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Learning payoff of ICT: What can make a difference from the perspective of students

Chunli WANG
Department of Educational Information Technology, East China Normal University, China
591364776@qq.com

Abstract: This study evaluated the payoff of Information and Communications Technology (ICT) on learning in China using a multiple case study design. Cases of how students used ICT for learning in 2005 and 2015 were collected from Shanghai K-12 schools. Semi-structured interviews and scales were the main data collection techniques utilized in the study. By case coding, the results showed that ICT influenced learning practice and skills. Furthermore, individualized ICT devices, specific learning resources, and refined activity contributed to the payoff.

Key words: Information and Communication Technologies, payoff, learning, case study

1. Introduction

The Chinese government has invested a certain amount of money on Information and Communications Technology (ICT) for education. From the beginning of the 21st century, the ICT access of schools has been improved significantly owing to policies such as "The Tenth Five-year Plan of ICT in Education" and "The Plan for ICT in Education (2011–2020)" (Ministry of Education of China, 2016). However, the effect of ICT in Chinese education, which features rote memorization and exam preparation, remains unclear. This study aims to provide a holistic view of the effect of ICT on learning using a multiple case study design.

2. Literature Review

2.1 Learning payoff of ICT

The data supporting the effectiveness of ICT in schools is, at best, mixed (Kirkpatrick & Cuban, 1998). Standardized tests for students are cited as a primary measure for program success. Studies upholding this view started with Angrist and Lavy (2002), whose findings showed no evidence that computerization in education raised test scores. However, an increasing number of researchers are struggling to promote the understanding of ICT's payoff from the perspective of learning practice and skills. The increasing diversity of technologies and ever-changing contexts in which ICT has been used makes the ICT impact more complex. Johnston and Baker (2002) provided two learning outcomes for ICT use; the cognitive and affective domains. Law, Kampylis, and Punie (2015) reported the outcome of using ICT included 21st century skills and learning motivation. Moreover, most studies reviewed are limited to America and Europe. Lee et al. (2009) studied 15–16 year-old learners in the US who indicated positive school behavior and literacy scores in relation to ICT use. Harrison et al. (2001) evaluated the ImpaCT2 project in the UK and showed a positive correlation between ICT use and academic attainment; a range of online social and communication skills were also improved using ICT.

Numerous international organizations have taken the initiative to form a framework to evaluate the payoff of ICT. The assessing framework established by Inter-American Development Bank (Cabrol & Severin, 2009) and the European Commission (Kikis, Scheuermann, & Villalba, 2009) shared similar features. They used "inputs," "process," and "impact" to monitor ICT integrated projects. Inputs referred to the project foundation, such as infrastructure, resources, support, and sustainability. Process

referred to the use of input elements in specific projects. Impact or payoff were measured based on learning practices and skills, as well as student involvement and achievement.

2.2 Theoretical framework

The theoretical framework formed for this study is shown in Figure 1. Cases of 2005 and 2015 are compared in terms of inputs, process, and outputs. The outputs represented the payoff of ICT. Inputs and ICT usage processes explained the final payoff. Each aspect is evaluated from the voice of students, including the perception and experience of ICT usage among students.

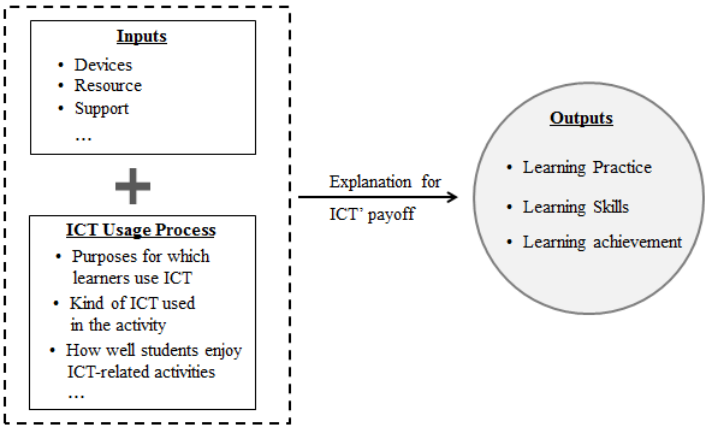

Figure 1. Theoretical framework of the ICT impact study

3. Methodology

3.1 Research questions

This research raises the following questions: (1) how different students perceived their learning being impacted by ICT between 2005 and 2015; and, (2) why differences existed and how could the differences be explained by ICT inputs and usage process.

3.2 Data collection process

Purposeful sampling strategies were applied in this study. For the 2015 cases, one primary school and one secondary school was respectively chosen from the 7 core distracts in Shanghai. The criteria for school chosen were as follows. Firstly the school should be funded by government or other organizations for ICT. Secondly the school had been using ICT in most courses. 14 schools were determined after consulting the Shanghai Municipal Education Committee, who knew the ICT using status in each school well. In each school, approximately 10 students who were about to graduate were voluntarily recruited to recall their ICT using experience. For the 2005 cases, considering the difficulty of finding graduates from the same school as 2015 cases, college students in East China Normal University who graduated from ICT-funded schools in Shanghai were recruited. 120 students were interviewed in the preliminary investigation stage. Demographic information is listed in Table 1.

Table 1: Demographic information of participants

Case	School Level	Gender		Grade	Average Age
		Male	Female		
2005	Primary School Secondary School	16 18	14 12	15 in 4th Grade, 15 in 5th Grade 12 in 8th Grade, 18 in 9th Grade	19.0 24.5
2015	Primary School Secondary School	15 13	15 17	14 in 4th Grade, 16 in 5th Grade 16 in 8th Grade, 14 in 9th Grade	10.0 14.0

Semi-structured interview and 5-point Likert scale were used for data collection from March to July in 2016. An interview field guide with sample question probes such as "How did you use ICT in class" and "What activities were taken" was provided to two research assistants. Students' perception on the ICT payoff was assessed by asking students to rate on scales of 1 to 5 in answering questions such as ''How do you perceive engaging in learning with ICT" and "How do you perceive your problem solving ability".

3.3 Data analysis

Independent T-test was conducted for the first research question. For the second question, the interview records were transcribed by two research assistants to form cases. There were respectively 3 cases for the primary school and secondary school for 2005 and 2015. Then the cases were coded by the assistants and the Cronbach's Alpha was 0.84. Table 2 shows the coding scheme, which was adapted from the ICT indicators by international organizations, such as the UNESCO Institute for Statistics (UIS, 2009) and the European Union (Pelgrum & Doornekamp, 2009).

Table 2 Coding scheme for the cases

Category	Sub category
Input	1) ICT devices availability: computer, Pad, whiteboard, ratio of learner-to-computer, Internet connection 2) Resource availability: digital learning materials, educational tools, and software developed for the learning process
Process	1) Curriculum activities where students use ICT for learning (e.g., literacy, mathematics, science, and language) 2) Extent of ICT use among students for cooperation and/or communication 3) Kind of ICT (Web 2.0, LMS, Learning software) used in the activity 4) Enjoyment of students in ICT-related activities 5) Purposes of using ICT for learners: informative, functional, creating, and communication
Output	1) Learning practice: attitude, motivation, engagement, and enthusiasm 2) Learning skills: critical thinking, problem-solving, collaboration, creativity 3) Learning achievement: homework performance and test scores

4. Preliminary results

For the first research question, the independent T-test results showed significant differences in learning practices ($t(118) = -3.65$, $p < .001$) and learning skills ($t(118) = -3.52$, $p < .001$) for 2005 and 2015. No significant difference was found in the learning achievement ($t(118) = -.58$, $p > .05$). Four subcategories, namely, learning motivation, learning engagement, critical thinking skills, and problem solving skills, of the year 2015 cases were significantly higher than that of the year 2005 cases. The results were $t(118) = -2.24$, $p < .05$; $t(118) = -2.20$, $p < .05$; $t(118) = -3.15$, $p < .005$; $t(118) = -2.34$, $p < .05$, respectively.

The coding results answered the second research question. Individualized ICT devices and available resources were revealed from the "inputs" coding. For the year 2005 cases, interviewees mostly mentioned image, flash, text, and the Internet. Secondary school students said "We use specific tools, such as geometer sketchpad for math learning." In 2015, more than half of the students said, "My teachers teach using the Pad", "the Pad has an electronic book, a foreign language app" , and "I have used Scratch, voice recognition software, and games on iPad". The resource was rich and specific in the year 2015 cases. Secondary school students stated that, "We are allowed to use laboratory computers for some subjects" and "We used the online evaluation system to test our math performance".

By reviewing ICT usage process transcription, the subjects, purpose, and organization for the activity were summarized. For the year 2005 cases, most students used ICT in "traditional" subjects, such as math and literacy for knowledge mastery. Interviewees indicated that "The flash presentations teachers showed helped me understand difficult contents." About the activity, interviewees said that, "My teacher carried out a collaborative problem-solving activity, but…, I did not engage in the activity very much." For the year 2015 cases, more ICTs were used for extracurricular learning to extend skill development. Students reported that, "On Friday afternoons, we can freely choose the 'Computational Thinking' course we are interested in." The activity was much refined in 2015. Students mentioned that, "The teacher provides us a learning task list to guide us in the problem solving process."

5. Research contribution

In conclusion, ICT has impacted learning practices and skills. More individualized ICT devices, specific learning resources, and refined activity have contributed to the payoff. The impact of ICT in education remains an open question considering the limited research found in East Asia. The proposed study contributed in enhancing our understanding of this topic and in developing propositions on the payoff of ICT.

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