The University of Hong Kong

DO STUDENTS LEARN BETTER WITH THE USE OF INFORMATION TECHNOLOGY AT HOME AND IN SCHOOL? UNRAVELLING A COMPLEX RELATIONSHIP

Tan, Cheng Yong (PhD)

Associate Professor

Social Contexts and Policies of Education Unit, Faculty of Education

The University of Hong Kong

QUESTIONS TO ADDRESS

Study 1: Clarifying the role of IT in student achievement

1. Do students learn better with IT resources both at home and in school?
2. Which is more important? Home or school IT resources?

Study 2: Understanding the nuances – family backgrounds

3. Do all students, regardless of their family backgrounds, benefit equally from IT being used to support their learning?

Study 3: Understanding the nuances – school factors

4. What types of teachers and schools use more IT in their lessons?

STUDY 1: CLARIFYING THE ROLE OF IT IN STUDENT ACHIEVEMENT

Citation:

Tan, C. Y. & Hew, K. F. (2019). The impact of digital divides on student mathematics achievement in Confucian Heritage Cultures: A critical examination using PISA 2012 data. *International Journal of Science and Mathematics Education, 17*(6), 1213-1232.

DO STUDENTS BENEFIT FROM IT IN THEIR LEARNING?

MOTIVATION FOR STUDY

Substantial investment in schools by many governments in IT resources

Critics who question the benefits of IT in learning

- Can the use of IT replace effective teachers?

Mixed empirical base on contribution of IT to learning

Digital divides in students accessing and using IT in their learning

AIMS OF STUDY

1. Access vs use - Must students use IT meaningfully to benefit from it?
2. Home vs school - Are home or school IT resources more important for student achievement?
3. Do students' achievement benefit from IT?

STAGES IN DIGITAL DIVIDES (SELWYN, 2004)

Stage	Description
Theoretical access to IT	Provision of IT at home and in school
Actual use of IT	Students have access to IT but may not use it meaningfully
Meaningful use of IT	Students exercise control and choice for relevant use of IT
Outcomes	Short/medium/long term outcomes of IT use

METHOD - SAMPLE

38,157 students from 1,030 schools in seven Confucian heritage cultures (CHCs) who participated in PISA 2012

- Hong Kong, Japan, Korea, Macau, Shanghai, Singapore, Taipei

METHOD – DEPENDENT VARIABLE

Mathematics achievement

METHOD – HOME IT VARIABLES

Students' access to home IT resources

- Student responses (1 = *Yes*; 0 = *No*) on the availability of a computer, educational software, and Internet connection in their home

Students' IT use at home for learning

- 7 items measuring the frequency of their computer use outside of school for different activities (e.g., browsing Internet for schoolwork, emailing teachers and other students about schoolwork, submitting schoolwork, downloading school website materials from school website, doing homework on computer)

METHOD – SCHOOL IT VARIABLES

Shortage of school IT resources for instruction

- Principals' responses (1 = *Not at all* to 4 = *A lot*) to 3 items on the shortage of computers, Internet connectivity, & computer software

2 variables measuring IT use in mathematics lessons ('*No*'; '*Yes, but only the teacher demonstrated this*'; '*Yes, students did this*') to 7 items on whether a computer had been used in their mathematics lessons

- No. of math topics where **students were involved** in use of computer in lessons
- No. of math topics where **only teacher was involved** in use of computer in lessons

METHOD – VARIABLES ON HOME RESOURCES

Parental human resources

- parents' highest educational level (0 = *None* to 6 = *Theoretically oriented tertiary and post-graduate*)

Home educational resources

- adding up student responses (1 = *Yes*; 0 = *No*) on availability of study desk, own room, quiet place to study, school-related books, reference books, & dictionary at home

Home cultural resources

- students' responses (1 = *Yes*; 0 = *No*) on availability of classic literature, poetry books, & art works at home

METHOD – CONTROL VARIABLES

Students' sex

- female (48.8%); male (51.2%)

Average class size in schools

- Principals' responses ('*15 students or fewer*' to '*More than 50 students*) to question asking them about average class size

Shortage of qualified mathematics teachers

- Principals' responses (1 = *Not at all* to 4 = *A* lot) to item on lack of qualified mathematics teachers

National economic development (OECD)

- coded as 1 for OECD economies (2 countries) and 0 otherwise (5 countries)

METHOD – ANALYTICAL STRATEGY

Multiple imputation (missing values 0 – 3.3%)

Three-level fixed effect hierarchical linear modeling (HLM) with full maximum likelihood estimation

Latent class analysis (LCA) to identify different combinations of IT resources associated with higher levels of students' achievement

- Students' access to IT home resources
- Students' usage of home IT resources for learning
- School availability of IT resources for instruction
- Mathematics teacher involvement of students in IT-enabled lessons

HLM RESULTS – HOME IT

Students who had **access** to more IT home resources had higher achievement levels

Student **use** of home IT resources for learning was related to their achievement after controlling for home IT resources **access** & other variables

Summary: Access to IT resources appeared to be more important than use of IT at home, but both made only small contribution to student achievement

HLM RESULTS – SCHOOL IT

School IT shortage did not predict students' achievement

Use of IT (involving student participation) in mathematics lessons was negatively related to student achievement

- Similar results when variable was teacher-centered mathematics lessons using IT

Summary: School IT resources did not contribute to student achievement as much as home IT resources

Class 1 (Low Home & School IT) – 88.16%	Class 2 (Moderate Home & High School IT) – 7.11%	Class 3 (High Home & Moderate School IT) – 4.73%
• Less home IT • Least home IT use • Schools with least IT shortage • Math Trs least likely to use IT with student participation	• Less home IT (=Class 1) • Moderate home IT use • Schools with less IT shortage • Math Trs most likely to use IT	• More home IT • Most home IT use • Schools with less IT shortage • Math Trs moderately likely to use IT
Highest math ach	Lowest math ach	Average math ach

IMPLICATIONS AND CONTRIBUTIONS

IT resources are not the same as other forms of family resources

- Are home IT resources another source of social inequity in learning opportunities?

Digital divide may not 'evolve' from access to meaningful use of IT resources

- Individuals have free will to use IT resources to support their learning
- Students in CHCs may not choose to use IT for learning, given that drill-and-practice is effective for high-stake examinations

IMPLICATIONS AND CONTRIBUTIONS

Schools may lag homes in effective adoption of IT to transform teaching

- Are schools convinced of IT potentiality to enhance students' learning?

Unclear why IT did not contribute to students' achievement

- Schools using IT to teach academically weaker students?
- Do schools have knowledge/skills to use IT to enhance teaching-learning?
- Some disadvantaged students may not know how to use technology

Challenges assumption that IT must always benefit students' achievement

LIMITATIONS OF STUDY & FUTURE RESEARCH

Significant relationships found should not be taken to be evidence of causality

- Future research can adopt a mixed methodology to include in-depth interviews of students and teachers, and classroom observations

Results from present study only pertain to CHCs

- Future research may replicate analysis on other categories of countries

BACK TO OUR QUESTIONS…

1. Do students learn better with IT resources both at home and in school?
2. Which is more important? Home or school IT resources?

- *Home IT resources appear to be more important than school IT resources*
- *Access to home IT resources seems to be more important than use of these resources (Why?)*

The University of Hong Kong

STUDY 2: UNDERSTANDING THE NUANCES – FAMILY BACKGROUNDS

Do all students, regardless of their family backgrounds, benefit equally from IT being used to support their learning?

Citation:

Tan, C. Y., & Hew, K. F. (2017). Information technology, mathematics achievement, and educational equity in developed economies. *Educational Studies, 43*(4), 371-390.

AIMS OF STUDY

The present study addresses two specific research questions:

- How is access to home and school IT resources related to student achievement?
- How do different levels of student home resources moderate the relationships between access to IT resources and student achievement?

WHY THIS STUDY?

Importance of quality of educational outcomes

- Does IT contribute to learning outcomes?

Equity in education

- Who benefits more from access to IT resources at home and in school?

THEORETICAL UNDERPINNINGS

Social construction of technology: impact of technological engagement depends on the social milieu in which the engagement occurs (Klein & Kleinman, 2002).

- Access to home **academic resources** affords students with more opportunities to engage in their learning and identify more areas where they can use IT in their learning.
- **Highly educated parents** help students to understand enablements and constraints of IT.
- School teachers may provide more opportunities for students **perceived to be competent** and to have greater learning potential.

THEORETICAL UNDERPINNINGS

These different forms of home capital may shape students' agentic perceptions of "***possibilities and impossibilities, freedoms and necessities, opportunities and prohibitions***" (Bourdieu, 1990, 54) related to the use of IT resources, which then influence their subsequent academic achievement.

SAMPLE

Participants were 144,395 secondary students (15-year-olds)and 7,308 school principals from 22 OECD economies who participated in PISA 2012.

- Australia, Austria, Belgium, Canada, Switzerland, Chile, Denmark, Finland, France, UK, Hungary, Ireland, Italy, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Portugal, Slovak Republic, Sweden, and US

VARIABLES (HOME IT, ACADEMIC, CULTURAL RESOURCES)

Students' access to **home IT resources** (*Yes; No*)

- computer for school work, educational software, Internet access

Students' access to **home academic resources** (*Yes; No*)

- study desk, students' own room, quiet place to study, books for school work, technical reference books, dictionary.

Students' access to **home cultural resources** (*Yes; No*)

- classic literature, poetry books, art works

VARIABLES (SCHOOL IT AND TEACHER RESOURCES)

Principals' perceived impact of **shortage of qualified teachers** in different subjects (1 = *Not at all to* 4 = *A lot*)

Principals' perceived impact of **shortage of IT resources** (1 = *Not at all to* 4 = *A lot*)

- shortage of computers, Internet, computer software for instruction

DEPENDENT VARIABLE

Students' mathematics achievement

CONTROL VARIABLES

Students' **sex** (*female, male*)

Students' **prior academic ability**

- Whether they had ever repeated a grade at primary, lower secondary, upper secondary level (1 = *No, never* to 3 = *Yes, twice or more*)

Mothers' education (1 = *Did not complete primary education to 5 = Completed upper secondary education that provided access to university level or non-university tertiary education)*

Average class size (1 = ≤ *15 students* to 9 = > *50 students*)

ANALYTICAL STRATEGY: HLM

Two-level HLM with restricted maximum likelihood estimation was employed to account for the correlations between mathematics achievement scores of students from the same school

RESULTS: IT AND MATH ACHIEVEMENT

Students benefited from access to IT resources

- students with greater access to home IT resources had **higher** achievement
- students whose schools had greater IT shortages had **lower** achievement

RESULTS: HOME IT RESOURCES

However, **not all students** benefited from access to IT resources equally

- students whose mothers were highly educated **benefited additionally** from home IT access
- students with less home academic and cultural resources **benefited more** from home IT access

RESULTS: SCHOOL IT RESOURCES

Shortages of qualified teachers **compounded** the challenges arising from IT resource shortages at school

Students with less home academic and cultural resources were **more adversely affected** by school IT resource shortages

CONTRIBUTIONS AND IMPLICATIONS

Study provided robust evidence on contribution of access to IT resources to student achievement

- **Controlled for confounding variables** (eg, mothers' education , schools' shortage of qualified teachers)
- **Examined main and interactive effects** of IT access (involving mothers' education and schools' shortage of qualified teachers)
- **Good statistical pow**er (by large sample of students and schools)
- Restricted analysis to students in schools located in **similar national contexts** (i.e. OECD countries)
- **Used multilevel modelling** to account for nested nature of PISA data.

CONTRIBUTIONS AND IMPLICATIONS

Highlight significant equity implications for students from disadvantaged families

- Digital divides

Important implications for educators and policymakers in light of **STEM career opportunities** predicated on students' mastery of mathematical and scientific literacies in knowledge-based economies

WHAT COULD SCHOOLS DO? IT RESOURCE SHORTAGES

Consider adopting cheaper computer systems

integrating IT into two or more subject areas at any one time

using laptops equipped with wireless connections instead of computer laboratories

locating computers in classrooms instead of centralised venues and rotating students in groups through small number of computers in classrooms

WHAT COULD SCHOOLS DO? TEACHERS' PROFESSIONAL DEVELOPMENT

Enhance

- teachers' professional development on IT knowledge and skills
- IT-related classroom management skills
- IT-supported pedagogical knowledge and skills

LIMITATIONS & FUTURE RESEARCH

Correlational study

Did not examine how students' **IT consumption** affects students' learning

- Future studies can examine how students use IT at home or how IT has been integrated in schools to benefit learning

Only examined moderating effects of human, academic, and cultural resources

- Future studies can examine impact of IT access for students differing in levels of other types of familial resources (e.g. social capital).

BACK TO OUR QUESTION…

3. Do all students, regardless of their family backgrounds, benefit equally from IT being used to support their learning?

- *students whose mothers were highly educated **benefited additionally** from home IT access*
- *students with less home academic and cultural resources **benefited more** from home IT access*
- *Students with less home academic and cultural resources were **more adversely affected** by school IT resource shortages*

The University of Hong Kong

STUDY 3: UNDERSTANDING THE NUANCES – SCHOOL FACTORS

What types of teachers and schools use more IT in their lessons?

Citation:

Hew, K. F., & Tan, C. Y. (2016). Predictors of information technology integration in secondary schools: Evidence from a large-scale study of more than 30,000 students. *PLoS ONE, 11*(12), e0168547. DOI: 10.1371/journal.pone.0168547

IT AND STUDENT LEARNING

Many schools and education systems implement IT-enabled teaching to improve student learning

BUT DOES IT INTEGRATION IN SCHOOLS REALLY BENEFIT STUDENT LEARNING?

Cheung & Slavin (2013): meta-analysis of 74 studies showed IT was only modestly associated with student math achievement

OECD (2015) : analysis of PISA 2012 data showed that access to IT resources not related to student math achievement

Leuven et al (2007) & Machin et al (2007): experimental studies: mixed evidence for effect of IT on student achievement

REFRAMING…

Instead of doing another study to find out if IT-integrated lessons benefit student learning, we ask the questions:

- which students are more likely to experience IT-enabled lessons?
- which teachers and schools are more likely to integrate IT in lessons?

This gives us an idea of why IT is integrated in teaching in the first place, and therefore allows us to understand the learning outcomes (positive, negative, none) that may be associated with the IT integration

AIMS OF STUDY

To examine

- different IT and non-IT-related predictors (student, teacher, school) of IT integration in schools
- Identify which sets of predictors are more important than others in predicting IT integration in schools

PARTICIPANTS

32,256 fifteen-year-old students and their school principals from 2,519 schools in 16 OECD countries who participated in PISA 2012

- Australia, Austria, Belgium, Switzerland, Chile, Denmark, Hungary, Ireland, Israel, Italy, Korea, Mexico, New Zealand, Portugal, Slovak Republic, Sweden

WHAT DO WE MEAN BY IT INTEGRATION?

IT INTEGRATION

Teachers using IT for instructional preparation, instructional delivery, enhance instructional effectiveness

Students using IT in classroom learning or learning higher-order competencies and skills

Present study:

- Whether IT was used in math lessons for seven topics (drawing graphs, performing calculations, constructing geometric figures, entering data in spreadsheets, algebraic expressions and equations, drawing histograms, and graph changes) that involved only teacher or students

HOW ABOUT TEACHERS? WHICH TEACHERS USE MORE IT IN THEIR LESSONS?

Math subject culture

- School-wide policy on using IT to support math learning
- Pedagogical and curricular differentiation in math instruction

Math teacher beliefs & practices

- Conceptions of student-centered teaching and learning
- Frequency of problem-solving learning tasks
- Frequency of teachers presenting novel mathematics problems

BUT WHAT SCHOOLS HAVE HIGHER LEVELS OF IT INTEGRATION?

School IT resources

- Student-computer ratio
- Availability of various IT resources for student use

Institution

- IT curricular expectations
- Teacher- or student-related school learning climate
- Principal leadership (focusing on student learning, solving problems, monitoring classroom learning and teacher effectiveness)

Accountability

- Parental academic expectations
- Posting student achievement data publicly
- Schools tracking student achievement

CONTROL VARIABLES IN ANALYSIS

Student-level controls

- Sex
- Repeated a grade
- Maternal education

School—level controls

- Average class size
- Number of full-time mathematics teachers
- Number of part-time mathematics teachers

RESULTS

HLM OVERALL RESULTS

Dependent variable: Level of IT integration in math lessons

Two-level HLM to account for similar learning experiences of students belonging to same schools

- 85.29% of variance occurred at level 1 (within-school)
- 14.71% occurred at level 2 (between-school)

WHICH STUDENTS WERE MORE LIKELY TO EXPERIENCE IT-INTEGRATED MATH LESSONS?

Boys

Students who repeated grades

Students with less educated mothers

WHICH TEACHERS WERE MORE LIKELY TO INTEGRATE IT IN MATH LESSONS?

Teachers who believed in student-centered teaching and learning

Teachers who provided more problem-solving activities in class

HOW ABOUT SCHOOLS?

What schools were ***more*** likely to have higher IT integration in math lessons?

- Schools with more computers per student
- Schools with greater availability of IT resources for students to use
- Schools with higher IT expectations in curriculum
- Schools with policy on use of IT in math instruction

HOW ABOUT SCHOOLS?

What schools were ***less*** likely to integrate IT in math lessons?

- Schools with more math teachers
- Schools with more positive teacher-related climate
- Schools with more parental pressure for academic achievement

NO SIGNIFICANT RELATIONSHIPS

Average class size

Student-related learning climate

Principal leadership

Schools' public posting of achievement results

Tracking of schs' achievement results by admin authorities

Pedagogical and curricular differentiation in math lessons

WHICH TEACHER AND SCHOOL VARIABLES WERE MOST PREDICTIVE OF IT INTEGRATION IN MATH LESSONS?

Predictors explained almost 16 % of school-level variance in levels of IT integration in math lessons

Access to school IT resources (about 6%) and teacher pedagogical beliefs (about 5%) explained more of variance compared to IT curricular expectations (1.53%), parental expectations (0.36%), or IT policies in schools (0.53%)

TEACHER PEDAGOGICAL BELIEFS & PRACTICES

Teacher beliefs in student-centered teaching and importance of problem-solving pedagogies

Schools could articulate shared vision for IT integration, provide resources to support teachers, provide teachers with professional development, encourage teachers to experiment with IT integration

COMPENSATORY USE OF IT

Students who repeated grades and less educated mothers experienced more IT integration in math lessons

- Teachers using IT as remediation strategy to address learning needs of lower achieving and unmotivated students? To enable students to obtain more immediate feedback in learning?

Students whose schools had less positive teacher-related learning climate experienced more IT integration in math lessons

- Did teachers use IT as baby-sitting tool?

LIMITATIONS AND FUTURE RESEARCH

Cross-sectional study

- Longitudinal or experimental study?

OECD countries

- Less developed countries?

BACK TO OUR QUESTION…

What types of teachers and schools use more IT in their lessons?

More likely to learn with IT in school	Less likely to learn with IT in school
Students who repeated grades	Schools with more math teachers
Students with less educated mothers	Schools with more positive teacher-related climate
Teachers with student-centered pedagogical beliefs	Schools with more parental academic pressure
Teachers using more problem-solving activities in class	

PUTTING IT ALL TOGETHER: COMPLEX RELATIONSHIP BETWEEN IT & STUDENT ACHIEVEMENT

Home IT resources appear to be ***more important*** than school IT resources

Not all students benefit equally from IT resources

- Considerations: parental education and home academic and cultural resources

The relationship between school IT resources and student achievement may be **weak** because IT is more frequently

- used for ***lower performing*** students, students from ***less-supportive*** families,
- used by teachers ***using student-centered pedagogies***
- used in ***poorly resourced*** schools, schools with ***less motivated*** teachers, schools with ***less parental academic pressure***

THANK YOU!