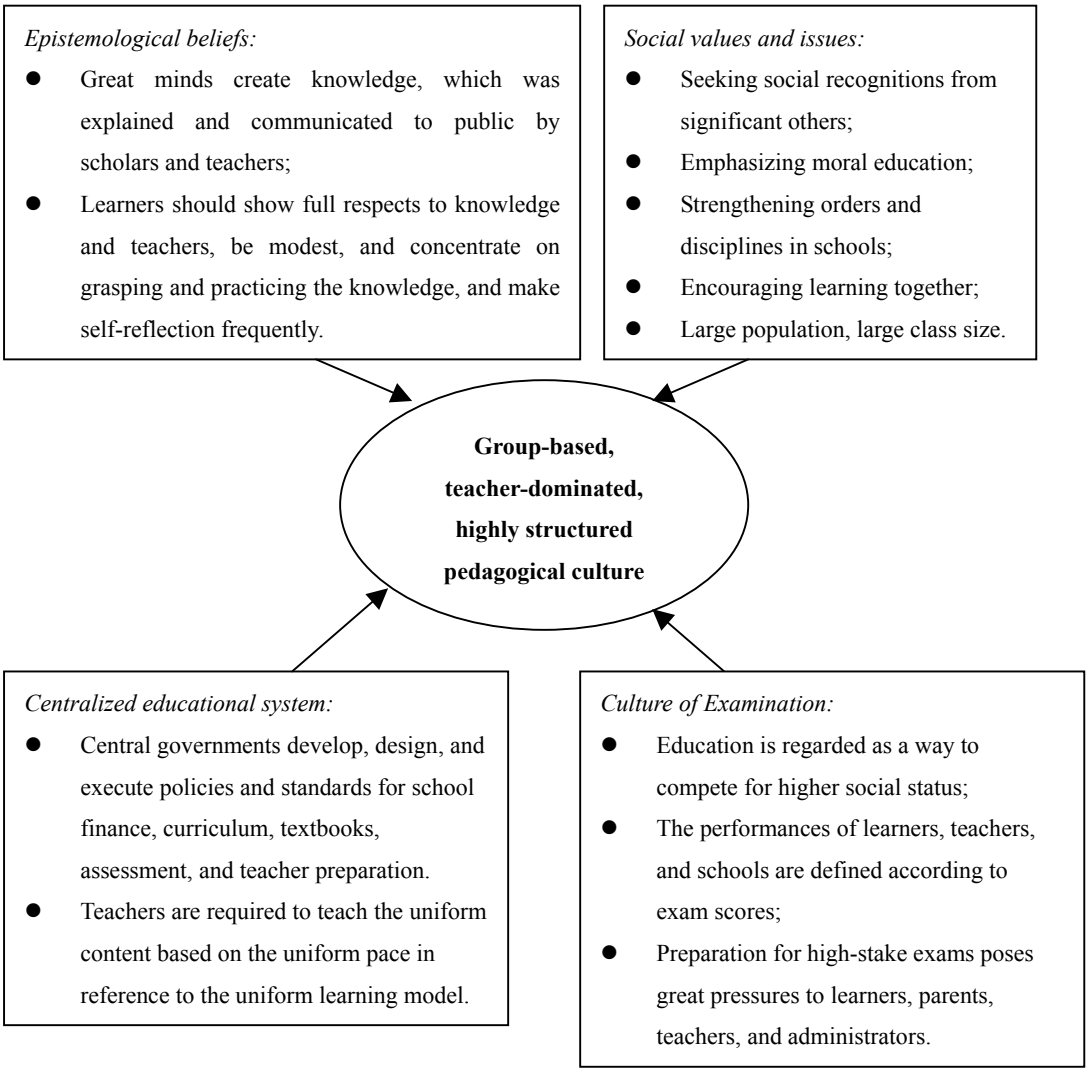

Figure 1. The basic features of Eastern pedagogical culture

The above cultural differences can be exemplified by a study of Jin & Cortazzi (1998) comparing the responses of Chinese and British students on a variety of attitudinal items relating to their perceptions of a good teacher. Chinese students were significantly more likely than British students to define a good teacher as: someone with deep knowledge, someone who sets a good example, and teaches the students about life. British students were significantly more likely to define a good teacher as: someone who arouses the students' interests, is helpful, explains clearly, is sympathetic to individual students, and organizes a variety of classroom activities.

There is a clear consensus that culture must have a definite and very strong influence on the design and use of ICT, as well as on their management (Wild, 1999). On the other hand, it is also important to see the transformative influences that ICT may have to social and academic cultures, i.e., encouraging diverse thinking and undermining knowledge authority (Hyun & Gilder, 1998). For Eastern countries, ICT-based learning technologies integrated with new learning approaches (i.e. learner-centered, problem-based, self-directed learning stressing higher-order thinking skills) embed a

new pedagogical culture often imported from Western countries, together with its rooted epistemological and ontological beliefs and social values. The incorporation of these new technologies as cultural artifacts that school contexts triggers a dual cultural interaction process that involves both "assimilation" and "accommodation".

On one hand, educational practitioners in a culture always assimilate new technologies by trying, although unconsciously sometimes, to select technologies that fit the existing pedagogical culture, and design and use them in the familiar patterns. A typical example is the development of distance learning in China. Unlike the individualized learning model based on self-paced learning materials adopted by distance learning institutions in UK and other Western countries, distance learning in China has been to a great extent localized as group-based distance lecturing, which organizes distance learners into classes at local learning centers to attend lectures delivered traditionally through television, and more recently via VCD/DVD, satellite-based digital video broadcasting, videoconferencing systems, and Internet-based video/audio streams synchronized with Powerpoint slides. As our survey of distance learners in undergraduate and graduate programs demonstrated, 85 percent of the learners agreed that it is important to study in a classroom together with their classmates. Only 44 percent of them agreed that it has no significant influence to learning effects whether they can see the teachers face-to-face or not (Zhang, Wu, & Li, 2003). This result is consistent with the observations of students in Korea (Jung, 2000) and South East Asia countries (i.e. Malaysia) (Ziguras, 2001), which showed that students prefer teacher-directed lectures face-to-face or delivered through videoconferencing systems. As another example, an earlier international comparison study indicated that more than 50% of the middle schools in Hong Kong had digital projectors and LCD display boards, which were both much higher than the average ratios in other countries and regions. This reflects the needs of the traditional pedagogical culture in Hong Kong schools that tend to assimilate ICT tools to support teacher-directed demonstrations and lectures in classrooms (Law et al., 1999).

Based upon a synthetic and holistic thinking style, the Eastern culture has a tendency to use one tool flexibly for a variety of purposes, rather than create differentiated tools. For instance, chopsticks are not only used to eat all kinds of foods spanning from noodles to meat, but also to whisk eggs, skin cucumbers and so on. This requires the tool users to develop adaptive skills to harness the tool to solve different problems. The same tendency can also be observed in the applications of educational technologies. Rather than using educational software by simply following its demos and manuals, a skillful teacher may reinvent or redesign a piece of educational software in his/her own ways, which can go beyond the thoughts of the original designers. For example, the Geometry SketchPad, as a dynamic geometry-learning tool designed in the USA, has been imaginatively used by physics teachers in China to simulate the motion of pendulum, water wave, and the reflection of light.

On the other hand, importing an artifact often involves importing cultural values and practices afforded by the artifact. Confronted with the new technological artifacts that embed alternative pedagogical cultures, teachers will have to deal with the inconsistencies and make necessary accommodations through a process of "reflective

adaptation". Lin (2002) documented a case study on how a fifth grade Hong Kong teacher used an educational artifact from the United States, *The Adventures of Jasper Woodbury* (Cognition and Technology Group at Vanderbilt, 1997). When this teacher firstly introduced Jasper in her classroom, she tried to maintain the routine structure of the lessons. However, this artifact afforded different patterns of interaction and disrupted the previously regimented classroom. The students seized on the open-ended structure of Jasper, and rejected the teacher's attempts to follow the routine. This raised challenges to the teacher's ability to sustain her regular classroom structure and caused intense self-questioning and reflections. She had to make real decisions about whether to change her practices in response to the artifact and what those changes would mean for her identity.

The effective utilizations of new technologies in schools entail both "assimilation" and "accommodation" processes between the existing and novice pedagogical culture. However, too often we observe the unbalance between these two: educational practitioners tend to choose and assimilate "domesticated technologies" that do not affect life in the classroom much, hence reject the opportunities for the "accommodation" process to take place. A paradox gradually became evident: The more a technology, and its usages, fits the prevailing educational philosophy and its pedagogical application, the more it is welcome and embraced, but the less of an effect it has (Salomon & Almog, 1998). This is one of the most important reasons why the expected rapid and profound impacts of novel technologies (i.e. CAI, multimedia, and Internet) are so hardly fulfilled. In order to use ICT to achieve educational innovations, we must integrate technologies with systematic reforms in curriculum, assessment, teacher development, management, and organizational culture.

A Framework for Using ICT to Enhance Education

It is indeed a massive and systematic project to incorporate ICT in education. Many interlocked strands are involved in it, and different stakeholders need to be stimulated and coordinated to participate in and contribute to this mission. Internationally, the use of ICT in education has evolved from a very technology-focused view to a systematic view that emphasizes the interrelated changes in pedagogy as well organizational culture. Based on the related researches and experiences, the overall framework for effectively integrating ICT in schools can be summarized as the following interrelated circles (Zhang, 2002, 2003) (see Figure 2).

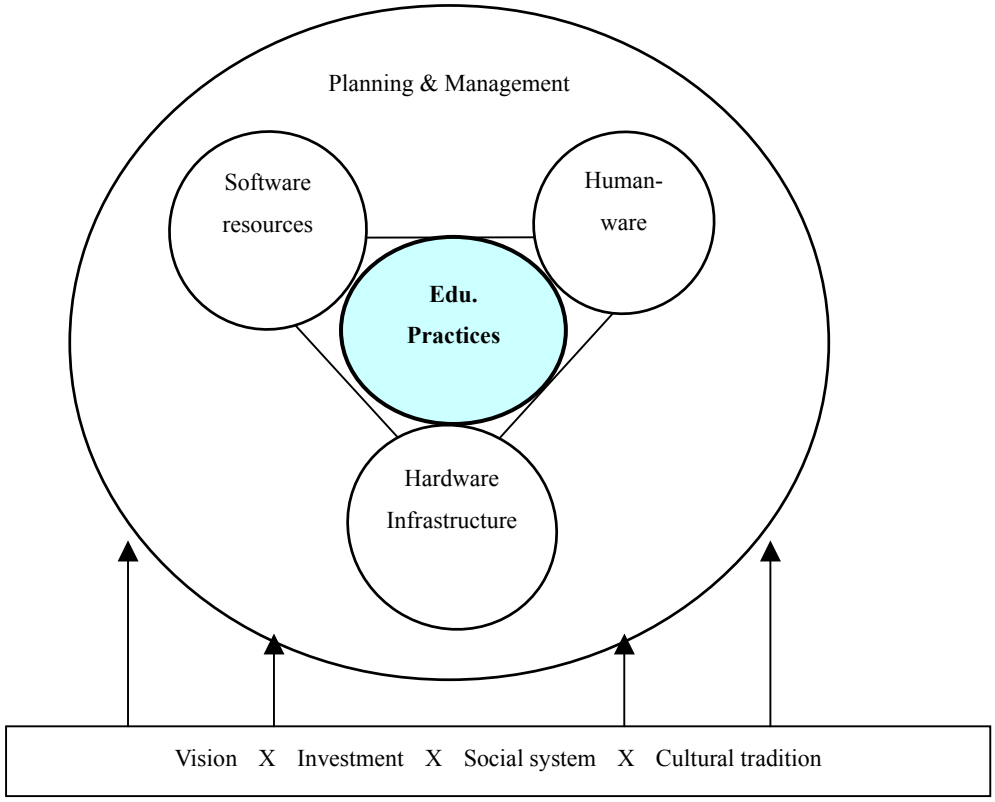

Figure 2. A framework for using ICT to transform education

In this framework, the core circle is the aim of using ICT in education, that is, to improve and transform educational practices by infusing ICT into curriculum and school systems. This aim entails four perspectives of essential work:

(1) Hardware and infrastructure: The construction of hardware and infrastructure facilities is intended to provide learners, teachers and institutions with adequate computers, network connections, related digital equipments (e.g. printers, LCD projectors, and cameras, etc.) and supporting facilities to allow the widening community to benefit from ICT. All these facilities should be able to run smoothly and update based on a regular time cycle.

(2) Software and services: This circle is responsible for providing learners, teachers, and educational institutions with educationally valuable software tools, content resources, and related services. Educational software encloses learning management systems (LMS), course content management systems (CCMS), multimedia and Web-based courseware, learning resources banks, computer-assisted testing systems, framework software such as modeling and Microworld environments, educational gateways, educational management systems and other application software. In this era of network, the public service institutions such as libraries, museums, and galleries can extend their rich learning resources and services to wider communities.

(3) Human-ware: Some thirty years ago, the pioneers of CAI research declared with full confidence that computer would bring about the fundamental changes in education. However, we have not yet seen that happens until today. One of the

bottleneck factors that constrain the effective integration of ICT in education is supposed to be the weakness in teacher training (Chen, 1996, 1997). The aims of the human-ware circle are to create a profession that makes effective use of ICT and understand the pedagogic issues. All teachers, technology coordinators, and administrators should have chances of professional development to formulate proper understandings of and adequate competencies with the educational uses of ICT. This entails the provision of sustainable pre- and in-service training and ongoing job-based performance support.

(4) Systematic planning and management: Using ICT to transform education entails the systematic planning and management to involve and coordinate related public and private sectors, plan, monitor, and regulate the processes, and guarantee the smooth, cost-effective, and sustainable development of ICT in education. This encompasses the planning and managements at the national, regional, and institutional levels.

The overall process of using ICT in education might be greatly influenced by four essential factors: the visions of educational practitioners and administrators, the available investments to support the missions, the overall social and political systems, and the cultural traditions. Based on the above framework, this article will make a critical reflection over the development of ICT in education in Eastern APEC region.

Educational ICT Development in Eastern APEC Region

Systematic Planning and Management

In almost every Eastern APEC economy, there are special governmental agencies responsible for the planning and management of ICT in schools. These agencies form a top-to-the-bottom system, through which the central and local policies can be pushed into actions. For example, the Center for Educational Computing was set up in Japan to promote the use of computers in education, particularly in elementary, middle and high schools, and is under the joint control of the Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Economy, Trade and Industry. In China, it is the system of educational technology centers that are mainly in charge of the planning and development of ICT in K-12 education. This system is consisted of the national central center, province centers, city centers, and county centers. This model is consistent with the overall centralized educational management system in China, and has the advantages of efficient execution and uniform control. However, in the past years, the system of educational technology centers is too self-contained and lacks coordination with other educational administration sections such as the Basic Education Department of the MOE. Partly because of this reason, the development of educational technology didn't function as an integral part of the educational reform and development. After 2001, the planning and management of ICT in K-12 schools became one of the responsibilities of the Basic Education Department of the MOE, which leads the system of educational technology centers. The development of educational ICT has been closely linked to the overall aims of educational reforms, i.e. the National Curriculum Reform in Basic Education.

In order to promote the development of ICT in schools, a nation needs to work out a development plan for educational uses of ICT that is coherent with the goals of educational and overall social development. Till now, almost every Eastern APEC economies has worked out a plan and started the related projects. In order to promote the development and utilizations of ICT in schools, Chinese Ministry of Education (MOE) launched the "Connecting Every School Project" and the "Modern Distance Education Project", which will be introduced in the later sections. In Singapore, the Masterplan for IT in Education is a blueprint for the integration of information technology in education as a strategy to meet the challenges of the 21st century. This Masterplan includes four key dimensions: curriculum & assessment, content & learning resources, physical & technological infrastructure, and human resource development. In July 2002, the second Master Plan was unveiled, continuing to provide the overall direction on how schools can harness the possibilities offered by ICT for learning based on a holistic approach. In Japan, in addition to the establishment of the Fundamental IT Law in 2000, the government established the "e-Japan Strategy" in 2001 and the "e-Japan Strategy II" in 2003. Cultivation of ICT personnel and promotion of ICT learning was positioned as important pillars under these strategies. Korea implemented its first Master Plan for ICT in Education during 1997-2000, which focused on the installations of basic infrastructure by providing and utilizing hardware and software, and professional development of in-service teachers. Its second Master Plan for 2001-2005 expands to the ICT capacities of general citizens, focusing on the enhancement of teachers' ICT application abilities, development of ICT-based educational content, and support for educational uses of ICT. Brunei, Malaysia, and Thailand are also implemented their master plans or national projects for ICT uses in Education.

Relatively, for China and most of the other Eastern APEC economies, it is an urgent task to mobilize, expand, and regulate the forces of market to provide abundant, high quality, and cost-effective ICT facilities, learning resources, and training services to schools. Also, it is of course important to guarantee adequate educational investments, and meanwhile develop a plausible budget that can support the effective applications and sustainable development of ICT in schools. As an international problem, too much of ICT investments were spent on hardware, with software resources, teacher training, and running costs overlooked to some extent. For example, Shanghai invested RMB 1.16 billion for the "Connecting Every School" project, 80 percent of which were spent on hardware and infrastructure construction.

The Development of Hardware and Infrastructure

The development of ICT hardware and infrastructures in schools in Eastern APEC economies is overall behind of that in Western countries. With regard to the ICT infrastructure in schools, an important statistic is the student/computer ratio, which indicates how many students there are in the school per computer. As was reported in an earlier international study of information technology in education accomplished by the International Association for the Evaluation of Educational Achievement (IEA) in 1999, the student/computer ratios in China Hong Kong and Taiwan, Thailand, and

Japan were more than 50:1 in primary schools and more than 30:1 in secondary schools. Whilst in the Western developed countries such as Canada, New Zealand, and Norway, the student/computer ratios were less than 18:1 in primary and less than 15:1 in secondary schools. Among the Eastern countries/regions in this study, Singapore was the only country that had a lower student/computer ratio and better information infrastructures (Law et al., 1999). The student/computer ratio in the US, which was not included in this study, was about 5:1 in 2000, and that in the UK was 7:1 in secondary school and 11:1 in elementary schools in 2001.

The hardware infrastructure has been undergoing a rapid growth in Eastern countries in the recent years. Taking China as an example, the construction of hardware and infrastructure facilities has been speeded up since 2000 (see Table 1). The student/computer ratio had dropped from 121:1 in 1999 to 35:1 by the end of 2002. The number of schools that was connected to computer networks has also increased rapidly. However, the construction of hardware and infrastructure is relatively a long-run task for China because of the weakness of foundation and limitation of educational investment. Sharp differences exist between developed regions and underdeveloped/rural regions. In the recent two years, many big cities (e.g. Shanghai and Beijing) in Eastern China have been establishing their metropolitan educational networks, which connect the educational information center in central cities, the LANs at county and district level, and the networks in all schools. At the end of 2001, the student/computer ratio in Beijing and Shanghai was 15:1 and 17:1 respectively. Whereas in such underdeveloped provinces as Yunnan, Guizhou and Gansu, this ratio was 186:1, 118:1, and 93:1 respectively (Zhu, 2003).

Table 1. The development of information infrastructure in schools in China mainland

	By the end of 1999	By the end of 2000	By the end of 2001	By the end of 2002
Number of computers	1,601,000	2,049,000	3,670,000	5,840,000
student / computer ratio	121:1	99:1	55:1	35:1
Number of networked schools	-	4,600	10,687	26,000

It is an ambitious mission for Eastern APEC economies to promote the development of ICT facilities in all schools. Taking the advantages of centralized administration systems, most of the economies launched national project to drive ICT development in schools. In 2000, the MOE of China launched the “Connecting Every School Project”, which is dedicated to get at least 90% of the elementary and secondary schools connected onto the network based on computer and satellite technologies, and help all teachers and students to access high quality online educational resources within 5-10 years. Even schools in poor areas should be equipped with multimedia facilities and resources. In 2003, the MOE started another important plan called “Modern Distance Education Project for Primary and Secondary Schools in

Countryside", which is intended to support the development of ICT in west rural areas in the coming five years. This project is aimed to equip 37,000 junior high schools in rural areas with computer classrooms, 384,000 rural primary schools with digital satellite receiving stations, and 110,000 small-scale, incomplete rural primary schools with DVD players, TV sets, and instructional videodisks. It will benefit 120,000,000 primary and secondary students to have chances to access to high quality electronic learning resources. With the rapid growth of the educational investment from the government and corporations, the problem of hardware and infrastructure is hopefully to be resolved in the near future.

In Korea, by the end of 2000, the student/computer ratio in primary and secondary schools had reached 16.7:1, and almost every school had been connected to the Internet. Between 1997 and 2000, Korean MOE spent $1.4 billion dollars on building educational system's ICT infrastructure. Also in 1997, the MOE of Singapore pushed out the Masterplan for IT in Education. The Masterplan envisaged that by 2002, pupils would spend up to 30% of curriculum time using IT. To achieve this, a pupil-computer ratio of 2:1 was targeted for every school by 2002. Pupils are provided with access to ICT in all learning areas of the school including computer laboratories, classrooms, libraries and special rooms. The Masterplan also provided for a teacher/notebook ratio of 2:1 in every school. Japan was surprisingly slow in implementing educational technologies into the K-12 system in the 1990s, but the country is aggressively changing course. As the goals specified in the e-Japan Priority Plan, by 2005, all public schools will have constant high-speed Internet connections; all classrooms will be connected to the Internet through LAN equipment; student/computer ratio will reach 5.4:1; and all teachers in public schools will be able to apply ICT in instruction. In Thailand, all schools will be connected with the Internet by 2006.

One of the seemingly successful experiences in infrastructure development in Eastern economies is to integrate computer multimedia and networks with other technologies including satellite communications, educational television, VCD/DVD, and more traditional overhead projectors. In China, this integrated technological solution is regarded as a necessary way to accommodate the big regional differences in terms of infrastructure foundations and available investments. In Japan, a typical case is NHK Educational Television, who, cooperating with a number of university professors and schoolteachers, initiated a TV and Internet combination model in teaching an environmental education program and a program of comparative culture concerning food. Via television, NHK can transmit the same visual image from a central TV station to all places in the country. Through the computers in classrooms that are connected to the Internet, students can send feedback comments to the TV station as well as collaborate with schools or laboratories in other regions or countries (see Mizukoshi, Kim, & Lee, 2000).

It is worthwhile to note the following issues that need to be addressed in future development:

1) Promote the development of technology in underdeveloped regions to enhance equal access;

2) Systematic planning and continuous investment;
3) Appropriate budgets: when investing into the ICT hardware, schools are usually more aware of the costs of the visible equipment, whilst often ignore the underneath cost: software, installation, cabling, Internet access, commissioning, technical support and management.
4) Distributing facilities properly: The dominant distribution model adopted by Chinese schools is to allocate computers in special computer labs. This model is convenient for management but difficult for wide uses of the technologies. More computers should be scattered into classrooms, learning centers, and offices to facilitate the wide and frequent uses by teachers and students.

The Development and Application of Educational Software Services

As has been highlighted by the researches (Chen, Li and Zhang, 1996; Chen, 1996; Law, 2000), the lack of usable educational software is one of the most important problems that constrain the educational uses of ICT in China as well as other Eastern APEC economies.

Within the knowledge-transmission oriented pedagogical culture, content-based software in forms of CAI courseware and resources bank are of special demands. During 1990's, China government launched several projects (e.g. The 96-750 National Project) to encourage educational technology researchers in universities to design and develop high-quality CAI software for schools. Teachers in schools have also developed numerous pieces of courseware mainly for their own uses in teaching. More and more ICT companies have entered the education market to provide digital educational resources and services. As a promising strategy adopted in the "Connecting Every School Project", China central and local governments have been investing a large number of money to establish the national and local educational resources centers as the "hubs" for educational resources. This is helpful for increasing the wide sharing and cost-effectiveness of educational resources. Some main cities are establishing their educational metropolitan networks that incorporate the educational resources banks and Web-based learning management systems. According the survey by CCID Company, the total scale of educational software market in China mainland was RMB1.63 billion in 2001. There were 200 companies that produced 3,000 pieces of educational software (see Zhu, 2003).

In Singapore, The Masterplan for IT in Education set out strategies for acquiring and developing a range of software relevant to their curricula objectives. MOE of Singapore provided a central clearing-house service to source, review and recommend software titles and Internet sites for schools. The development and commercialization of a full range of educational software relevant to the local curriculum was regarded as a critical component of the Masterplan.

The frequently used educational software and resources in China and other Eastern economies can be classified into the following categories:

1) CAI courseware in the forms of tutorial or drill-and-practice: These types of courseware were developed both for teachers to demonstrate and present learning content in classrooms and for learners to use at home. In China, the examinations

for the entrance to higher-level schools (from junior high schools to senior high schools and esp. from senior high schools to colleges and universities) bring about tremendous pressures to students, teachers as well as parents. The tutorial and practice courseware scripted by some famous teachers from famous elementary or secondary schools is supposed to be of high values in preparing students for examinations, thus has great charms to students, parents and teachers. These types of courseware had dominated the educational software market during 1990's.

2) Computer-Assisted Test (CAT) systems: CAT software has also gained great attentions because it can help teachers with the creation and implementation of quizzes and examinations and help students to make self-evaluations in their own learning.
3) General application software: For instance, using MS Words in Chinese and English language lessons, using MS Excel in math. A so-called "Four-In-One Project" has been undergoing since 1994 to integrate Chinese characters recognition, reading, writing and computer application in elementary and secondary Chinese language classes (Li, 2000).
4) CD-ROM-based and Web-based resources banks: Tutorial courseware has the limitation in that it usually provides a whole program for certain learning unit and leaves little spaces for teachers' flexible instructional design and integration. Under this circumstance, there appeared the concept of "integral-ware", which represents the micro learning objects in learning resources that can be integrated or orchestrated into a lesson plan using platform tools (Li, 1997). Evoked by this conception, many companies in China have developed CD-ROM or Web-based resources banks geared to particular subjects in elementary or secondary schools. These resources banks are composed of such formats of instruction resources as texts, images, audio, video, animations, and simulations and the like. Teachers and students can find out the target resources using the provided search tools.
5) Framework software as tools for learning and teaching: Framework software is not designed to deliver the target subject matter, but to function as a tool for learners' thinking, learning, and teachers' work. The Geometer's SketchPad developed by the Key Curriculum Press in the US has been translated and localized into Chinese version and used widely in mathematics and even science education. A similar but more powerful geometry learning software called “Z + Z” intelligent platform have been recently developed and disseminated into primary and secondary schools in China.
6) Web-based learning management (LMS) systems: The design and development of Web-based learning management systems is currently the focus of many e-Learning corporations. More and more schools are starting to use Web-based LMS to setup their online courses and virtual communities.
7) "Web Schools": Some famous and influential schools in China have established their "Web Schools" to extend their classrooms to more students and provide them with high quality mentoring. This model can also meet the needs of the students who are striving to get better scores in their examinations.
8) Comprehensive educational Website such as China Basic Education Resources

Network (http://www.cbern.gov.cn/index.html) sponsored by the MOE of China, and Study Malaysia website (www.studymalaysia.com) supported by the Malaysian government. The Websites usually include special columns for almost every subject in elementary and secondary schools Teachers and students can search for and download the resources of their interests, upload and share their thoughts and products, and communicate with peers online.

It is important to note the following issues in this perspective:

1) Transforming the pedagogical models embedded in E-Learning courseware: More courseware should be designed to promote learners' higher-order thinking, knowledge construction and social interactions;
2) E-Learning resources standards and quality control: It is of great needs to develop a set of standards for E-Learning resources. The MOE of China has established the China E-Learning Technology Standards Committee (CELTSC) responsible for the research, development and dissemination of E-Learning technological standards.
3) The stimulation and regulation of the e-Learning market: Due to the shortage of educational software, teachers have to spend too much energy in designing and developing courseware for their own classes, which is usually not professional or transferable. According to a recent survey of software used by schoolteachers in Beijing, about 68 percent of the software was made by teacher themselves (often assisted by technicians), 27 percent was commercial software bought from market, 10 percent was downloaded from the Internet (Beijing Basic Education Teaching Research Center, 2003). Hence, it is an urgent mission for the governments to encourage and regulate the commercial and public service (e.g. libraries, museums) institutions to develop educational resources of good quality and develop a rich learning recourses market.

Staff Development and Support

Staff development and support is now a worldwide critical issue for using ICT in education. The lack of knowledge of teachers was seen as a major obstacle by a substantial group of school principals in many countries (Pelgrum & Anderson, 1999). According to a recent survey of schoolteachers (excluding ICT teachers) in Beijing, only 57 percent of these teachers can use a word processor, 21 percent of them can browse the Internet to find usable resources, 6 percent can use e-mails. Senior teachers were found to have much lower proficiencies with ICT than young teachers (Beijing Basic Education Teaching Research Center, 2003).

Internationally, teachers' ICT training has undergone a model evolution from technique-oriented training (or say, "isolation model") that focuses on the concepts and operations of technology *per se* to the integration-oriented training that emphasizes the educational use of ICT in curriculum and the integration of technology in training programs (Collis, 1994; Taylor & Stuhlmann, 1995). As our survey (Chen, Li, & Zhang, 1996) revealed, the teacher training model implemented in China in 1990's was relatively very technique-oriented. The "educational uses" of technology should be strengthened in future staff training and development.

In a national project on using ICT to support curriculum reform, we (Zhang et al., 2003) developed a standard for teachers' competencies of educationally using ICT. This standard encloses a list of training content that falls into five dimensions: (1) general knowledge and skills of ICT, (2) using ICT in learning and teaching processes, (3) assessment and ICT applications, (4) using ICT for professional development and life-long learning, and (5) the humanity, ethical, and legal issues related to educational uses of ICT. In order to examine the degree of schoolteachers' demands concerning these five dimensions, we conducted a survey among ICT teaching researchers who function as ICT coordinators across the districts of Beijing. As Figure 3 displays, all of the five dimensions of training content were rated as highly important, with especially higher concerns with dimension 5 and 2, and lowest concerns with dimension 1 (F (4, 128)=7.52, p=0.00). This result converges with the trend of integration-oriented training model. It also reflects the great concerns with ethical and moral issues in technology-rich learning environment within the Chinese cultural background.

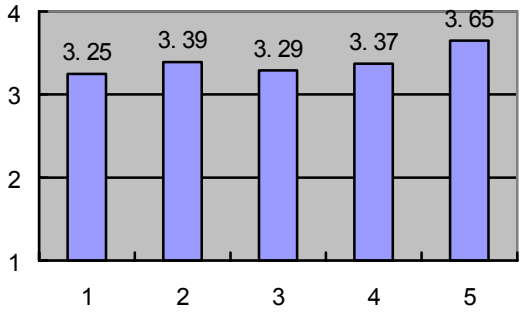

Figure 3. Teachers' demands of the five dimensions of training content
(Likert type four-point scale)

The MOE of Singapore included the effective and continuous training of teachers as one of the central missions in its Masterplan. Every teacher was required to be trained to handle ICT-based instruction and support new learning strategies among their pupils by 2002. In the Republic of Korea, all the teachers will be trained before 2004. China government has recognized the importance of teacher training and launched a national project to promote the continuing education of elementary and secondary teachers in 1999. One of the missions of this project is to elevate all teachers' competencies with ICT. Distance learning technologies have been used as an assisting solution in this project. In 2003, the MOE established the National Networked Teacher Education Union, which is aimed to integrate the resources provided by several high-level teacher education institutions like Beijing Normal University and East China Normal University and so on to provide life-long learning and development opportunities to all schoolteachers.

Also, China has a system of subject-based teaching groups in schools. In a school, teachers teaching the same subject (i.e. Chinese language, math) are organized into a group to work together, communicating their understandings of curriculum standards

and textbooks, designing instructional activities, sharing materials, observing and reflecting over each others' teaching activities occasionally, and composing tests to evaluate their students. When a novice teacher enters a school, he or she will be allotted a mentor to guide his/her professional development. At the higher hierarchy levels, almost every school district, city, and province has a "teaching research center", the members of which are called "teaching researchers" who work with particular subjects and are responsible for coordinating schoolteachers to design high quality "demo" lessons, share experiences, and learn about educational reform theories and policies. This system help formulate the structural communities of teaching practices that have strong influences to teachers' professional activities and development. Like a model of "cognitive apprenticeship" (Brown, Collins, & Duguid, 1989), newcomers in these communities have chances to learn from oldtimers' experiences and can gradually progress toward expert teachers through a process of "Legitimate Peripheral Participation" (Lave & Wenger, 1991). Of course, it is important to notice that these communities of teaching practices are too often dominated by senior teachers who show more resistances to the changes in mainstream teaching models and the incorporations of new technologies.

An effective teacher-training project in China is the Intel Teach to the Future, which is aimed to improve teachers' performances of educationally using ICT through cooperative project-based training. During 2000-2002, 110,000 schoolteachers in China took part in this training program.

The brief recommendations for teacher training can be summarized as the following:

1) There needs a model shift from technique-oriented training to integration-oriented training that strengthens the educational uses of ICT and integrating ICT into the training processes.
2) Standards for teachers' competencies and performances of educational ICT need to be worked out to control and assure the effectiveness of training.
3) Training will never be a "once-and-forever" matter. It is of great importance to build up a sustainable mechanism to provide teachers with ongoing supports. Performance improvement technology can be adopted to identify the performance gaps and decide the systematic countermeasures to support performance improvement (Zhang & Yang, 2002).

A Critical Reflection over the Practical Uses of ICT in Education

ICT as a subject

To provide courses about computer (informatics) was the earliest attempt when computer was firstly introduced into schools in China as well as many other Eastern APEC economies. In recent years, the learning and teaching of ICT has been strengthened, because the Eastern APEC economies realize that ICT has a ubiquitous position in the information economy, and the ability to use ICT is essential for citizens.

In October 2001, Chinese MOE pushed out the policy to popularize ICT education as

one of the compulsive curriculum in all elementary and secondary schools before 2010. In specific, all senior high schools will provide ICT curriculum by 2001, all junior high schools will offer ICT education before 2005, and all elementary schools by 2010. The particular timetable for this process can been seen in Figure 4 (Zhang, 2002). By the end of 2001, 92% of senior high schools had provided ICT courses (Li, 2003, pp.14).

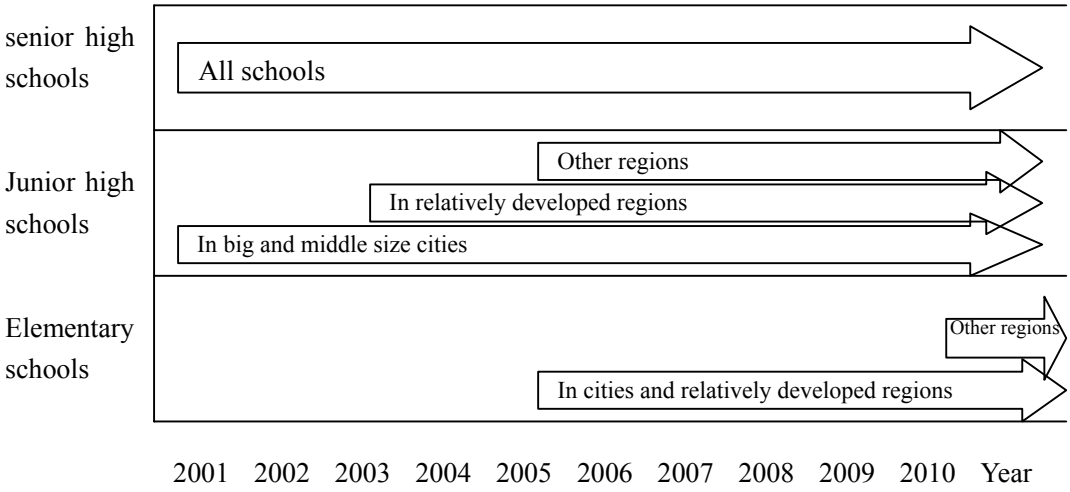

Figure 4. The primary timetable for popularizing ICT education in China

According to the Primary Guidelines for ICT Curriculum published by the MOE in 2000, the content in ICT curriculum covers not only the main areas in new ICTs including system architecture, operation system, tool software, multimedia, and network, but also the so-called "information literacy" concerning the abilities for finding, approaching, evaluating, using, generating, and communicating information, as well as the related social and cultural issues on a broader sense. Based on this guideline, a formal National Curriculum of ICT for senior high school was published in 2003, which highlights information literacy as the core of ICT education. Li (2003, pp.107) made a comparison of the key descriptors concerning with information literacy that appear in ICT curricula in different countries and regions (Table 2).

Table 2. A international comparison of the key descriptors concerning with information literacy in ICT curricula

Countries/ regions		Tools/ applications/ solving problems	Life-long learning	Innovation/ creativity	Integration/ combination	Express/ communicate/ exchange	Ethics/ morality
USA		✔	✔	✔	✔		
Korea		✔			✔		✔
Japan		✔					✔
Hong Kong SAR		✔	✔	✔	✔	✔	✔
Chinese Taipei		✔	✔	✔	✔	✔	
China Mainland	2000		✔		✔		
	2003	✔	✔	✔	✔	✔	✔

In Japan, in junior high schools, there had been a selective course called "Elementary Information", which was redesigned as a compulsory course named "Information and

Computers" in 2002. In senior high schools, Information Technology was introduced to the curriculum for academic courses in 2003. Although the subject itself is compulsory, each school may select its choice from the three courses: course option #1 emphasizing the ability to make use of information, course option # 2 emphasizing scientific understanding of information theory and network systems, and course option #3 geared toward participation in the information society (see Mizukoshi, Kim, & Lee, 2000).

The challenging problems in popularizing ICT education include:

1) Revising and streaming the ICT curriculum during implementation: The learning content in different stages overlapped with each other to a fairly great extent because most of the current target students are fresh learners in ICT education whatever stages they are in. In this case, the ICT curriculum must have the flexibility to adapt to all students and be revised and streamed gradually during implementation;
2) Finding out proper methods for ICT education and evaluation: Authentic tasks-driven learning approaches and performance-based assessment have been advocated in carrying out ICT education. But the practical implementations of these approaches are relatively new to most teachers and thus need to be experimented during the processes;
3) Preparation of ICT teachers;
4) Preparation of ICT facilities.

Using ICT in learning and teaching

(1) Using ICT to strengthen expositive teaching

As has been noted in beginning of this article, Eastern APEC regions have a group-based, teacher-dominated, highly structured pedagogical culture. Within this culture background, computers have been exclusively used as assisting tools to support expository teaching in classrooms and after-school assignments for a fairly long period. They are mainly expected to help deliver vivid demonstrations and presentations, enriched information, and drill and practice with immediate feedback. As the most frequently used teaching method, expository teaching is commonly used in curriculum components where the primary objective is the students' mastery of standardized facts, concepts, rules and procedures. It is also used when the objects of learning and/or resources available are too complex to be understood by the learners (Law et al., 2000, pp.55). The primary activities and steps in expository teaching and the applications of ICT can be roughly represented as Figure 5.

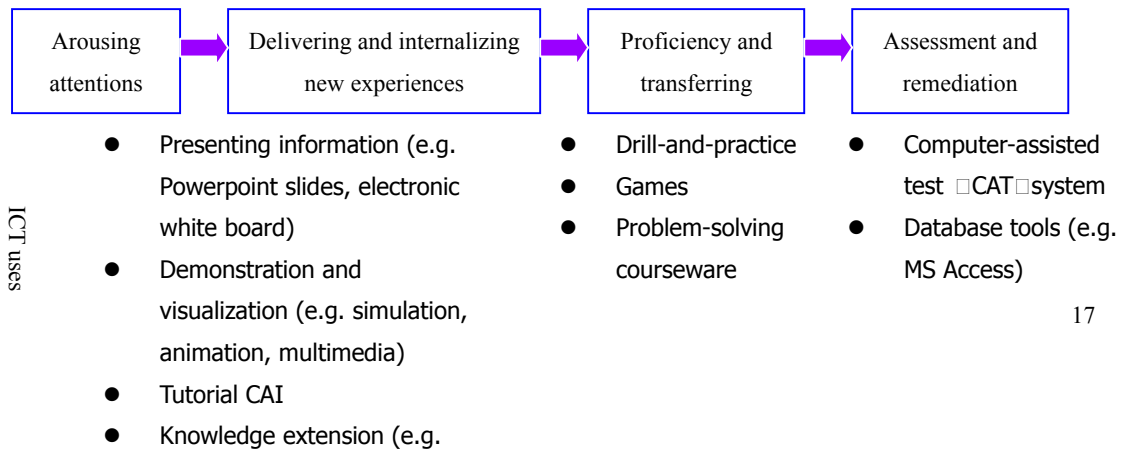

Figure 5. Using ICT in expository teaching

(2) Enlarge learning opportunities through distance learning

Distance learning is more than 150 years old and has been a practical option for many students and institutions, but the advances in ICT has accelerated the interest in DL to an unprecedented degree. Almost all Eastern APEC economies face the pressure of population. Thus it is not surprising that ICT are adopted to increase the participation ratio of education, esp. higher education by supporting distance learning programs. In China, the MOE launched the Modern Distance Education Project in 1999 aiming at promoting the development of lifelong learning systems across China. So far, more than sixty prestigious universities have been involved in this project to establish Web-based Education Schools offering distance learning programs spanning from vocational training to undergraduate and graduate level education. The Vietnamese government has encouraged the growth of more flexible modes of delivery in higher education. In the early 1990s, enrolments in informal and flexibly-delivered courses (including distance education and part-time studies) in Vietnamese higher education institutions rose much faster than enrolments in formal courses (full-time on-campus courses). There were around 50,000 students enrolled in distance education at university level in Vietnam in late 1990s (Le & Tran, 1999) and this number is growing rapidly. Distance learning is also chosen as a way to enlarge learning opportunities in Japan (by the turn of the century, there were 250,000 to 300,000 distance learners in Japan (Albrechtsen et al., 2001)), Korea, and Malaysia.

With the rapid development of online distance learning, there arise great concerns of its quality and effectiveness. In one of our earlier studies (Zhang et al., 2003), we implemented a survey on learners' utilizations and experiences of various formats of distance learning resources spanning from the sub-system of course package to that of learning support and services. One of the main findings was the unbalanced development between the two sub-systems: the educational institution focuses much on the development of course packages while to some extent neglects the importance of providing sufficient learning support and services. As the specific items displayed, it is not convenient for the learners to consult their instructors for learning help; The local teaching assistants had not functioned as expected in promoting learners' learning activities; More than half of the learners reported that their instructors couldn't grade and return their assignments in time, and seldom gave them meaningful learning advice in their feedback. About 70% of the learners reported to have felt somewhat lonely in learning and eager to communicate more with their classmates. It is one of the most urgent tasks to establish a more powerful, flexible,

and effective learning support and services system in order to assure quality distance learning. Aiming at the quality assurance of distance higher education, the MOE of China funded several research projects to establish the quality benchmarks for Web-based Education Schools and their online courses and learning support services (see Chen, Zhang, & Li, 2003).

Also, after years' of development, distance learning in Eastern APEC economies is undergoing an important shift: from a focus on providing educational opportunities to those who were unable to attend a traditional university to providing life-long learning opportunities to those who have already got a diploma or degree (Jung, 2000).

(3) Creating innovative learning practices by harnessing the potentials of ICT

Influenced by the belief that education should pass on what great minds have already discovered, the Eastern APEC economies have historically emphasized knowledge acquisition. This has generally resulted in greater school accountability, better student learning of content, and greater focus on academics; However it also leads to learners' weakness in self-directed learning abilities, creativity, and critical thinking skills. Facing the challenges of knowledge society, almost all the Eastern economies are increasingly promoting the use of educational technology as a way to enhance problem solving abilities, lifelong learning skills, creativity and inventiveness of students. These personal qualities are seen as essential to future national economic development (see also Ziguras, 2001).

In late 1990's, a new national policy of "quality education" came out in China to shift schools' focus from competitive examinations to the substantial developments of all students. As one of the important actions taken under this policy, the New National Curriculum for Basic Education have been worked out and experimented, and will be implemented national wide after 2005. The New National Curriculum is aimed to update and restructure the curriculum content, and promote the fundamental changes in learning and teaching approaches to engage students more deeply in active and creative learning, problem solving, higher-order thinking, and communication and collaboration. ICT is of particular concerns in this reform both as a subject and a tool integrated across the curricula. It provides much larger spaces for using ICT to support innovative learning. The Singaporean government's Masterplan for IT in Education also sets out a strategy of using educational technology to encourage active and self-directed learning. In Malaysia, it was stressed that IT-supported learning must be exploratory and it must promote discovery, with students constantly engaged in finding, organizing, analyzing and applying information in creative and novel ways to solve problems (see Ziguras, 2001). Driven by these educational reform policies, an increasing number of new pedagogical practices are emerging, which have the characteristics of student-centered instruction, self-directed and resources-based learning, problem-driven collaborative knowledge building, and authentic assessment. Here list two exemplar cases:

Research-Oriented Learning in China: The New National Curriculum in China advocates Research-Oriented Learning both as a special course module and a general learning approach used across the curricula. Research-Oriented Learning is intended

to drive learning with research projects arising from personal and social life. In order to accomplish a research project, learners need to identify the problems; find out, apply, and evaluate knowledge and resources; solve problems; and communicate and negotiate research results. ICT is often used to support Research-Oriented Learning by facilitating the access and integration of information resources, the acquisition and analysis of data, and the communication and cooperation among learners. For example, the learners of grade 3 from a primary school in central Beijing and a primary school located beside Miyun Reservoir (the most important water source of Beijing) in suburban Beijing jointly accomplished a research project on the problem of water shortages in Beijing region. They browsed WWW resources to help generate deeper understandings of this problem, used FTP to share resources, and used videoconferencing systems to present and communicate their findings.

"Internet Schools" in Japan: The MOE of Japan designated "Internet Schools" that initiate experimental programs for advanced teaching and learning with special recourse to the ICT. For instance, these Internet Schools use ICT to organize collaborative inquiry activities in environmental education. Students in several schools observed the growth of a plant of the same kind and measured the critical timings of germination, flowering, and fruition, using the same criteria. They then exchanged their own data with others through the Internet or videoconferences. Students investigated, for example, air pollutants such as NO2 and SO2 (nitrogen and sulphur dioxides), water contamination (in rivers, lakes and Inland Sea), acid rain, and the noise pollution around highways. Those data were sent to the host computers of their own project, such as in a hosting senior high school, teachers college, or the Globe Plan secretariat. The data were processed and compared there, and the results were returned to each school (Mizukoshi, Kim & Lee, 2000).

These types of learning activities bring about new scenes in schools. Meanwhile, it is noticeable that students are often found only active in hands-on activities, but not in tranformative interactions or higher-order thinking that lie at the heart of collaborative inquiry learning (Zhang & Lu, 2003; Zhang & Sun, in press). For the future development, there need a pedagogical shift from hands-on inquiries producing material artifacts to knowledge-building communities that continuously improve conceptual artifacts in form of ideas in a community knowledge space (Scardamalia & Bereiter, in press).

From 2000 to 2003, the International Association for the Evaluation of Education Achievement (IEA) coordinated the Second International Information Technology in Education Study Module 2 (SITES M2) to make an international review of case studies that reflect innovative pedagogical practices using technology (Kozma, 2003). Altogether 174 case studies were conducted and reported by research teams in the 28 participating countries/regions including China Hong Kong and Taiwan, Japan, Korea, Philippines, Singapore, and Thailand, as well those Western countries like Australia, Canada, Chile, and USA. An analysis of the 174 cases found that technology is supporting significant changes in classroom teaching and learning. They paint a very different picture than the traditional classroom where the teacher lectures in front of the classroom and students take notes or do worksheets. They show important

similarities in how technology is being used in many countries around the world. In these cases, students were often actively engaged in what are sometimes called "constructivist activities", such as searching for information, designing products, and publishing or presenting the results of their work. Students often collaborated with each other on these projects and occasionally they collaborated with others outside the classroom. Productivity tools, such as word processors and presentation software, were used in a majority of the cases, as were World Wide Web resources, email, and multimedia software. However, it is important to notice the limitations of these innovation cases:

(1) These technology supported innovations had a limited impact on the curriculum. Only 18% of the 174 cases reported a change in curriculum goals or content that was supported by technology;

(2) These innovations had limited impact elsewhere. While 75% of the innovations had been used for at least a year, only 41% provided evidence that the innovation had been disseminated to other classrooms or schools; and

(3) It is difficult to disseminate even successful innovations. This process of transfer is dependent on such factors as adequate infrastructure and resources, relevance to the new setting, teacher perceptions of the value of the innovation, and plans and policies that encourage the transfer of the innovation.

In comparison, the cases from Asian counties and regions were found lower in degree of innovations than the international average level (CITE, 2003). It is the fact that expository teaching approach is still dominating the practices in classrooms in Eastern countries at present. Since open inquiries and collaborations as well as ICT applications entails the profound changes in student-teacher relationships, they are often perceived by teachers as the threats to the order and disciplines in classrooms, and as challenges to an individual's world view (Worthington & Zhao, 1999). There is still a long way to go in order to achieve cost-effective sustainable, and scalable innovations using ICT.

The Vision into the Future

The above depicts an overview of ICT development and uses in education in Eastern APEC economies. Core issues and challenges have already been addressed along with the text. Before concluding this article, I'd like to make a vision into the future by highlighting three directions, which might be the case for not only Eastern but also Western countries.

Generalization and inclusion

In many Eastern APEC economies, ICT-enhanced learning has long been confined within the few classes of the few pioneer and volunteer teachers in the few top schools. It is an urgent task to generalize ICT in large scale to all practices of all teachers and all schools in both developed and underdeveloped areas.

Also, ICT should not be the privilege of those small advantageous groups. Every

student should have the opportunity to benefit from ICT, in spite of his/her social economical status, talent, characteristics, gender, ethic, or region. It is of critical importance to improve the universal access to ICT resources and avoid the possible "digital divide" in school environments. It is also important to find out the better ways to adapt classroom instruction to learners' individual differences- their learning styles, ability levels, and characteristics etc., and particularly to provide facilitative learning supports to those with special needs. In this aspect, the 100-School Networking Project (Phase II) in Japan made a meaningful trial to improve Internet access for handicapped children and students.

Internationally, it is important to notice the digital gaps between countries and cultures. Obviously, the English language and Western cultures are dominating the Internet. The Internet tends to reinforce the World Information Order, i.e. the flow of information from industrialized to developing countries; and fails to ensure mutual respect and the protection of the diversity of information, languages and cultures (Joo, 1999). This will very possibly reinforce the “cultural imperialism” in the information era (Blurton, 1999).

From access to actual adoptions and integrations

In the recent years, most Eastern countries have concentrated to raise the access rate of ICT in schools. However, even in areas that already have good ICT facilities, technologies are always found underused. According to a recent survey among schoolteachers (excluding ICT teachers) in Beijing, in average, primary teachers spent only 24 minutes per week on using computers in schools. This number is 38 minutes per week for secondary teachers. Most of these minutes were spent in writing teaching note, rather than on actual teaching processes. 87% of these teachers have never used computers in classrooms (Beijing Basic Education Teaching Research Center, 2003). This result converges with Cuban et al. (2001)’s qualitative study of two high schools located in the heart of technological progress, Northern California’s Silicon Valley. They found that access to equipment and software seldom led to widespread teacher and student use. Most teachers were occasional users or nonusers. When they used computers for classroom work, more often than not their use sustained rather than altered existing patterns of teaching practice. The seemingly marginal use of ICT in schools and classrooms is due less to inadequate funds, unprepared teachers, and indifferent administrators than it is due to dominant social beliefs about what teaching, learning and proper knowledge are and how schools are organized for instruction. In an examination-oriented educational culture, the average scores of the classes and the rate of students who are able to enter higher level schools or colleges are often regarded as the exclusive standards to evaluate teachers' work. This is disadvantageous to those volunteer teachers because the examination achievements do not fully reflect their efforts of ICT uses. New social context that encourages ICT uses and educational reforms should be established in schools.

Effectively using ICT to transform education entails the profound integration of ICT in the whole school environment: to integrate the technology with the perspectives of pedagogy and social culture in schools; to integrate ICT across the curricula; to

integrate ICT into all the fields of school activities including learning, teaching, management and professional development; and eventually to establish a new productive learning ecology incorporated with ICT in the whole school system.

Striving for sustainable and scalable innovations

Innovative learning and teaching practices are emerging. However, most of the innovations have prominent limitations in sustainability, scalability, and transferability. It is a challenging mission for both Eastern and Western world to find a route to achieve sustainable and scalable innovations in ICT-enhanced educational reforms.

As was noted by Demetriadis et al. (2003), teachers are willing to explore new modes of ICT-based teaching whenever school objectives permit, otherwise they appear to cautiously adapt the use of ICT to the traditional teacher-centered mode of teaching. Successful implementation of educational change in classrooms is a complex process, fabricated by a complex interaction of contextual factors at the school level as well as educational policies at the system level. Based on the analysis of international innovation case studies, CITE (2003) group in Hong Kong identified five major contextual factors that are of great importance: (1) school culture and background, including the school vision, the existence of a collaborative school culture, and the experience of carrying out innovations; (2) supportive principal leadership; (3) appropriate implementation strategies such as team-building, technical support; (4) government and community support; and (5) school ICT infrastructure. These contextual factors influenced changes at the school level within which the classroom innovations took place. This result is helpful for further explorations of sustainable and scalable innovations.

In order to achieve the widespread uses and integrations of ICT in education that can enhance sustainable innovations, we need adopt a systematic and holistic strategy that addresses not only technological and pedagogical issues, but also the transformations of the holistic school cultures including their curricula, evaluation standards, rules, division of labors, and core values and beliefs. In this global age, the Eastern and Western worlds are facing many common as well as culture-specific challenges and opportunities in development, hence have immense spaces to communicate and collaborate. This is particularly the case in the field of education.

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Biography

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