Students' 21st Century Skills Development in Technology-rich Learning Environment: A Study towards Analyzing Teachers' Lesson Plans in Chinese Primary Schools

Chen CHEN, Bao-ping LI*
School of Educational Technology, Beijing Normal University, China
*libp@bnu.edu.cn

Abstract: More attention is paid in students' 21st century skills development in China. This paper presented the cultivation of 21st century skills in Chinese primary schools by analyzing 20 lesson plans in technology-rich environment. The paper found teachers focus more on learning and innovation skills and lack aware of information, media and technology skills. In 1:1 technological environment students had more opportunities to develop 21st century skills than non 1:1 environment. There were also some differences between subjects.

Keywords: 21st century skills; lesson plan analysis; technology-rich learning environment; Chinese primary education;

1. Introduction

In the new age, many organizations such as the Organization for Economic Cooperation and Development, The National Research Council, and the Partnership For 21st Century skills have proposed the standards of 21st century skills. Some researchers compared them and proposed that standards given by P21 (Partnership For 21st Century skills) is much more comprehensive than others (Zhou, Zhang& Zhang, 2015). Even some details of frameworks are different, advanced thinking and learning skills for 21st century such as critical thinking, problem solving, and creation are primarily focused. In China, with the social development and education reform process, more attention are paid in the cultivation of 21st century skills rather than just focus on the assessment of basic knowledge. Niu(2012) pointed out that P21 framework is also the most connectible one with the requirement of New Course Reform Standards issued by Chinese government.

Charalambidis (2014) proposed that in order to provide to the students significant 21st century skills, a pleiade of ICT tools is needed such as an efficient infrastructure (internet access, multi-touch LCD interactive boards, tablets and so on) as well as the proper educational content. Many researches also advocates for accessing technology like Skype, blog, GPS(Global Positioning System) for incorporating 21st century skills into academic content(Walser,2008; Knobel and Wilber,2009; Sprenger,2009). Zurita, Baloian, Hasbun(2015)designed a blended learning environment enhanced undergraduate students' meaningful learning practicing 21st century skills and found a positive development. In the technology-rich environment, K-12 schools should take advantage of e-learning for the development of 21st century skills (Kong, Chan, Griffin, et.al, 2014).The Chinese government also invested a large amount of money in the construction of technology-rich learning environment in schools for students' comprehensive development in the past five years.

Learning By Design approach that can help teachers develop a flexible and situated understanding of technology (J. Koehler & Mishra, 2005). Also, with the benefits acknowledged of Teachers as Designers (TaD), more research is needed to understand how teacher involvement in design impacts the quality of the artifacts created, their implementation, and ultimately, students learning(Kali, Kenny & Sagy,2012).In order to know more about the cultivation of 21st century skills in technology-rich environment in Chinese primary schools, lesson plans could be an effective way. Lesson plan provides the researcher information about a larger unit of teaching than observation (Jacobs, Martin & Otieno, 2008).

There are some researches of 21st century skills by analyzing teacher's lesson plans. Forty-three graduate students in a university-based teacher training program were asked to incorporate

at least one 21st century skill into each of their lesson plans. In the created 167 lessons, 46 times of the 21st century themes were addressed, and 218 times for the Learning and innovation skill, 81 for the Information, media and technology skill and 45 for the Life and career skills. Forty-five lesson plans from the Ohio Resource Center database were randomly selected and analyzed to determine which P21 skills have been integrated into each lesson. 21st century themes were only addressed six times and Learning and Innovation skills were included most frequently similarly to the pre-service teachers (Gut,2010). Niu (2012) has focused on the cultivation of 21st skills by analyzing lesson plans in the 1:1 tablet-computer environment in Shanghai and tried to give some guidance and advices for teachers in class activities designs.

The study chooses 20 lesson plans from in-service teachers in Futian district of Shenzhen City to analyze their pedagogical designs. Shenzhen is a developed city in China with an early start of e-Learning so these samples represent a better level of technology and curriculum integration. Therefore, the research aims to analyze the current situation of 21st century skills cultivation from in-service teachers' lesson plans by descriptive statistics and compare differences in 1:1 and non 1:1 learning environment and diverse subjects.

2. Methods and procedure

2.1 Samples

The 20 lesson plans are full samples from a competition named *Creative Lesson Plans in Technology-rich classroom.* All the lesson plans were implemented in the class. Six Chinese lesson plans, two math lessons, two English lessons, five Science lessons, and five Art lessons are included. All of the teachers have training experience of technology-enhanced instructional design. The technology environment is different in each school and detailed information can be seen in Table1. Classes equipped with intelligent terminal like tablet computer, computer, and mobile phone for each student can be defined as 1:1 learning environment. While the others are defined as non 1:1 learning environment.

Table1: Technological learning environments of the samples

	Hardware	Frequency	Software	Frequency
Non 1:1 environment	Computer +projector (for teacher-used only)	3	PowerPoint Only	2
			Micro class video	1
	Interactive Whiteboard	4	Interactive Response System & Interactive Courseware	4
1:1 environment	1:1 Desktop PCs	7	Cognitive tools*	10
	1:1 Tablet computer	5	Tablet Course Management	3
	1:1 Smart phone	1	Cognitive tools	1

** Software like Concept map that facilitated learners' cognitive process*

3.2 Instrumentation

As it mentioned above, the P21 framework (clarified detailedly by Trilling and Fadel,2009 *in 21st century skills: Learning for life in our times*) was chosen as the grounding one and there are little changes for the following considerations: (1) divide the sub-skills of "Critical thinking and problem-solving" into two sub-skills separately, because in some lesson designs they may not appeared at the same time (2) delete the sub-skills of "Initiative and self-direction", which is not easy to extract from lesson plans (3) add the sub-skills of "Application of knowledge in life", which is thought to be very important as kind of Life and Career skills.

By analyzing the lesson plans, the study found that some of the cultivation of 21st century skills are obvious to see in the "instructional objectives" like "promote students' abilities of communication and collaboration by group work", while some are implicit like "ask students to use mobile phones to test the noise level" (can be seen as the skill of ICT literacy). Then we give detailed descriptions and examples as guidelines in Table2.

Table2: The description of 21st century skills analysis framework

	Sub-skills	Descriptions	Examples
Learning and innovation skills	Critical thinking	Reason effectively; Use systems thinking; Reflect critically	Teacher asks the question " Do you think robot must be similar with real person? Why?"
	Problem-solving	Make judgments and decisions; Solve different kinds of non-familiar problems in both conventional and innovative ways	Students need to solve different kinds of problems in inquiry activities
	Communication and collaboration	Communicate clearly; Collaborate with others willingly and responsibly	Students are divided into different groups to finish tasks
	Creation and innovation	Creative thinking and working with others; Implement innovations	Students propose their ideas for creation and make them into real product like robots
Information, media and technology skills	Information literacy	Access and evaluate information efficiently and effectively; Use and manage information	Students search and evaluate information on the internet
	Media literacy	Analyze media and create media products	Students need to choose proper kinds of media to show the project work
	ICT literacy	Apply technology effectively	Students use mobile apps to test the noise level
Life and career skills	Application of knowledge in life	Connect and use knowledge in real life	Students observe and take photos of the spot in life before learning "spot"
	Flexibility and Adaptability	Adapt to change and be flexible	Students write papers in different roles
	Social and Cross-cultural Interaction	Interact effectively with others; Work effectively in diverse teams	Students interview people from community and government
	Productivity and Accountability	Manage projects and produce results;	Students design and optimize questionnaires for research activities;
	Leadership and Responsibility	Guide and lead others; Be responsible to others	Students choose one leader of each group and take relevant responsibilities

3.3 Coding

According to the standards above, two graduated students with experience of teaching guidance in technology-rich environment and coding works are as the coders in the research. The rule is that once the coders see the cultivation of sub-skills in lesson designs they remark 1 times and repeated sub-skills in the same lesson plan is not included. Jaccard Similarity Coefficient (JSC) was computed as a measure of inter-rater reliability and the areas of disagreement were discussed and rectified. In JSC test all the items are more than 0.7, which imply the coding has a good reliability.

4. Results

4.1 Overview

As shown in table 3, in all the 20 lesson plans there were 104 times of sub-skills can be remarked. Learning and innovation skills were identified most frequently (55times), particularly the creation and innovation skill. The fewest were Information, media and technology skills with 22 times. It can also be seen that there's lack of attention on the sub-skill of Social and cross-cultural communication as well as Production and accountability skill.

Table 3: The result of teachers' cultivation of 21st Century Skills in the 20 lesson plans

21st Century Skills	Frequency	Percentage

Learning and innovation skills	Critical thinking	11	52.9%
	Problem-solving	15	
	Communication and collaboration	13	
	Creation and innovation	16	
Information, media and technology skills	Information literacy	8	21.1%
	Media literacy	4	
	ICT literacy	10	
Life and career skills	Application of knowledge in life	17	26%
	Flexibility and Adaptability	5	
	Social and Cross-cultural communication	1	
	Production and Accountability	1	
	Leadership and Responsibility	3	

4.2 Comparison of different technological environment

There's difference in the cultivation of 21st century skills between two different environments as Figure 1 presented. In the 1:1 digital classroom, there are more opportunities for students to develop 21st century skills not only in the quantity, but also in a wide range. Abilities such as information literacy, media literacy, leadership and responsibility, social and cross-cultural skills could not be found in non 1:1 environment lesson designs. However, skills of critical thinking, application of knowledge in real life, non 1:1 environment outweigh the 1:1 environment. (The number is the average frequency of item in each environment)

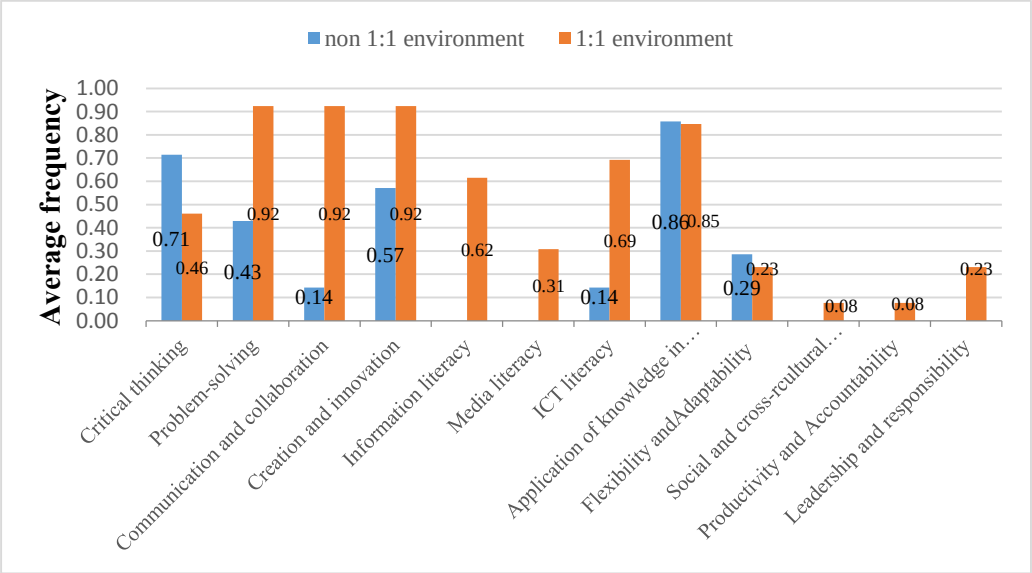

Figure.1 Comparison of 21st century skills in 1:1 and non 1:1 environment

4.3 Analysis on high-quality lesson plans

Seven lesson plans, which win the first and second prize in this competition were chosen as representations of high-quality samples. The scoring standards of this contest include design philosophy (10%), instruction content (30%), class activities (30%), assessment (20%) and innovation (10%). Student-centered learning design with comprehensive ablity-based assessment, usage of new ICT tools or creatively integration of technology ,which lead to meaningful learning were well accepted and encouraged. All the works were reviewed by one professional teacher and one experienced postgraduate in university. There's also a discussion on works with divergence and one doctor and two postgraduates were invited to make a final consensus. These samples were student-centered class and teacher encouraged students to engage learning by project-based learning, inquiry learning and so on.

There are two main characteristics in the cultivation of 21st century skills of these high-quality ones. Firstly, the average skill frequency is higher, which is 6.14 (43/7=6.14), comparing with the average frequency in all samples which is 5.2(104/20=5.2). Moreover, Table 4 shows the

number of sub-skills in each plan and it can be seen that among these seven plans, six of them covered all the three aspects of skills, which means that the teachers focused more on the comprehensive development of students.

Table 4: Frequency of 21st century skills in the high-quality lesson plans

	Learning and innovation skills	Information, media and technology skills	Life and career skills
No.1	2	0	2
No.2	4	1	2
No.3	3	1	1
No.4	3	3	3
No.5	3	2	2
No.6	2	2	2
No.7	3	1	1

4.4 21st century skills in different subjects

Five subjects were classified into three kinds of courses: Chinese and English as Language courses(8 lesson plans) ; Math and Science as Science courses(7 lesson plans) ; and art courses(5 lesson plans) . Figure 2 demonstrates a difference of 21st century skills in different kinds of subjects (the number represents the average times). It can be seen that science and art courses contributes more to the cultivation of Learning and innovation skills and Information, media and technology skills than language courses.

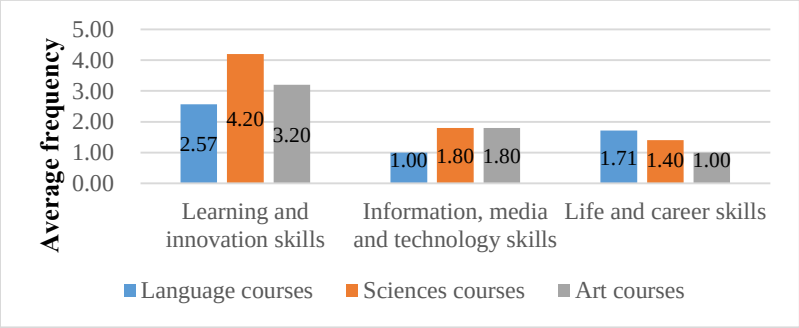

Figure2. Comparison of of 21st century skills in different subjects

5. Conclusion and discussion

The research focused on the overview and comparison between different technological environment, quality and subjects of cultivation of 21st century skills in primary education from teachers' lesson plans. There're also observation in teachers' design skills and technology pedagogical and content knowledge (TPACK).

Similarly with research of Gut (2010), Learning and innovation skill takes the largest proportion, while the other two is lack of attention. And this is a little different with research by Niu(2012)finding that Information, media and technology skill is the highest. The probable reason is that in the environment of 1:1 tablet computer classrooms, each student own a device and more opportunities are provided for promoting Information, media and technology skills. In this analysis, the study also found that in non 1:1 environment, teacher seldom ask students to use the technology in the classroom or at home so they have little chances developing this kind of skills, which remind teachers raising the awareness on this.

Even the quantity and range of 21st century skill development is better in 1:1 learning environment, we should realize that it's the teachers' design, not technology, is the critical factor. In some classrooms there are one computer only but many heuristic questions and activities helping students to construct their knowledge can be found in the lesson plans, thus the skills frequency is very high, such as critical thinking and application of knowledge in life. Also, in the high-quality lesson plans, teachers adopt the student-centered pedagogical methods with using technology in a constructive way. For example, in a science lesson, a mobile application of smart phone named Baidu

Map with the function of GPS were used for students to learn the knowledge of maps, and to explore the surroundings in their real life. Teachers adopted constructive alignment with ability-based goal, well designed learning activity and assessment criteria in a rich, authentic and practical context for technology-enhanced active learning and also promote their professional development.

Comparing with science and art courses, language course teachers need to pay more attention in the cultivation of 21st century skills. Social and intercultural communication is low for just appearing once, which gave a potential space for language teaching. Cutshall (2009) suggests the use asynchronous communication methods like Skype and Web sites that provide global connections to enhance the teaching and learning of foreign languages and such interactions provide support for developing global awareness, and social and cross-cultural interaction, in addition to communication and collaboration skills.

By analyzing the plans, we found that teachers tended to use the technology proficiently learned in the training program before, which shows the importance of supporting of TaD in technology enhanced learning environment. Teachers' perception of TPACK development throughout ICT lesson design could be complex thus the variations among different groups of teachers need to be better understood (Kho& Chai, 2013). For this group, comparing with technology pedagogical knowledge (TPK), more attention should be paid in the improvement of technology content knowledge (TCK).

This is a pilot study and it has many limitations. The amount of lesson plans is small and it's better to make a more precise analysis integrating the class observation, students' and teachers' perceptions in each item. In the future, the framework of the scale will be improved and the larger samples will be used for analysis.

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References

Charalambidis, D. (2014). ICT in the Future Classrooms and Teaching: Preparing the Knowledge Workers of the 21st Century. *Artificial Intelligence Applications and Innovations*. Springer Berlin Heidelberg, 56-62.

Cutshall, S. (2009). Clicking across cultures. *Educational Leadership, 67*(1), 40–44

Jacobs, C. L., Martin, S. N., & Otieno, T. C. 2008. A science lesson plan analysis instrument for formative and summative program evaluation of a teacher education program. *Science Education, 92*(6), 1096-1126.

Kali, Y., McKenney, S., & Sagy, O. (2015). Teachers as designers of technology enhanced learning. *Instructional science, 43*(2), 173-179.

Koehler, M. J., & Mishra, P. (2005). Teachers learning technology by design. *Journal of computing in teacher education, 21*(3), 94-102.

Koh, J. H. L., & Chai, C. S. (2014). Teacher clusters and their perceptions of technological pedagogical content knowledge (TPACK) development through ICT lesson design. *Computers & Education, 70*, 222-232.

Kong, S. C., CHAN, T. W., GRIFFIN, P., HOPPE, U., & YU, S et al. 2014. E-learning in school education in the coming 10 years for developing 21st century skills: Critical research issues and policy implications. *Educational Technology & Society, 17*(1), 70-78.

Niu,L.2012. Framework Design of Teaching Activities to Training Primary and Middle School Students' 21st Century Skills in the One-to-one Digital Learning Environment (In Chinese).Shanghai: Shanghai Normal University.

Walser, N. (2008, September/October). Teaching 21st century skills. Harvard Education Letter,24(5). Retrieved from http://www.hepg.org/hel/article/184

Wan, G. and D. M. Gut, et al. (2011). Integrating 21st Century Skills into the Curriculum. G. Wan and D. M. Gut, Springer Netherlands: 137-157.

Sprenger, M. (2009). Focusing the digital brain. *Educational Leadership, 67*(1), 34–39.

Trilling, B., & Fadel, C. (2009). 21st century skills: Learning for life in our times. John Wiley & Sons.

Zurita, G., Hasbun, B., Baloian, N., & Jerez, O. (2015). A Blended Learning Environment for enhancing Meaningful Learning using 21st Century Skills. In Emerging Issues in Smart Learning (pp. 1-8). Springer Berlin Heidelberg.

Zhang,Q.,Zhang,Y. & Zhang,Y.2015.Preparation for Opportunities and Challenges in the New Age----Contrastive Analysis of Framework and Element of 21st Century Skills(In Chinese).*Journal of Capital Normal University,36*(1)65-69