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Exploratory Study of Widespread Practice of ICT-Enhanced Education

-Leapfrogging Development Project: a Case Study of ICT Use in Schools in China

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【要旨】

近年、高度知識基盤社会では知識の急速な蓄積が教育システムに大きな変革をもたらそうをしている。各 国ではICT(Information and Communication Technology)を活用した新しい教育システムの試みが続けら れている。それらの試みの中でICT活用の妥当性及び有効性の検証は活発に行われているが、教育現場の高 度な複雑さから、ICT活用の全容はまだ解明されていない。

本稿では、中国において150校で検証された大規模ICT活用実践プロジェクト「跨越式課題」を紹介し、 その結果について検討する。本プロジェクトの狙いはICTを知識の種類に応じて、カリキュラムに高度に融 合にさせることである。また、各種の教授理論の比較及び検証を通じ、ICTの適性に応じて、より有効な活 用ができるように「教授構造」を分析する理論的枠組みと実践するためのインストラクションナル・デザイ ン手法を開発した。結果、本プロジェクトを通じて、児童・生徒の成績に大きな伸長がみられた。また、こ の手法はICT活用のダイナミクス理解にも有効ともいえるだろう。

1. Introduction

1.1 Challenge from rapid development of knowledge and crisis of education

Many scholars have talked about our transition to becoming a knowledge-based society (Drucker, 1993, Toffler, 1990, Quinn, 1992). During the process of transition, educational systems are also facing a great challenge because of the explosion of new knowledge. As Duffy and Jonassen (1992, p. ix) put it, "Traditional models of learning and instruction emphasized forms of mastering the information in a content domain... However, it is simply no longer possible (there is too much) or even reasonable (it changes too rapidly) to master most content domains." Detailed evidence and a description of this rapid societal change was provided by information scientists at the University of California, Berkley. In a study directed by Lyman and Varian (2003), statistics and analysis showed people produced about 5 exabytes of new information in 2002. Five exabytes of information is equivalent in size to the information contained in 37,000 new libraries the size of the Library of Congress book collections. If all of that information, which would take about 30 feet of books to store on paper. Moreover, it was estimated that newly stored information grew about 30% a year between 1999 and 2002. The study predicted that knowledge would continue to grow at an increasingly higher rate.

To meet the challenges caused by the rapid development of knowledge, policy makers around the world proposed ambitious education policies calling for greater personalisation, flexibility and inclusion. Laurillard pointed out that our current educational policies have the right ideas, but are probably unattainable. She provides one example saying that providing the extra time needed to increase individual teaching by just 10 minutes a week per primary school child would need the equivalent of an additional 3000 full-time teachers. However, governments cannot provide this kind of funding. (Laurillard, 2008)

Researchers argued that the great crisis of education and pedagogy is waiting to be solved with statements such as "Pedagogy's embarrassment and embarrassed pedagogy" (Chen, 1989), "On termination of pedagogy" (Wu, 1995) and "Pedagogy's embarrassment" (Zhao, 2001).

1.2 Nationwide projects for ICT-enhanced education in China

Information and Communication Technology (ICT) refers to devices or services such as personal computers, mobile phones, and the Internet. As usage has increased, ICT has drawn attention as a potential solution to current problems facing education systems. Many governments have begun trying to use ICT to enhance teaching and learning. In the United States, the Congressional Web-Based Education Commission was organized by the Department of Education and produced a report entitled, "The Power of the Internet for Learning: Moving from Promise to Practice" (2001). Also, in the United Kingdom, Japan, and Korea, similar ICT-related educational policies and nationwide projects have been launched since 1995.

In China, Zhi Li Chen, the former minister of the Ministry of Education, proposed that educational technology could be viewed as increasing the effectiveness of reforms of the education system (1998). However, there were many obstacles to creating a public ICT infrastructure at that time. In addition to receiving access to hardware, citizens and children also needed to learn ICT skills and literacy. Since then, the population of Internet users in China has increased dramatically and as ICT use has become more ubiquitous, larger scale projects and use in education has become possible.

However, in spite of the rapid growth of Internet users, the problems facing the Ministry of Education of China (MOE) are still numerous. One of them is the huge digital divide caused by the widely varying societal, cultural, and geographic conditions around China, making it impossible to provide one universal solution for the entire nation. Another problem is that exceptional teachers and digital resources for education are very limited in developing countries such as China.

To solve these problems, several nationwide projects have been conducted since 2000.

One of them is the Modern Distance Education Project for Rural Schools (MDEPRS) (2003-2007). It was designed to meet the needs of rural areas. Three different technology models were used and selected based on differing geographical and population distributions in the participating locations: a CD/DVD-TV playing centre with TV sets, DVD players and instructional CD's; a satellite resource-reception station

including satellite-reception systems, computers, televisions, DVD players and instructional resources; fully-networked computer classrooms with satellite-reception systems.

A lot of ICT equipment has been put into service by funds from the project. By 2006, 291631 CD/DVD-TV playing centres, 167113 satellite resource-reception stations, and 25389 computer classrooms had been built in rural areas in the western region of China. This nationwide distributive network for teaching and learning resources included 168793 rural elementary schools and 30329 rural junior high schools.

To ensure the effective use of the equipment provided by this project, digital resources are continuously developed and distributed to all project sites. By 2007, The National Center of Educational Technology had developed over 5831 lesson hours of multimedia instructional resources, 3130 lesson hours of video instructional resources, and 12507 lesson hours of traditional instructional resources. Over 300 lesson hours of new digital resources are provided for teachers and pupils in rural areas every week.

There are also some projects with wide area networks (WAN) in cities to meet the needs of metropolitan areas. Funding comes primarily from local governments with adequate budgets and enthusiasm for improving their education systems. These projects usually are run by local universities.

Experiments with higher level integration of ICT into educational practices are being conducted in conjunction with these projects. The results of these experiments are being used to develop technical standards for educational informatization, standards for teachers' educational technology skills and other technical materials. The results of the experiments are also very helpful in understanding the nature of ICT use in education under the diverse and changeable conditions in China.

2. Address of problems

2.1 Studies on validity and effectiveness of ICT use in education

There are numbers of studies on the validity and effectiveness of ICT use in education around the world. In the UK, a large assessment project called ImpaCT2 was conducted on ICT use in K-12 schools. The results of this study show a positive relation between ICT use and achievement, especially on the National Test (Harrison, et al, 2004). Another study by the United States Department of Education shows that students using online learning or blended learning (mixed online learning and face-to-face learning) performed better than those receiving face-to-face instruction (Means, B. et al, 2009). The findings also suggest that the positive effects associated with blended learning should not be attributed to the media, but learning time. In a study carried out in Japan, the positive effects of ICT are validated from data analysis of 752 ICT-enhanced classes held around Japan. In addition, teacher guided ICT-enhanced teaching were shown to be more effective (Shimizu, et al, 2008).

In a longitudinal study, results suggested that "the quantity of technology uses alone is not critical to increasing student learning" (Lei and Zhao, 2007). Moreover, when ICT use is not adapted for teaching and

learning, it may be more harmful than beneficial. In other words, the quality of ICT use is more critical to learning outcome than quantity.

However, current research related to ICT-enhanced learning may not be widely applicable because of the various factors that affect usability and success in real classroom environments. As Suchman pointed out, these practices "cannot be studied adequately in laboratory conditions because controlled experiments do not capture the rich context of social collaboration, where the interaction among variables undermines the validity of reductionist methods" (Suchman, 1987). Although researchers have found many characteristics of ICT use in the field of education, the relationship between ICT media and specific contexts within which ICT-enhanced teaching and learning occurs needs to be studied further to provide teachers a clearer direction for the instructional use of ICT in education.

2.2 Exploring the dynamics of ICT use in education in China

Differences in culture and history make the application of overseas research difficult in China. As a result, Chinese researchers need to develop new research methods tailored to specifically to China.

Kekang He (2007) suggests that the dynamics of ICT-enhanced teaching and learning could be described and analyzed by certain instructional patterns. In this theory, an instructional pattern is defined as a set of teaching activity procedures within specific teaching or learning environments which are designed based on instructional and learning theories. Examination and analysis of the dynamics of instructional systems can be completed by analyzing the relationships, interconnections and interactions between teachers and students and among the basic components of instructional patterns which include teaching materials and instructional/learning media.

Based on analysis of present-day problems and various traditional teaching styles in China through the theory of instructional patterns, He proposes that when ICT is used in education, the more flexible model of teacher guided learner-centered learning (TGLCL) would get better effects than the teacher-centered teaching model derived mainly from Soviet pedagogical traditions and learner-centered learning model from American pedagogical traditions. Because both teachers and learners can become the "center" at different times during the learning process, the model of TGLCL also is called "two centers model"

To verify He's theory, a widespread explorative study on ICT-enhanced learning practices has been carried out in China since 2000.

3. The Leapfrogging Development Project: Widespread practical project in ICT-enhanced education

3.1 Overview of the Leapfrogging Development Project

A widespread explorative study entitled, "Leapfrogging Development," has been conducted since 2000 in China. In this project, researchers (research staff and postgraduates interested in educational technology)

Exploratory Study of Widespread Practice of ICT-Enhanced Education —Leapfrogging Development Project: a Case Study of ICT Use in Schools in China

from universities cooperating with classroom teachers from schools integrate ICT into everyday lessons in classrooms using the Teacher Guided Learner-centered Learning (TGLCL) model. The goals of this project are to greatly improve achievement of pupils in all subjects, but especially Chinese and English classes, with the help of ICT and without adding lesson hours or additional homework for pupils.

The teaching strategies used in the project are not simply traditional strategies with ICT use added on, but redesigned to integrate ICT with traditional teaching strategies. Redesign took place through various interactions between researchers and teachers including training sessions, discussions, dialogues, meetings, workshops and conferences. The new teaching method that resulted was called "higher level integration of ICT into everyday teaching."

In many experiments, the achievement of pupils was greatly improved. As a result, more and more school districts began asking to participate in this widespread study. By 2008, there were approximately 145 participating elementary schools in 13 locations around China. To improve Chinese language teaching, even some schools in Singapore have participated in this project since 2007. There are over 4,400,000 results directly related to the project when the keywords of "跨越式课题" ("Leapfrogging Development Project" in Chinese) are searched for on google. com.

This widespread study has been helpful in examining the validity and effectiveness of ICT use in education. It incorporates action research as well as a longitudinal study and it has involved numerous researchers, postgraduates, classroom teachers, other teaching staff at all levels, and pupils. Many lessons integrating ICT were observed, discussed and improved. Some explorative studies have also been conducted to examine the dynamics of ICT-enhanced teaching and learning.

The author of this paper participated in the project as a sub team director and a lecturer since 2003, accumulating a lot of research data and experiences firsthand while in the field. This paper presents and reviews some of the more interesting results from participation in this project by the author.

3.2 Theoretical framework of blended teaching and learning theories

As previously stated, the dynamics of ICT-enhanced teaching and learning in this project are described as an Instructional Patterns, "a set of teaching activity procedures within specific teaching or learning environments which are designed based on instructional and learning theories" (He 2007). The relationship between teachers, students, teaching materials and instructional/learning media with regards to teaching procedures is analyzed through examination of instructional patterns. Under different theoretical frameworks for teaching and learning, teaching models and the dynamics of teaching and learning could be very different. He (2007) has done a detailed analysis of various kinds of theoretical frameworks for teaching and proposed a blended theoretical framework for integrating ICT use into everyday teaching. Prior to the 1990's, most instructional patterns in China were based on "teacher-centered teaching" with an emphasis on "teaching" and were influenced by the pedagogy of the former Soviet Union.

After the 1990's, "learner-centered" constructivist learning theories were introduced into China and became widely accepted in the field of pedagogy. In the field of educational technology, this kind of theory has also come to be considered providing a good descriptive framework for ICT use.

Under this kind of theoretical framework, three instructional structures could be analyzed as show below in Table 1.

From the debate instigated by Kirschner, Sweller and Clark (2006), defenders of constructivist learning theories have had to admit that teaching procedure is quite complicated so that "guided learning" is more suitable than "minimally guided instruction" (Tobias and Duffy, 2009). They have admitted that there are many types of knowledge including ontological, epistemological and phenomenological. A blended theoretical framework which is more flexible and can adapt to a wide variety of situations and provides different levels of teacher guidance as appropriate is better suited to real classroom teaching.

	Teacher-centered teaching	Learner-centered learning	Teacher Guided Learner-centered Learning			
Teacher	He or she is a transferor of knowledge, an active agency and an absolute authority on instructional procedure. He controls all procedures related to teaching activities.	He or she is an organizer for implementing a lesson, a mentor for students, a helper or facilitator that helps students to process information from teachers and other sources to develop their own interpretations regarding meaning and usage.	He or she is an active agency for transferring base knowledge such as facts and principles, also an organizer for implementing lessons, a mentor for students, a helper or facilitator that helps students to process information from teachers and other sources to develop their own interpretations regarding meaning and usage. He controls all procedures related to teaching activities.			
Student	He or she is a receiver of knowledge and a passive agency of outer stimulus.	He or she is an active agency for processing information and developing their own interpretations regarding meaning and usage from knowledge. He or she is not a passive agency for receiving knowledge.	He or she is an active agency for processing information and developing their own interpretations regarding meaning and usage from knowledge.			
Instructional/ learning media	These play a secondary assistant role as presentation tools to visual knowledge.	These are cognitive tools, cooperative tools and communicative tools for helping students to learning independently.	These include presentation tools used to visual knowledge. They also could be cognitive tools, cooperative tools and communicative tools for helping students to learn independently.			
Teaching materials	These are only learning materials for students and primary resources of knowledge.	These are not the only learning materials students use as primary resources of knowledge. Students can learn from multiple learning materials and resources including teachers, classmates, experts, websites, databases, CD's, libraries and other digital resources.	These are not only learning materials for students and primary resources of knowledge. Students can learn from multiple learning materials and resources including teachers, classmates, experts, websites, databases, CD's, libraries, and other digital resource.			

Table 1. ANALYSIS OF INSTRUCTIONAL PATTERNS IN THREE MODELS

3.3 Model of blended instructional design and development of digital resources to implement TGLCL

For the Leapfrogging Development project, a model of instructional design that is easier for classroom teachers to integrate into their existing teaching methods is provided for classroom teachers, which uses a blended instructional design modeled as shown in Figure 1.

Instructional strategies are developed according to the type of knowledge involved. When instructional goals target ontological or epistemological knowledge, classroom teachers would be advised to select a



Figure 1. Blended instructional design model for implement TGLCL (adapted from a figure in Kekang He,'s "Theory of Instructional Structure and Deep Reform of Instruction", E-Education Research 2007 (7) & (8))

model of "teacher-centered teaching" based on the Dick and Carey Model, a traditional instructional design model. On the other hand, when instructional goals target epistemological or phenomenological knowledge, they would be advised to select a model of "learner-centered learning".

Regarding development of digital resources, methods and a set of guidelines for selecting instructional/ learning media according to the characteristics of ICT involved as well as developing and selecting highquality digital resources for implementing TGLCL are made available to classroom teachers through training sessions, workshops and conferences. Classroom teachers are asked to develop and select interesting, activities context-appropriate digital resources to better motivate and engage learners and help them develop their own interpretations and usages of knowledge. Classroom teachers develop and select activities based on their curriculum and have continuous access to guidance from educational technology experts (researchers and postgraduates).

4. Experimental Procedure

4.1 Purpose

Different educational goals generate different dynamics. This is similar to the variety of ecological niches that can exist in a single ecosystem in nature. ICT can play different roles depending of the context it is used in.

The objectives of the study are to consider how to solve the problems with multiple contexts such as the digital divide while also meeting the requirements of the current education system in China such as increasing student achievement by analyzing teaching and learning in the authentic learning environments of real classrooms in China.

4.2 Participants

All schools participating in the project were divided into ten experimental districts spread around China. Six experimental teams are in charge of no more than two districts each. Members of the experimental teams are both from local schools and universities.

Members from local schools primarily included headmasters, teachers, technical staff from schools and the staffs of local education committees. These members deal with fields related to practical teachings.

The other members were from universities. These members deal with fields related to experimental designs and researches. As leader, one PhD candidate or one lecturer from a university direct and supervise two or three postgraduates or undergraduate students on every team.

Because an experimental district usually covers about ten schools, at least about twenty members are active in each experimental team, one researcher (PhD candidate or lecturer), two or three postgraduates and about twenty practical teachers. As a leader of one experimental team, the primary author of this paper was in charge of two experimental districts.

4.3 Procedure

The experiment was carried out in four steps.

In the first step, postgraduates whose major is educational technology visited participating schools. They interviewed school headmasters, practical teachers in the schools and staff of the local education committee. Standardized questionnaires were distributed to collect background information about pupils, parents, teachers, other school staff, hardware such as ICT devices, Internet access and school facilities as well as determine the problems in instructional methods to be solved. The information was analyzed and used to create a customized solution for each school. The experimental teams usually spent an entire day carrying out this first step.

In the second step, a local educational information infrastructure was created by postgraduates by connecting the participating school to a virtual private network which links all member schools and provides access to the Internet. At the center of this network, a server with running a database was setup. All of the digital resources developed could be uploaded, shared and managed through the digital resource distributive network (see figure 2). The funding to set up this network was provided by the local governments. The experimental team usually spent less than a week carrying out this step.

In the third step, the theoretical framework is taught to classroom teachers. Postgraduates gave lessons to teachers on fundamental concepts and educational theories, analysis methods of instructional structure, methods of designing blended instructional procedures, and the selection and development of digital resources using tools such as Microsoft Word, PowerPoint, and Adobe Flash. An experimental team would spend one week training for teachers.

These three steps comprise the preparation stage. After finishing them, the main part of the experiment started with the fourth step.

All team members including postgraduates and teachers listened to lessons by every teacher member. After that, workshops and discussions were conducted to try to find problems in the current instructional methods. Some potential solutions to the problems were discussed and proposed by researchers and postgraduates. According to the advice given, teachers selected and developed digital resources using blended instructional design to implement TGLCL. The instructional designs were executed in teachers' daily lessons. The teaching using ICT-enhanced learning environments and instructional design was carried out in daily Chinese language lessons. Figure 3 shows one ICT self-learning program created as part of the project.



Figure 2. Interface used to upload, share and manage digital resource



Figure 3. Pupils' self-learning using ICT-enhanced learning environments under teacher's guidance

An active development/revision process was followed with at least two workshops held with all team members in a local district every month. At other times, teachers could share and refer to shared digital resources as well as communicate with each other using web-based instant message software, email or BBS. Once every year, representatives from around the nation gathered to share and communicate experiences at a national conference.

4.4 Research methodology

Because of complexity in analyzing factors related to teaching and learning in the field of education, multiply research methodologies were adapted to collect a wide variety of information as much as possible during the study. These methods included participating observation, interviews and questionnaires, analysis of video of lessons and teaching portfolios, grounded theory based qualitative study and quantitative study on improving the achievement of pupils. Different teams used different methodologies based on the particular environments in their respective schools under study.

5. Results and discussions

5.1 Data collection and analysis

As Table 2 shows, quantitative data was collected to compare the achievement scores of the experiment group (group 1) with the control group (group 2). The group division method was random. A pre-test was given and pupils in the experimental group and control group were found to have statistically equivalent academic achievement at the beginning of the study. A small number of experimental group subjects had worse achievement scores than the control group subjects. Teachers in both the experimental groups and control groups had diverse backgrounds and included older teachers, younger teachers, master teachers, and novice teachers. There was not a significant difference between teachers for the experimental group and the control group. In the control group, teachers used traditional teaching methods based on a teacher-centered teaching model. In the experimental group, teachers used blended teaching methods based on a TGLCL model and frequently used ICT. Teachers in the experimental group were prohibited from added lesson hours or homework while teachers in the control group were free to teach without any restrictions.

Table 2 shows data for the study with 3048 subjects in the experimental group and 2394 subjects in the control group. The data was collected from an achievement test which was carried out simultaneously in the same grade at 48 participating schools distributed across 11 districts. The pupils in the experimental group participated in the experiment for one year.

	Group	Ν	Mean	Std. Deviation	Std. Error Mean	
Reading Chinese in Kanji	$\frac{1}{2}$	3048 2394	23.25 20.86	4.720 4.909	.085 .100	
Reading Chinese comprehension	$\frac{1}{2}$	3048 2394	24.89 19.83	8.692 8.875	.157 .181	
Writing Chinese by hand	$\frac{1}{2}$	3048 2394	11.17 9.39	2.734 3.507	.050 .072	
Writing Chinese by computer	$\frac{1}{2}$	3048 2394	11.32 8.97	3.011 3.886	.055 .079	
Total score	$\frac{1}{2}$	3048 2394	70.54 59.19	15.572 16.929	.282 .346	

Table 2. DATA COMPARATIVE ANALYSIS IN SUBJECT OF CHINESE (in June 2004) Group Statistics

The achievement test was designed by a team of experts consisting of researchers from universities and exceptional classroom teachers. After three rounds of negotiations and discussion, the members reached agreement on the content of the achievement test. ZHANG Hai, HE Kekang

The test covered reading Chinese characters, Chinese language comprehension, writing Chinese by hand and writing Chinese by computer. The mean score of the experimental group was higher than the control group in all of the subject areas. The standard deviation of scores for the experimental group was lower than the control group in all of the subject areas.

As Table 3 shows, there were significant differences between the experimental group and the control group. The pupils of the experimental group showed greater achievement.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
			Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Reading Chinese in Kanji	Equal variances assumed Equal variances not assumed	14.307	.000	18.154 18.068	5440 5041.910	.000 .000	2.38 2.38	.131 .132	2.125 2.123	2.639 2.640
Compre- hension	Equal variances assumed Equal variances not assumed	.466	.495	21.140 21.087	5440 5088.499	.000 .000	5.06 5.06	.240 .240	4.595 4.594	5.535 5.536
Writing Chinese by hand	Equal variances assumed Equal variances not assumed	121.334	.000	20.975 20.369	5440 4430.329	.000 .000	1.77 1.77	.085 .087	1.609 1.604	1.940 1.945
Writing Chinese by PC	Equal variances assumed Equal variances not assumed	164.510	.000	25.133 24.390	5440 4411.533	.000 .000	2.35 2.35	.093 .096	2.166 2.161	2.533 2.538
Total score	Equal variances assumed Equal variances not assumed	20.975	.000	25.697 25.440	5440 4922.942	.000 .000	11.36 11.36	.442 .446	10.490 10.482	12.223 12.232

Table 3. DATA COMPARATIVE ANALYSIS IN SUBJECT OF CHINESE (in June 2004) Independent Samples Test

During the experimental process, reflections of classroom teachers and video records of lessons were also collected to be analyzed as a supplement to the quantitative data. The reflections of classroom teachers showed that there was a great improvement in critical skills, motivation, and literacy by pupils in addition to the improved achievement scores.

5.2 Discussion

To help alleviate current education problems including the digital divide, a small group of exceptional classroom teachers was assembled, a common theoretical framework introduced, and a distributive digital network was built for sharing ideas and digital contents. This allowed experiences and teaching materials such as lesson plans from classroom teachers to be shared, discussed and studied by researchers as well as other teachers.

Teachers have to balance meeting the requirements of the pre-existing educational system while they implement new teaching methods integrated with ICT. The dynamics of traditional teaching methods were studied through dialogues between researchers and teachers. Class time was limited so teachers had to fulfill traditional teaching requirements in less time in order to add ICT-enhanced learning to their teaching.

There were different problems for different subjects, different schools, and even for different teachers. For example, there were two areas that were difficult to teach using traditional methods in Chinese language classes: reading Chinese characters and writing Chinese. After discussion and analysis by Chinese language researchers, it was concluded that teachers should focus on the application of language. Therefore, when developing instructional design and digital resources, teachers should put the emphasis on provoking interest in learning the Chinese language, pronunciation of the Chinese language and structured writing.

Analyzing the pre-existing skill levels and contexts (parent literacy, levels of teachers, etc.) of children in China, two goals of the experiment were considered for the subject of Chinese language for experimental groups. First, pupils of grade two in elementary schools should be able to read 2500-3000 Chinese characters in two years so that they have the ability to read newspapers and books fluently. Second, they should be able to write compositions which have a length of 800-1000 characters by hand or by computer.

According to the pupils' performance, the children in the experimental groups had better achievement scores in the subject of Chinese language. The motivation of children greatly improved so much that they spontaneously began to write stories and fiction which they published on the class BBS. Some fiction pieces even had hundreds of thousands of words.

In addition to improvements in academic achievement, students have obtained other benefits. For example, they adjusted to learning within ICT-enhanced learning environments. They also learned information literacy. Some teachers also said that students had become more polite than in the past.

According to discussions by teachers and postgraduates at workshops and seminars, ICT-enhanced teaching and learning should be developed to accommodate the cognitive characteristics of pupils and teaching subjects. With the support of these learning resources, based on the innovative instructional design, pupils would learn in the environment for reading or listening. Teachers play a key role in designing these digital learning environments because they are the people that are most familiar with learners and teaching subjects.

Social contexts vary greatly so digital contents often need to be redesigned and redeveloped. Children in different situations have different strengths and weaknesses. Their parents also have wide-ranging contexts. A uniform development framework of reused digital teaching resources can improve the efficiency of teachers. For teachers, the basic steps of developing teaching resources are as follows: completing the instructional design draft of one lesson or one unit, searching related materials and integrating them into lessons. According to detailed interviews, we found that the period of transformation of teaching styles of teachers from traditional delivery models to constructivist ICT-enhanced learning and teaching models was long. It was not an easy process even with the help of experts. The support of school leaders was very important.

6. Conclusion

In this paper, an exploratory study of widespread practice of ICT-enhanced education in China was presented including part of the results of the China Leapfrogging Development Project, a case study of ICT use in schools in China.

The project involved over 100 schools and over 10,000 pupils. The study has been continuing for 9 years since it started in 2000. Many characteristics of ICT-enhanced teaching and learning have been examined and verified by various methods. Similar to other studies on ICT use in schools, the results show ICT use can significantly improve the achievement of learners.

In the study, many specific characteristics of ICT and the contexts within which ICT use occurs were studied to try to uncover the ecological niches of various kinds of ICT in authentic learning environments. The results of this study may make higher level ICT integration possible in everyday teaching rather than simply using traditional teaching methods with ICT.

The dynamics of ICT use in an authentic context using an analytical theoretical framework of instructional structures was studied. Many traditional pedagogical approaches and constructivist approaches were examined in the process of this framework. Finally, a blended approach to implementing ICT use in everyday teaching was proposed. This study verified the validity and effectiveness of the teacher guided learner-centered learning (TGLCL) model.

7. Future direction

There are several ways that the results of this study could be developed in the future.

First, a comparative study is needed to provide more detailed data showing the difference in efficiencies of so-called "higher level ICT integration into everyday teaching" and teacher guided learner-centered learning. This kind of performance-price ratio problem is important to justify the "cost" in time and effort required by teachers to implement ICT-enhanced learning.

Second, a set of assessment and measurement techniques for ICT use need to be developed. Traditional assessment and measurement techniques used in the field of psychology for teaching and learning are based primarily on teacher-centered learning. They don't take into account ICT use and the flexible learning methods possible using these new tools. This makes it difficult for researchers to analyze ICT-enhanced learning in depth and explore the roles and relationships of the wide range of variables and

factors involved in the processes of teaching and learning.

Also, the development of handheld and computing technologies is making the storage and analysis of learners' behaviors and interactions easier. Use of these tools could help us further understand the process of learning and development for students and create better, more effective learning resources for students in the future.

Reference

- Bruer, J.T. 1993. Schools for Thought. Cambridge, MA: MIT Press.
- Chen, G.S. 1989. "Pedagogy's Embarrassment and Embarrassed Pedagogy", <u>Journal of East China Normal</u> University. 1989(3).
- Chen, Z.L. 1989. "Pushing Reform of Education System through Implying Educational Technology", <u>Newspaper</u> of Education in China.
- Drucker, P.F.1993 Post-capitalist Society. Butterworth Heinemann.
- Duffy, T.M., & Jonassen, D.(eds.). 1992 <u>Constructivism and the technology of instruction: a conversation</u>. Lawrence Erlbaum Associates.
- Harrison, C., Lunzer, E.A., Tymms, P., Fitz-Gibbon, C.T. & Restorick, J., 2004. "Use of ICT and Its Relationship with Performance in Examinations: a Comparison of the ImpaCT2 Project's Research Findings Using Pupillevel, School-level and Multilevel Modelling Data", Journal of Computer Assisted Learning, 20(5), pp.319-337.
- He, K.K. 2007 "Theory of Instructional Structure and Deep Reform of Instruction", <u>E-Education Research</u> 2007(7)&(8).
- Kirschner, P. A., Sweller, J., & Clark, R. E. 2006 "Why Minimal Guidance During Instruction Does Not Work: an Analysis of The Failure of Constructivist, Discovery, Problem-Based Experiential and Inquiry-Based Teaching". Educational Psychologist, Vol. 41(2), pp. 75-86
- Laurillard, D. 2008 <u>Digital technologies and their roles in achieving our educational ambitions.</u> retrieved Oct 30th. 2009 from the World Wide Web:

http://www.lkl.ac.uk/cms/files/jce/presentations/laurillard-inaugural-20080226.ppt, (2008).

- Lei, J. & Zhao,Y. 2007 "Technology Uses and Student Achievement: a Longitudinal Study" <u>Computers &</u> Education Vol.49 pp. 284-296
- Lyman, P & Varian, H. R. 2003 <u>HOW MUCH INFORMATION 2003</u>? retrieved Oct 30th. 2009 from the World Wide Web: http://www2.sims.berkeley.edu/research/projects/how-much-info-2003/index.htm
- Means, B., Toyama, Y., Murphy, R., Bakia, M. & Jones, K. 2009 <u>Evidence-Based Practices in Online Learning: A</u> Meta-Analysis and Review of Online Learning Studies. Centre for Learning Technology.
- Quinn, J.B. 1992 Intelligent Enterprise: a Knowledge and Service Based Paradigm for Industry. The Free Press.
- Resnick, L.B. 1987. <u>Education and Learning to Think.</u> Committee on Mathematics, Science, and Technology Education, Commission on Behavioral and Social Sciences and Education, National Research Council. Washington, DC: National Academy Press.
- SHIMIZU Yasutaka, YAMAMOTO Tomohiro, HORITA Tatsuya, KOIZUMI Rikiichi, YOKOYAMA Takamitsu 2008 "The Comprehensive Analysis Results for Advancement of Student's Academic Achievement in Classes by Use of ICT", Japan journal of educational technology Vol. 32(3) pp.293-303
- Suchman, L. A. 1987 Plans and Situated Actions: the Problem of Human-Machine Communication. Cambridge University Press.
- Tobias, S. & Duffy T. D. (Eds.) 2009 <u>Constructivist Instruction: Success or Failure?</u> NY: Routledge, Taylor, & Francis.
- Toffler, A. 1990 Powershift: Knowledge, Wealth and Violence at the Edge of the 21st Century. Bantam Books. Wu, G. 1995. "On Termination of Pedagogy", Research of Pedagogy. 1995(3).
- Zhao, M.C. 2001. "Pedagogy's Embarrassment", Reading. 2001(5).

Exploratory Study of Widespread Practice of ICT-Enhanced Education —Leapfrogging Development Project: Case Study of ICT Use in Schools in China

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Abstract In recent years, the knowledge explosion of the knowledge-based society has significantly challenged the present education system. One of the solutions is the use of ICT (Information and Communication Technology) to improve the education system. Although its validity and effectiveness are studied by researchers around the world, for the higher complexity of the field of education, the detailed dynamics of ICT use is still to be unearthed. This paper reviews an exploratory study of the widespread practice of ICT-enhanced education in 150 schools in China. One of the aims of the project is to implement higher level ICT integration in everyday teaching by matching the characteristics of ICT and the types of knowledge. The other aim is to develop some methods for uncovering the dynamics of ICT use in education. An analytical framework is developed through "instructional structure" and relational methods of instructional design are designed. The results of the experiments show that these methods are valid and effective for ICT use in education.

Keywords: ICT-enhanced education, ICT integration, analytical framework, primary school, instructional structure