

Comparative international evidence on the impact of digital technologies on learning outcomes: Tentative findings from SITES 2006 and related studies

A discussion paper for
CERI-KERIS International Expert Meeting on ICT and Educational Performance
(Cheju Island, South Korea, October 16-17, 2007)

Nancy Law
University of Hong Kong

Technology as a lever for pedagogical innovation: a conceptual framework for studying the impact of digital technologies on learning outcomes in the knowledge society

Much of the existing literature on educational uses of ICT categorizes the modes of usage according to the function played by technology, e.g. as tutor, tool or tutee (Taylor, 1980), as cognitive tools (Solomon, 1986) or mindtools (Jonassen, 2000). Such categorizations are very useful when one is conceptualizing the role that technology plays in the teaching and learning process or when designing or selecting technology tools for education. However, as Jonassen et al. (1999) eloquently pointed out, educational uses of technology that strive to be "teacher-proof" or "learner-proof" do not exploit the capabilities of the technologies or the students. In designing effective learning experiences supported by technology, it is important not only to choose the appropriate technological tool, but also to have a clear understanding of the roles played by the teacher, the learner and the technology.

In both academic literature and policy documents on ICT in education, there are strong arguments put forward for ICT to be used in schools in order to realize new goals of education which are seen to be important for the 21st century. These include goals such as developing lifelong learning skills and the ability to engage in collaborative knowledge creation and problem solving with peers and experts around the world. These two bodies of literature both anticipate that significant changes in the pedagogical process (this term is used interchangeably with the teaching and learning process) have to take place in order to achieve these new curriculum goals. Hence, an important question to ask in examining the pedagogical adoption of ICT is whether the use of technology is seen as a lever for pedagogical innovation, and in particular, whether it involves any changes in the roles played by the teacher and the learners in the process. Thus, for the purpose of understanding the impacts made by the use of ICT on pedagogical practices at the classroom level, the focus is not on the functional characteristics of the technology used but rather the roles played by the three actors, the teacher, the learner and the technology used, as well as the interactions between them.

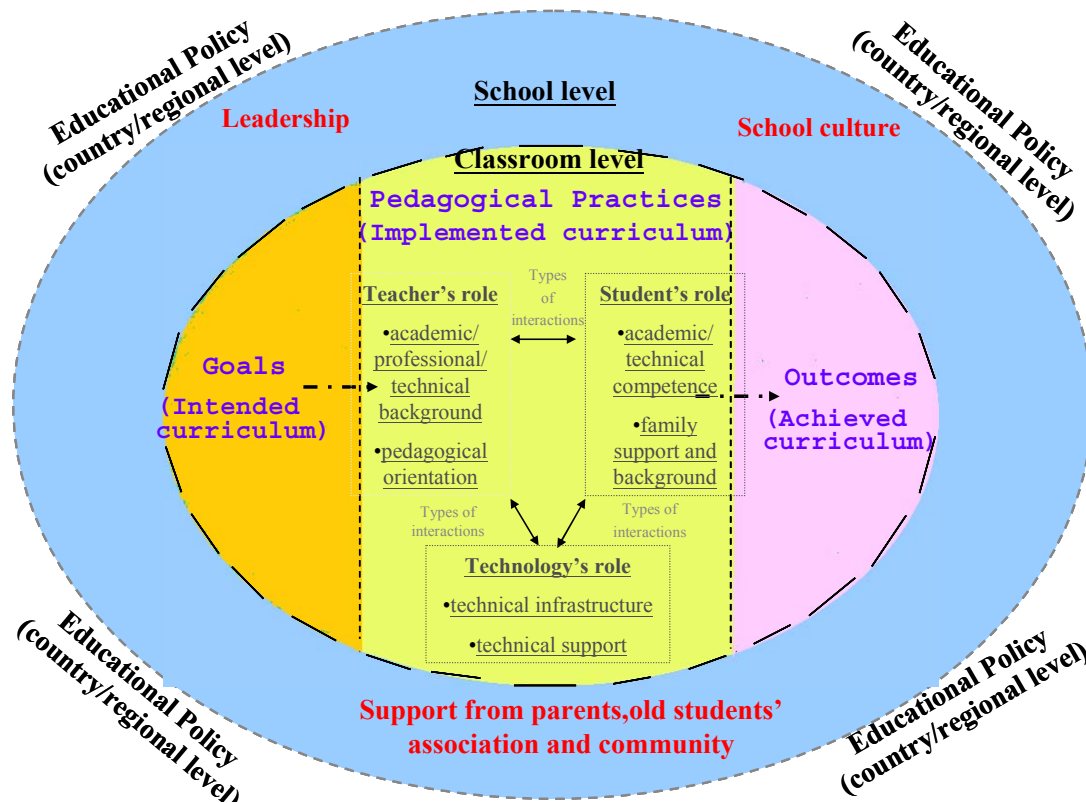


Figure 1 Diagrammatic representation of the framework for conceptualizing and analyzing ICT-supported pedagogical practices in school settings. (Source: Law et al. (2000), p. 25)

SITES M1 & M2 – evidence of emerging practices and use of ICT in them in countries around the world

SITES M1 therefore constructed the concept of “emerging pedagogical practices” to capture the changes that are taking place in classrooms around the world, in contrast to “traditionally important practices”. The SITES M1 study found significant differences across countries in terms of the relative importance of these two kinds of practices as perceived by principals in their own schools. By focusing only on innovative pedagogical practices, the SITES M2 case studies provided very rich descriptions of what may count as emerging characteristics of pedagogical practices that made substantial uses of ICT. Law (2003, 2004) identified, in addition to the use of technology, five dimensions along which significant changes have taken place in the SITES M2 case studies: curriculum goals, roles of the teacher, roles of the learner, the multidimensional ways in which students’ learning outcomes can be manifested and the connectedness with peers and experts outside of the classroom walls.

SITES 2006 – a study of ICT use in pedagogical practices and the contextual factors influencing them

SITES 2006 is a comparative study of schools and teachers to examine:

- The kinds of pedagogical practices adopted in different countries and the use of ICT in them,

- The status in terms of the contextual factors at the teacher, school and national levels that may impact on pedagogical practice and ICT use in different countries,
- Explanatory models that link teachers' pedagogical use of ICT with different contextual factors and on that basis to make policy recommendations on ICT in education

The study involved the application of three questionnaires (principals, technology coordinators and teachers) to a sample of not more than 400 schools and an education system questionnaire for the National Research Coordinator for each participating system.

As both of the earlier SITES studies indicate that there are new pedagogical approaches emerging from classroom practices in conjunction with the use of ICT, SITES 2006 sought to construct *pedagogical practice orientation indicators* to reflect the differences in pedagogical approaches adopted by teachers. Based on the SITES M2 findings, it was considered appropriate that in addition to indicators for the *traditionally important* orientation, the emerging paradigm could be further refined to provide indicators for the *lifelong learning* and *connectedness* orientations. Traditionally important practices are those that focus on content goals, with the teacher typically playing the main role as instructor and assessor in the process while the students work on assigned close ended tasks. Lifelong learning practices are typically those that require students to work in teams on open ended real work problems to develop problem solving, collaborative and organizational skills with the teacher playing a facilitative role. Connectedness oriented practices are those that provide opportunities to learn from and work with experts and peers outside of the school, locally or internationally.

In the design of SITES 2006, ICT-using pedagogical practices are conceptualized as part of the overall pedagogical practices of the teacher. For a teacher, the reasons for and the ways of using ICT in the classroom are underpinned by his/her overall pedagogical vision and competence. Furthermore, pedagogical practices are not solely determined by the characteristics of the teachers such as their academic qualifications and ICT competence, but also on school and system level factors. While it is expected that students' learning outcomes are influenced by the pedagogical practices they experience, the perceived outcomes also impact on subsequent pedagogical decisions of the teacher through the changes in teacher, school and system level factors that may take place as a consequence of the perceived impact of the pedagogical practice on students. Figure 2 presents the overall conceptual framework for the study.

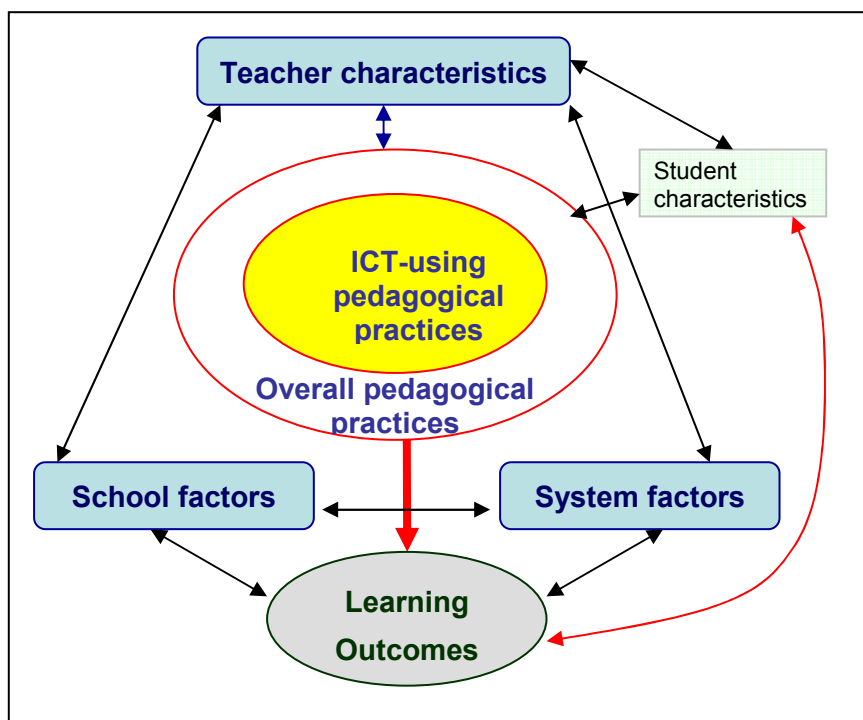


Figure 2.1 Overall conceptual framework for the SITES 2006 study.

Impact of ICT use on students – teachers' perceptions

Obviously, one would wish to have evidence on the impacts ICT use might have on students. Unfortunately, SITES 2006 was a study on schools and teachers only. On the other hand, the teacher questionnaire also asked teachers to indicate their perceptions on the extent to which ICT use had impact on their students in 15 different areas. These areas of impact can be categorized into 8 groups as listed in Box 1. Teachers were asked to indicate the impact they perceived on a five-point Likert scale (1 = decreased a lot, 2 = decreased a little, 3 = no impact, 4 = increased a little and 5 = increased a lot). Thus teachers were allowed to indicate the impact as positive or negative.

It is important to note that amongst the list were two negative impacts. Hence, a positive score is not necessarily a positive impact. An increase in the achievement gap among students and an increase in inequity between students from different socioeconomic backgrounds are both educationally negative outcomes. The key findings in terms of impact on students were:

- The highest perceived impact on students was in the area of improved ICT skills
- In most systems, the perceived extents of the negative impacts were lower than the other six areas of affective and cognitive outcomes, indicating that teachers generally perceived the positive impacts on students to outweigh the negative ones.
- Another notable observation is that the profiles of the extents of different perceived impacts on students were very similar for both science and mathematics teachers within the same system but may vary substantially across systems.
- In some systems, the perceived impact in areas other than ICT skills was very low.
- In some other systems the perceived impacts on the other cognitive and affective outcomes were comparable to the gain in ICT skills. In particular, in some systems, the

use of ICT was perceived to bring about comparable gains in inquiry skills, collaboration and students' ability to work at their own pace.

- The use of ICT was generally perceived to also have positive impacts on students' traditionally important outcomes (i.e. subject matter knowledge and assessment results), though the extent was generally not perceived to be particularly high.

Box 1 Kinds of impacts of ICT use on students

Type of impact	Specific impact
Traditionally important skills	<ul style="list-style-type: none"> • Subject matter knowledge • Assessment results
Inquiry skills	<ul style="list-style-type: none"> • Information-handling skills • Problem-solving skills • Self-directed learning skills
Collaboration	<ul style="list-style-type: none"> • Collaborative skills • Communication skills
ICT skills	<ul style="list-style-type: none"> • ICT skills
Self-paced learning	<ul style="list-style-type: none"> • Ability to learn at own pace
Affective impact	<ul style="list-style-type: none"> • Learning motivation • Self-esteem • Time spent on learning • School attendance
Achievement gap	<ul style="list-style-type: none"> • Achievement gap among students
Socioeconomic divide	<ul style="list-style-type: none"> • Inequity between students from different socioeconomic backgrounds

Impact of ICT use on students – how it is related to teachers' pedagogical practice orientations

Given that the international report for SITES 2006 is still under preparation and that international analysis results are still under embargo, it is not possible to provide specific results from the study. However, tentative results from the analysis indicate that the scores for traditional orientation show no significant correlation with any of the perceived outcomes except the gain in ICT skills. On the other hand, both lifelong learning and connectedness orientations show significant correlations with all perceived positive learning outcomes, with highest correlation shown for collaboration and inquiry skills. This means that teachers whose response indicate that they adopted more of these 21st century oriented practices, they also reported stronger indications of students' learning outcomes that are considered to be important for the knowledge society. Hence preliminary findings indicate a possible relationship between teachers' pedagogy and their students' learning outcomes.

Teachers' personal characteristics, (self-reported) contextual factors and their relationship with teachers' pedagogical adoption of ICT

Many countries have introduced ICT related educational policies and strategies in the form of an IT masterplan or integrated into the overall education policy of the country (Plomp et al. 2003, 2008). Commonly identified strategies include:

- Infrastructure provisions to improve the student : computer ratio, internet connectivity, etc.
- Technical support for maintenance and user support, which can be measured in the form of staff time available/student/week
- Technical support for ICT use in various lifelong learning and connectedness-oriented learning activities such as extended student projects, media production, self-accessed learning activities, field study activities, etc.
- Pedagogical support for ICT use in LLL & connectedness-oriented learning activities
- Professional development on ICT use for teachers which may be technical or pedagogical in focus
- Leadership development in school to lead ICT-supported change and innovation in the school

In examining the teachers' self-reports on themselves and contextual characteristics of their schools, the following tentative observations have important policy implication:

- Of the personal and contextual variables that may have an impact on ICT use, there is no evidence that age and gender per se have deterministic impact on pedagogical ICT use.
- In most systems, the teacher's academic qualification, technical and pedagogical ICT competence and attendance at ICT-related professional development are positively and significantly related to ICT adoption.
- The extent to which school-related (infrastructure and professional autonomy), teacher-related (competence, confidence and time) and student-related (ICT skills & out-of-school access) obstacles were reported varied greatly across systems.
- Overall, school-related obstacles showed stronger negative covariance with teachers' pedagogical adoption of ICT
- In terms of the level of reported presence of the four aspects of a community of practice in schools (shared vision, shared decision making, professional collaboration, technical and administrative support), generally shared vision was the highest and professional collaboration was the lowest
- Overall, teachers' pedagogical ICT competence, participation in pedagogical-oriented ICT-related professional development activities, pedagogical and technical support given to teachers and teachers' participation in shared decision-making showed the strongest positive covariance with teachers' pedagogical adoption of ICT.

Contextual factors reported at the school level and their relationship with teachers' reported ICT use and ICT-using pedagogical practice orientations

Some initial multilevel explorations were also conducted to examine the relationship between the school level contexts, leadership practices and priorities as reported by the school principal and technology coordinators and the teachers' pedagogy and ICT in the same school. The preliminary findings indicate that to foster ICT use to support learning effectively, the following conditions are very important:

- Infrastructure & support staff time availability
- Both technical & pedagogical support, in particular pedagogical support for using ICT in lifelong learning and connectedness oriented learning activities
- Teachers' ICT competence, in particular their pedagogical competence in ICT use
- Vision of school leadership for ICT use to support lifelong learning.

Some policy implications from the tentative findings

Given that there is on-going analysis of the study data and the international report is still under preparation, it is too early to draw any firm conclusion from the study. However, the following implications are plausible on the basis of the preliminary analysis results:

- Policy implementations have impacts on perceptions, beliefs and practices in schools
- Infrastructure, support, professional development & leadership development are all important conditions to foster pedagogical use of ICT by teachers for improved learning outcomes
- A balanced, holistic approach probably work best rather than a model of implementation that focus on one or two strategic areas at different stages of development
- Pedagogy matters, and strategy in all four areas identified above need to maintain a strong pedagogic consideration in its provisions
- Longitudinal data are valuable for informing policy.

References

- Jonassen, D. H., Peck, K.L. & Wilson, B.G. (1999). *Learning with Technology*. Upper Saddle River, New Jersey: Merrill.
- Jonassen, D. H. (2000). *Computers as Mindtools for Schools*. (2nd ed.). Upper Saddle River, New Jersey: Merrill.
- Law, N. (2003). Innovative Classroom Practices and the Teacher of the Future. In C. Dowling & K. W. Lai (Eds.), *Information and Communication Technology and the Teacher of the Future* (pp. 171-182). Dordrecht: Kluwer Academic Publishers.
- Law, N. (2004). Teachers and Teaching Innovations in a Connected World. In A. Brown & N. Davis (Eds.), *Digital Technology, Communities and Education*. London: Kogan Page.
- Law, N., Yuen, H.K., Ki, W.W., Li, S.C. Lee, Y. & Chow, Y. (2000). *Changing Classrooms & Changing Schools. A study of Good Practices in Hong Kong Schools*. Hong Kong: CITE, University of Hong Kong.
- Plomp, T., Anderson, R. E., Law, N., & Quale, A. (Eds.). (2003). *Cross-national Policies and Practices on Information and Communication Technology in Education*. 580pp. Greenwich, CT: Information Age Publishing Inc.
- Plomp, T., Anderson, R. E., Law, N., & Quale, A. (Eds.). (2008). *Cross-national Policies and Practices on Information and Communication Technology in Education*, 2nd Edition. Greenwich, CT: Information Age Publishing Inc.
- Solomon, C. (1986). *Computer Environments for Children: A Reflection on Theories of Learning and Education*. Cambridge, Mass.: MIT Press.
- Taylor, R. P. (1980). *The Computer in the School: Tutor, Tool, Tutee*. New York: Teachers College Press.