Investigation on the Relationship between Information Communication Technology and Reading Literacy for Northeast Asian Students

Yi-Horng Lai
Department of Health Care Administration
Oriental Institute of Technology
New Taipei City, Taiwan
Email: FL006 {at} mail.oit.edu.tw

Abstract—**The purpose of this study was to investigate the relationship of internet communication technologies (ICT) usage and reading literacy of Northeast Asian Students in PISA 2009. ICT was crucial for all governments in the world towards promoting equity. ICT had been considered a low cost opportunity towards equalizing educational systems. A multilevel modeling (MLM) was applied to identify at which school-level the largest variations in the three indicators exist in this study. With MLM, it could be examine simultaneously the effects of different hierarchical school-level variables; to take account of possible correlations of students' reading literacy in this study within higher levels (Urbanization, Total number of students Computers for education) which may otherwise lead to incorrect standard errors and inefficient estimates; to treat higher levels as related; and to examine inter-area variations at each level. The empirical results include the different between group components was significant. Self-confidence in ICT high level tasks was positive with students' reading literacy, and self-confidence in ICT high level tasks was negative with students' reading literacy. The urbanization of schools' area and total number of students of schools were positive with students' reading literacy. The urbanization of schools' area was negative with the relationship of ICT for school related tasks and students' reading literacy. Total number of students was negative with the relationship of ICT for school related tasks and students' reading literacy, and ICT availability in school and students' reading literacy.**

Keywords-Information and communication technology, Reading literacy, Multilevel linear modeling

I. INTRODUCTION

The purpose of this study was to investigate the relationship of Internet Communication Technologies (ICT) usage and reading literacy of Northeast Asian Students in PISA 2009. Studies on educational efficiency have been on the rise in the past decade. Since, investments in education pays back in the long run, this leads countries to evaluate educational systems with their functions based on student achievement. ICT was crucial for all governments in the world towards promoting equity. ICT had been considered a low cost opportunity towards equalizing educational systems.

These years, scholars were often confronted with the collection of correlated data. This generic term hold a multitude of data structures, such as multivariate observations, repeated measurements, clustered data, longitudinal data, and spatially correlated data. Instances of this type of research can be encountered in virtually every empirical branch of science. Different areas of research will refer to the same or similar concepts with different terminology. Such as multilevel modeling [1] was a frequently encountered term in sociological applications, whereas in classical experimental design research one often refers to variance component models [2]. A multilevel modeling can consist of more than two levels and examples also abound in practice. Schooling systems, for instance, present an obvious multilevel structure, with pupils grouped into classrooms, which are nested within schools which themselves may be clustered within education authorities [3]. Often in sample surveys, for cost-related reasons or administrative considerations, multistage sampling schemes were adopted. In multistage sampling, the sample was selected in stages, with the sampling units at each stage being sub-sampled from the larger units drawn at the previous stage. Thus, it immediately becomes apparent that a sample obtained by multistage sampling was hierarchical in nature and, therefore, this study need to analyze such data using appropriate multilevel modeling [4].

A multilevel modeling (MLM) was applied to identify at which school-level the largest variations in the three indicators exist in this study. With MLM, it could be examine simultaneously the effects of different hierarchical school-level variables; to take account of possible correlations of outcomes (students' reading literacy in this study) within middle or higher levels which may otherwise lead to incorrect standard errors and inefficient estimates; to treat middle and higher levels as related; and to examine inter-area variations at each level.

The ICT resources for students include home ICT resource and school ICT resource [5]. ICT connects information, products, ideas, people, individuals as well as communities globally at a low cost. Peoples worry the importance of preparation of young generations with ICT skills in their education policy documents. ICT brings new structures in learning. In PISA survey, students are asked about their familiarity with ICT, mainly with computers. Almost all 15-year-old students reported that they are familiar with using computers, although the length of computer usage differs across the countries surveyed. Students usually have access to computers in schools. However, access to computers at home varied greatly among students. Students use computers for various purposes in addition to playing games. A small group of students reported that they often used specific educational software. Half of the students reported that they frequently used internet and word processors. A great majority reported that they were confident with basic ICT skills without getting help. Raising the level of low achievers is critical for all peoples if they aim at raising all students' educational achievement since the latent gains are greater for these students in any educational system [6]. The widespread contact to ICT in the past decade increased hopes for improving students' learning [7].

With the low price of information technology products, students can contact computers and communication technology products and in school and at home easily. Students who had been using computers longer had higher scores while students who had medium level access to computers and internet in school had higher scores than the others. Aşkar and Olkun suggested that on the one hand computer ownership and access to computers in school should be increased while usage should be more functional and computers should be integrated into courses [8].

Previous studies that survey the relationship between ICT usage and problem-solving found that when students have access to computers at home, they had better achievement scores [8]. With 297295 fifteen-year-old students in PISA 2009 data, Lee and Wu indicate that ICT availability at home and self-confidence in ICT high level tasks was positive with students' reading literacy [9]. Besides, with enough ICT resource at home, students need more help in self-confidence in ICT high level tasks and ICT for school related tasks for improve reading literacy, now [10]. Although lots of studies point out that computers are helpful in students' reading literacy, Tse, Yuen, Loh, Lam, & Ng recommend that computers can have a beneficial impact on students' reading but only if computer usage is well targeted and does not consist of students playing repetitive games [11].

II. MATERIALS AND METHOD

The research frame was as Figure 1. School-level variables include urbanization, total number of students, and computers for education. Student-level variables include self-confidence in ICT, high level tasks, ICT for school related tasks, ICT availability at home, and ICT availability in school. The Hypothesis 1 is the student-level variables were positive with reading literacy. The Hypothesis 2 is the school-level variables were positive with reading literacy. The Hypothesis 3 is the student-level variables were positive with reading literacy dependent on school-level variables.

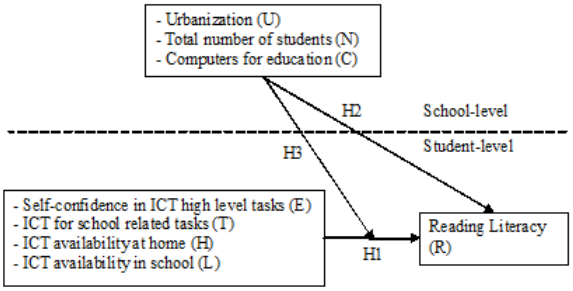

Figure 1. Research framework of this study

A. Research Data

The primary source of data for our analysis is the fourth wave of the Programme for International Student Assessment (PISA) administered in 2009. PISA is a cross national survey that, every three years since 2000, has assessed 15 year-old students' performance in mathematics, reading and science, as well as cross-curricular problem-solving skills. PISA considers students' knowledge in these areas not in isolation, but in relation to their ability to reflect on their knowledge and experience and apply them to real-world issues. The emphasis is on mastering processes, understanding concepts and functioning in various contexts within each assessment area.

The three domains assessed in PISA 2009 can be synthesized include reading literacy, scientific literacy, and mathematical literacy. Reading literacy is understanding, using, and reflecting on written texts, in order to achieve one's goals, to develop one's knowledge and potential, and to participate in society. Mathematical literacy is an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen. Scientific literacy is the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity (OECD, 2011).

In each PISA cycle, only one domain was tested in detail, taking up nearly two-thirds of the total testing time (about 390 minutes). The major domain in 2000 was reading, in 2003 it was mathematics and in 2006 it was science. In 2009 it was reading again, building on a modified reading framework which incorporates the reading of electronic texts and elaborates the constructs of reading engagement and meta-cognition [7].

In addition to evaluating student performance, PISA collects contextual data on the characteristics of students,

families and schools. Furthermore, PISA gives each country the option to administer a 10-minute questionnaire on students' familiarity with ICTs [12]. Through this questionnaire, students are asked which kinds of new technologies are at their disposal at home and in school, if they use them, how often and for what purposes. Students are also asked to self-assess their level of proficiency in performing certain tasks using a computer and to express their attitude toward computers.

The PISA survey uses a two-stage stratified sampling procedure to collect the data. First, schools in which 15 year-old students are enrolled are selected systematically with probabilities proportional to their size. Second, eligible students within the sampled schools are selected with equal probability [12]. Given this complex sampling design, the student sample is characterized by a hierarchical structure in which students are nested within classes and schools which, in turn, are nested in countries or geographic regions.

The analyses contained in this work consider only the European countries that completed the optional questionnaire on students' familiarity with ICT (plus Iceland, Norway and Turkey) and only the student-level observations with no missing values on any variable of interest (list-wise deletion). The full sample is composed of 23 countries and most students within this sample have some experience in using ICT.1 France, Luxembourg, the United Kingdom and Romania are not in the dataset because they did not complete the PISA-ICT questionnaire, while the Netherlands has been excluded from the econometric estimates because of missing data issues.2 Similarly, Austria was not considered in the econometric analysis of the study because of data reliability issues.

The cross-sectional data for this study come from the 2009 administration of the PISA that was an internationally standardized assessment jointly developed by participating countries and administered to 15-year-olds in schools. PISA is an assessment of domains such as reading, mathematical, and scientific literacy. In addition to content assessments, PISA includes student, parents, and school surveys that have questions related to students' and parents' background, students' attitude towards reading and ICT.

B. Research Tools

TABLE I. THE RESEARCH FACTORS AND THE ITEMS IN PISA 2009

	Item in PISA 2009
Student-level	
Self-confidence in ICT high level tasks	HIGHCONF
ICT for school related tasks	HOMSCH
ICT availability at home	ICTHOME
ICT availability in school	ICTSCH
School-level	
Urbanization	SC04Q01
Total number of students	SC10Q01
Computers for education	SC10Q02

The research factors for student-level include self-confidence in ICT high level tasks, ICT for school related tasks, ICT availability at home, and ICT availability in school. The research factors for school-level include urbanization, total number of students, and computers for education. The items for them in PISA 2009 were as Table 1.

C. Data Analysis

In this study, a two multi-level be estimated with random intercepts models. The multilevel modeling (MLM) was applied to identify at which school-level the largest variations in the three indicators exist in this study. The two-level CFA model of reading literacy was as Figure 2. Reading literacy include three indicators: access and retrieve, integrate and interpret, and reflect and evaluate. With MLM, it could be examine simultaneously the effects of different hierarchical school-level variables; to take account of possible correlations of outcomes (reading literacy) within higher levels (school-level variables) which may otherwise lead to incorrect standard errors and inefficient estimates; to treat higher levels as related; and to examine inter-area variations at each level.

MLM were variations on the familiar regression-based theme in which the error term was decomposed into parts attributable to each level of the hierarchy. The decomposability of the residual variance was particularly important as it allows one to establish at which level of the hierarchy most variation occurs. It could be able to identify residual variances at each geographical level, which isolate geographical areas that were significantly different from the average, after accounting for measures of deprivation and performance indicators.

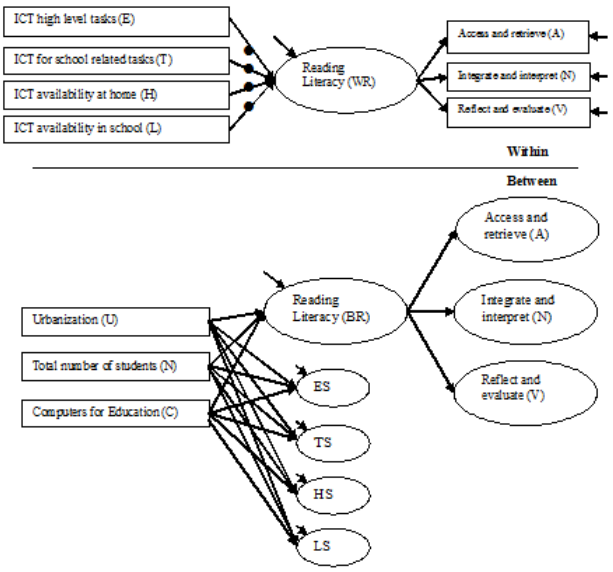

Figure 2. Two-level CFA model of reading literacy

Multilevel models were derived using the computer package Mplus 7.0 and STATA 12. Null, random-effects models were first derived, and then individual-, school-, and finally municipality-level fixed effects were subsequently added to the models in this order. Birth year was included in all random-effects and fixed-effects models. Because outcomes were binary, we used multilevel logistic regression. In a binary response multilevel model, the measurement level variance was a function of the mean and is on the probability scale.

III. RESULTS

The sample includes 10199 students from 343 schools in PISA 2009 data in Japan and Korea. The sample consisted of 41.92% female and 58.08% male students. 186 Japanese schools and 157 Korean schools, and the data summarize of student-level and school-level was as Table 2. The descriptive statistics of student-level and school-level were as Table 3. Besides, only Japan and Korea do ICT survey in PISA 2009 data. The Cronbach's α of reading literacy was .96.

TABLE II. DATA SUMMARIZE OF STUDENT-LEVEL AND SCHOOL-LEVEL

		Student-level		School-level	
Geographic		**Frequency**	**Percent (%)**	**Frequency**	**Percent (%)**
Gender	Male	4923	41.92	-	-
	Female	5276	58.08	-	-
Country	Japan	5455	53.49	186	54.23
	Korea	4744	46.51	157	45.77
Urbanization	Village	69	.68	2	.58
	Small Town	330	3.24	14	4.08
	Town	1948	19.10	64	18.66
	City	4552	44.62	151	44.03
	Large City	3300	32.36	112	32.65
Total		10199	100.00	343	100.00

For testing the hypotheses in this study (Figure 1), multilevel linear modeling been used for data analysis in this study. This study explored the relationship in the cross-level variables with multilevel linear modeling.

TABLE III. DATA SUMMARIZE OF STUDENT-LEVEL AND SCHOOL-LEVEL

Geographic	Mean	S.D.	Cronbach's α
Student-level			
Self-confidence in ICT high level tasks	-.51	1.01	-
ICT for school related tasks	-.57	.99	-
ICT availability at home	-.39	.90	-
ICT availability in school	-.26	1.09	-
Reading Literacy	537.27	86.62	.96
School-level			
Total number of students	308.45	175.13	-
Computers for education	110.13	107.05	-

A. *Null Model*

This study explored the relationship of students' personal opinion factors and class factors, and detecting the effect of cross-level with multilevel linear modeling. The result of data analysis was as Table 4. The different between each class with null model were significant. With the result of the null model in this study, it could be found that the different between group components (u0) was significant (u0=3935.25, S.E.<.01).

TABLE IV. THE RESULT OF MULTILEVEL LINEAR MODELING

		Null Model	**Random Coefficient Model**	**Contextual Model**	**Full Model**
I	γ_{00}_1	536.54* (3.45)	538.13* (3.55)	504.19* (16.90)	507.48* (16.76)
	γ_{00}_2	529.63* (3.39)	531.23* (3.49)	496.95* (17.18)	500.29* (17.04)
	γ_{00}_3	531.01* (3.63)	532.54* (3.71)	494.51* (18.83)	498.05* (18.73)
U	γ_{01}	-	-	10.63* (4.29)	9.68 (4.28)
N	γ_{02}	-	-	.01* (.01)	-.01* (.01)
C	γ_{03}	-	-	-.11* (.03)	-.10* (.03)
E	γ_{10}	-	5.78* (.75)	5.76* (.75)	2.60 (.48)
E	γ_{11}	-	-	-	.60 (.90)
E	γ_{12}	-	-	-	<.01 (<.01)
E	γ_{13}	-	-	-	.01 (.01)
T	γ_{20}	-	-.49 (.88)	-.56 (.88)	8.42* (.01)
T	γ_{21}	-	-	-	-2.42* (.99)
T	γ_{22}	-	-	-	<-.01* (<.01)
T	γ_{23}	-	-	-	.01 (.01)
H	γ_{30}	-	-2.98* (.80)	-2.97* (.80)	-1.84 (.43)
H	γ_{31}	-	-	-	-.18 (.91)
H	γ_{32}	-	-	-	<.01 (<.01)
H	γ_{33}	-	-	-	<.01 (.01)
L	γ_{40}	-	.25 (.68)	.26 (.68)	3.32 (.32)
L	γ_{41}	-	-	-	-.47 (.83)
L	γ_{42}	-	-	-	<-.01* (<.01)
L	γ_{43}	-	-	-	-.01 (.01)
	r	3518.83* (126.38)	3534.07* (390.72)	3115.67* (400.37)	3084.30* (402.55)
	u_0	3935.25* (384.13)	3903.16* (125.95)	3904.37* (126.04)	3846.94* (127.91)
	u_1	-	-	-	1089.14 (12.60)
	u_2	-	-	-	54.91 (15.85)
	u_3	-	-	-	978.87 (14.57)
	u_4	-	-	-	3846.94 (11.59)
	AIC	316790.22	316720.26	316791.06	316799.69
	BIC	316898.67	316857.63	316942.89	317067.20

1: * p-value<0.05. 2: () is Standard deviation.

B. *Random Coefficient Model*

Random coefficient model was the model with all individual level variables. It means a regression model with all individual level variables in individual level and null model in group level. The relationship of dependent variables and independent variables in individual level could be detected with random coefficient model. The result of random coefficient model was as Table 4. It could be found that self-confidence in ICT high level tasks (E) (γ10=5.78, S.E.= .75) and ICT availability at home (H) (γ30=.-2.97, S.E.= .80) were significant, but CT for school related tasks (T) (γ20=-.48, S.E.= .88) and ICT availability in school (L) (γ40=.24, S.E.= .68) were not significant. With the result, self-confidence in ICT

high level tasks was positive with students' reading literacy, and self-confidence in ICT high level tasks was negative with students' reading literacy.

C. Contextual Model

The percent of the direct effects that can be explained by intercept variance could be detected with contextual model. The result of contextual model was as Table 4. It could be find that urbanization (U) (γ01=10.63, S.E.= 4.29), total number of students (N) (γ02=.01, S.E.=.01), and computers for education (C) (γ03=.03, S.E.=.03) were significant. With the result, the urbanization of schools' area and total number of students of schools were positive with students' reading literacy. Computers for education in schools were negative with students' reading literacy.

D. Full Model

The result of full model was as Table 4. It could be find that urbanization (U) was a moderator for ICT for school related tasks (T) with reading literacy (R) (γ21=-2.42, S.E.= .99). Total number of students (N) were moderators for ICT for school related tasks (T) with reading literacy (R) (γ22<-.1, S.E.<.01) and ICT availability in school (L) with reading literacy (R) (γ42<-.1, S.E.<.01). With the result, the urbanization of schools' area was negative with the relationship of ICT for school related tasks and students' reading literacy. Total number of students was negative with the relationship of ICT for school related tasks and students' reading literacy, and ICT availability in school and students' reading literacy.

IV. DISCUSSION AND CONCLUSION

The data on the Northeast Asian student sample regarding their use of computers on a number of variables and their reading literacy was investigated. The results indicated that there is significant relationship between their use of ICT and reading literacy. The descriptive statistics revealed that a quite high percentage of students had access to computers. The results indicated that there was a high difference in terms of percentages between different schools.

Self-confidence in ICT high level tasks was helpful in students' reading literacy, and this result was the same as Lee and Wu's study [9, 10]. If students want finish high level tasks themselves, they should read and learn more with Internet or other information communication technology. Students would improve reading literacy by ICT with the object of self-confidence high level tasks. But ICT availability (or resource) at home was harmful in students' reading literacy, and this result was the same as Tse, Yuen, Loh, Lam, and Ng's study [11]. For most of students or youth, information communication technology was a tool for online games. Most students that without teachers' advice only want play internet game. With these two student-level result, it could find that teachers play an important role in improving students' reading literacy. Teachers can improve students' reading literacy by self-confidence in ICT high level tasks in a full ICT resource at home. Besides, it could fund that ICT for school related tasks and ICT availability in school were not helpful in students' reading literacy. Students like learning with their wish, they don't like learning with teachers' wish.

Most study only focus on student-level variables, such as Lee and Wu's study [9, 10] and Tse, Yuen, Loh, Lam, and Ng's study [11]. The study focus on both student-level variables and school-level variables. The urbanization of school area and the total number of students of school were positive with students' reading literacy. Most schools in large city were also many students, so these two results were similar. The gap of students' reading literacy was large, and government should pay attention to these schools in village or small town for their weak reading literacy. Computers for education in schools were negative with students' reading literacy. Students think computers in school were for learning, and learning was active as teachers wish and unfunny. So improve students' reading literacy was not just mean lots computers in school. Teachers should let students know the meaning of reading literacy and make learning with computers more fun.

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