Determinants of a Computer and Information Literacy Test Score: A Comparison Across 19 Countries

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This paper explores the International Computer and Information Literacy Study (ICILS) and applies both the two-level and three-level hierarchical linear regression models to study the various determinants of students' achievement in the CIL test. The main result shows that, across almost all the 19 countries where data is available, National Index of Students Socioeconomic Background has the largest and most significant positive impact on students' CIL test scores. Another important finding is that in 8 out of the 19 countries there is a gender gap in which male students usually have a statistically and significantly lower CIL test score than female students.

Keywords: ICT, computer and information efficacy, computer and information literacy, socioeconomic factor, hierarchical linear model

INTRODUCTION

The International Computer and Information Literacy Study (ICILS) is the first international comparative study of student preparedness for life in the information age - the ability to use computers to investigate, create and communicate in order to participate effectively at home, at school, in the workplace and in the community (http://icils.cite.hku.hk/en/index.htm). With a considerable amount of technological advances in the 21st century, computer literacy has become key in educational success. Information technology can provide vast new ways to interact with students, convey and disseminate information. It also has fundamentally changed the way we approach education. Therefore, inequality in the access to technology and computer literacy is a major issue in all levels of education around the world. This is known as the "digital divide"[1]. As evident in previous literature, access to and literacy in technology can increase further access to information and opportunities for many people. For students, computer literacy can aid them in a world where that particular skill has become indispensable in almost every career. The main objective in our paper is to explore the determinants of students' achievement in the CIL test. Using both the two-level and three-level multilevel approaches, we examine student, school and teacher characteristics such as gender, expected levels of education, number of computers, the uses of ICT application in school versus out of school and personal interest and enjoyment of ICT in 19 ICILS participating countries or regions. The countries are Australia, Chile, Croatia, Czech Republic, Denmark, Germany, Hong Kong, SAR, Korea, Republic of, Lithuania, Netherlands, Norway, Newfoundland and

Labrador, Canada, Ontario, Canada, Poland, Russian Federation, Slovak Republic, Slovenia, Thailand, and Turkey. The main result shows that, across all 19 countries where data is available, the National Index of Students Socioeconomic Background has the largest and most significant positive impact on students' CIL test scores except for Hong Kong, China, where it has a slightly significant negative impact on students' CIL test scores, while the Netherlands is excluded due to the lack of data on this variable. Another important finding is that in most countries there is a gender gap in which male students tend to have a statistically and significantly lower CIL test score than female students.

In the past, similar research has been conducted using the ICILS 2013 data. These research papers include Rohatgi, Scherer, and Hatlevik (2016), Scherer, Rohatgi, and Hatlevik (2017), Hatlevik, Throndsen, Loi, and Gudmundsdottir (2018), and Gerick, Eickelmann and Bos (2017) among others. Their methodologies entail a structural equation model (SEM) such as in Rohatgi, Scherer, and Hatlevik (2016), multi-group SEM such as in Rohatgi, Scherer, and Hatlevik (2016), latent profile analysis (LPA) such as in Scherer, Rohatgi, and Hatlevik (2017), path analyses such as in Hatlevik, Throndsen, Loi, and Gudmundsdottir (2018), and multilevel approach such as in Gerick, Eickelmann and Bos (2017). Though we will be using a similar methodology, our paper differs in the number of countries included in the analysis. Many of these papers focused on one country or a few countries, whereas this paper will cover 19 out of the entire 21 ICILS participating countries or regions.

The rest of the paper is organized as follows. Section 2 is a literature review. Section 3 discusses data and methods. Section 4 presents the estimation results. Finally, section 5 draws conclusions of the paper.

LITERATURE REVIEW

It is expected that students' socioeconomic statuses predict ICT literacy (Hatlevik, Throndsen, Loi, and Gudmundsdottir, 2018; Scherer, Rohatgi, and Hatlevik, 2017; Kim, Kil, and Shin, 2014; Law, Yuen, and Lee, 2015; Siddiq, Gochyyev, and Wilson, 2017; Bowers and Urick, 2011; Delen and Bulut, 2011; Gustafsson, 2007; Kim and Bagaka, 2005; Uyar and Brown, 2007; Young, Reynolds, and Walberg, 1996).

"Thus, socioeconomic status seems to be the most important predictor of students' computer and information literacy across all countries. This is in line with prior research (e.g., Claro et. al., 2012; Goldhammer et. al., 2013; Hatlevik et. al., 2015) and indicates that students' socioeconomic backgrounds seems to be one of the drivers of the so-called second level of the digital divide rather than access which is the first level digital divide." (Hatlevik et. al., 2018, p. 116.)

Scherer, Rohatgi, and Hatlevik (2017) even detailed how the socioeconomic status of students is measured. "In ICILS 2013, students' socioeconomic status is indicated by the highest education level of parent(s), parent(s) occupation, and home literacy (number of books at home) resources in the family. These three variables have been reported by students, and ISCO coding has been used for coding the occupation for comparisons between countries. In the questionnaire, students were required to identify their parents' level of education on predefined categories based on the ISCED definitions (UNESCO, 2006). In Norway, almost 66 percent of the students reported having at least one parent with a university degree. The highest occupational status was estimated as the maximum of the mother's and the father's status (HISEI). On average, Norwegian students' HISEI was 54.3 points (SD = 15.4). Students' home literacy index (HOMLIT) was derived from their estimations of the number of books at home. The resultant categorical codes ranged from 0 (0-10 books) to 4 (more than 200 books)." (Scherer, Rohatgi, and Hatlevik, 2017, p. 489.) "Based on students' responses to these questions, the international research team computed an index of students' socioeconomic background (S_NISB). The exact computation for this index differs across countries, depending on the principal component analysis of the variables." (Law, Yuen, and Lee, 2015, p. 55.) Please find more details on this index in Fraillon et. al. (2015).

The relationship between students' gender and the dependent variable ICT literacy or academic performance is also significant, though it varies across countries. "In Slovenia and Norway, girls demonstrate better CIL than boys, and the gender difference in these two countries are much higher than in countries like Poland, Russia, and Turkey." (Hatlevik, Throndsen, Loi, and Gudmundsdottir, 2018, p. 117.) The primary objective of Lau (2017) was to examine whether and how social media usage and social media multitasking (SMM) influenced the academic performance of university students. A gender difference in academic performance was found in which female students generally attained a higher CGPA than that of male students. "There are arguably various cognitive and noncognitive factors that explain academic gender differences (Cooper, 2014). Against this background, it is crucial to explore further how differences in social media usage and SMM between genders may exacerbate or ameliorate the noticeable gender gap in academic performance." (Lau, 2017, p. 290). Lau's data was collected from undergraduate students at a comprehensive university in Hong Kong, SAR, China. Gender was also a factor in Demir and Kiliç (2009) in their study of the effects of computer use on students' mathematics achievement in Turkey. Results from this study indicated that some of the school type, male students and computer use at home variables had positive effects. One of the research questions that Scherer, Rohatgi, and Hatlevik (2017) tried to answer was to what extent do students' background and motivational characteristics differentiate the latent profiles of ICT use? (Research Question 2). They pointed out that students' immigration background, gender, self-efficacy in basic and advanced ICT skills, and their interest and enjoyment in ICT differentiated between the two latent profiles, where profile 1 can be characterized by students who frequently use ICT for school- and study-related purposes but a less frequent use of Internet outside of school, whereas profile 2 can be characterized by students who consistently and frequently use ICT for different purposes and in various settings (Scherer, Rohatgi, and Hatlevik, 2017, p. 493-494.) In other word, students' gender and their immigration background were significant covariates of profile membership. "As the probability of being a member of profile 2 was associated with being a girl, it seems as if girls tended to use ICT across different contexts and for different purposes consistently in this group. It is interesting that gender determined profile membership in this study, because gender differences did rarely exist in the ICT use variables for the Norwegian ICILS 2013 sample (Fraillon et. al., 2014)." (Scherer, Rohatgi, and Hatlevik, 2017, p. 496.) They interpreted this result as indicative of the existence of potential gender-specific user profiles. Using a stratified sample of 11,767 students in 173 Korean elementary schools, Kim, Kil, and Shin (2014) revealed that male students have positive effects on ICT literacy score in their hierarchical linear model (HLM) analysis, whereas the ICT level of female students was higher than that of male students in average or lower levels in their hierarchical generalized linear model (HGLM) analysis, where students' ICT literacy level was classified into four levels: below basic, basic, average, and excellent.

However, gender was not a statistically significant factor in Felisoni and Godoi (2018). They studied the relationship between the actual average time students spend using their smartphones per day and academic performance. "Independent sample t-tests were performed and showed no significant difference in the average G-MNPS between males and females (p-value = 51.3%)." (Felisoni and Godoi, 2018, p. 180.) G-MNPS is a proxy for academic performance and they collected data from 43 students at Fundação Getúlio Vargas (FGV), a business school from São Paulo, Brazil. Similarly, Giunchiglia, Zeni, Gobbi, Bignotti, and Bison (2018) also found gender is not a significant control factor when studying the smartphone use and its impact on academic performance. Their data was collected from students at the University of Trento, Italy, in the academic year 2015. Kiss and Gastelú (2015) compared the ICT literacy level of the Mexican and Hungarian students in the higher education. The analysis was completed by gender at the country level, but it didn't yield any significant differences in the subjective ICT literacy level between the Mexican girls and boys. Furthermore, in higher education, the subjective ICT knowledge level between the two genders is also the same. In Hungary, the situation varied. The Hungarian girls demonstrated a higher subjective knowledge level by using ICT tools in their learning process and they are more creative by image editing. On the other hand, the subjective ICT literacy level of Hungarian boys is higher by Item 1^{st}: "Handling Operating System (OS)", Item 5^{th}: "Multimedia" and Item 6^{th}: "Software specific to my degree" so Hungarian boys are more successful by finding the deeper secret of operating systems, using different multimedia tools and software connection with the learning strategy in higher education (Kiss and Gastelú, 2015, p. 833.) Kim and Bagaka (2005) used survey data collected from 1,027 fourth- and fifth-grade students in 48 classrooms in northeastern Ohio to estimate a two-level hierarchical linear model to examine the extent to which teacher/classroom, school, and home variables can predict the average classroom usage of specific technology tools. Although Kim and Bagaka

(2005) found no statistically significant evidence of a gender gap among students in fourth- and fifth-grade levels in usage of computer tools in the classroom, they pointed out that "boys on average spend more hours on computers at home than do girls. This difference in home usage of computers by gender, if unchecked, may lead to a gender digital divide later on in their school life. Educators should make an effort to identify more institutional and societal factors that may lead to the widening of this gender digital divide, as well as incorporating gender equity strategies in the curriculum of teacher training programs." (Kim and Bagaka, 2005, p. 327.) Song and Kang (2012) used data from the 2010 Survey of Seoul Education Longitudinal Research to evaluate the impacts of ICT use on mathematic achievement. They found that the use of ICT explained a significant portion in the overall variance in mathematic achievement at the elementary school level, at the middle school level, and at the high school level, respectively, but they did not find gender to be statistically significant.

DATA AND METHODS

Data Sources

We collected data from IEA's ICILS 2013, in which the computer and information literacy of Grade 8 students were examined for the first time in an international comparison using computer-based testing. In addition, information on teaching and learning with ICT was collected using questionnaires for students, teachers, school principals and ICT coordinators as well as a national context questionnaire (Jung and Carstens, 2015). 21 education systems around the globe participated in ICILS 2013, whose research design defined two target populations: Grade 8 students and teachers teaching in Grade 8 (Jung and Carstens, 2015). Within each of the selected schools, a random sample of 20 students and 15 teachers was chosen. The countries chosen for the international comparison in our paper were Australia, Chile, Croatia, Czech Republic, Denmark, Germany, Hong Kong, SAR, Korea, Republic of, Lithuania, Netherlands, Norway, Newfoundland and Labrador, Canada, Ontario, Canada, Poland, Russian Federation, Slovak Republic, Slovenia, Thailand, and Turkey.

Variables

The dependent variable in this study is the first of five plausible values of Computer and Information Literacy scores. The achievement score variable names are based on a six-character alphanumeric code where PV1CIL represents the first plausible value and PV5CIL represents the fifth plausible value. From the variables mentioned in precedent studies, several independent variables derived from the student questionnaire data used in this study are ICT self-efficacy basic skills (S_BASEFF), ICT self-efficacy advanced skills (S_ADVEFF), the sex of the student (IS1G02), the education level/ISCED the student expected to attain (IS1G03), answers to the question "How many computers are currently used in your home? a) Desktop computer (IS1G13A), b) Portable computer (notebook, netbook, iPad or other tablet device) (IS1G13B)", Learning of ICT tasks at school (S_TSKLRN), use of specific ICT applications (S_USEAPP), use of ICT during lessons at school (S_USELRN), use of ICT for recreation (S_USEREC), use of ICT for study purposes (S_USESTD), use of ICT for social communication (S_USECOM), interest and enjoyment in using ICT (S_INTRST), use of ICT for exchanging information (S_USEINF), and National index of students' socioeconomic background (S_NISB). Several independent variables derived from the teacher questionnaire data used in this study are use of ICT for learning at school (T_USELRN), use of specific ICT applications (T_USEAPP), use of ICT for teaching at school (T_USETCH), ICT self-efficacy (T_EFF), emphasis on teaching ICT skills (T_EMPH), positive views on using ICT in teaching and learning (T_VWPOS), negative views on using ICT in teaching and learning (T_VWNEG), computer resources at school (T_RESRC), and collaboration between teachers in using ICT (T_COLICT). The number of independent variables is 15 and 9 at the individual student and school levels, respectively. All of the above-mentioned teacher data has been aggregated at the school level to provide information about the school environment. The descriptive statistics for these variables are shown in Table 1 and the analysis sample in the selected 19 education systems is summarized in Table 2. Detailed information from ICILS 2013 on the 24 independent variables in this analysis is available from the authors upon request.

TABLE 1
DESCRIPTIVE STATISTICS

	VARIABLES	MEANING	N	mean	sd	min	max
	PV1CIL	Plausible value 1 of CIL	55,129	508.7	96.23	7.060	805.4
1	S_BASEFF	ICT self-efficacy basic skills	54,451	50.20	9.932	9.470	58.86
2	S_ADVEFF	ICT self-efficacy advanced skills	54,464	49.81	10.14	21.38	71.74
3	IS1G02	Gender: 1 = Girl, 2 = Boy	54,852	1.507	0.500	1	2
4	IS1G03	Education level expected: 1 = 5A or 6, 2 = 4 or 5B, 3 = 3, 4 = 2, 5 = < 2	54,672	1.838	1.043	1	5
5	IS1G13A	Number of desktop computers at home	54,848	1.174	1.152	0	9
6	IS1G13B	Number of portable computers at home	54,848	2.276	2.115	0	9
7	S_TSKLRN	Learning of ICT tasks at school	54,456	50.41	9.863	24.08	60.14
8	S_USEAPP	Use of specific ICT applications	54,698	50.10	9.917	22.82	95.64
9	S_USELRN	Use of ICT during lessons	54,080	50.86	9.937	35.53	76.62
10	S_USEREC	Use of ICT for recreation	54,519	49.90	9.941	20.88	80.21
11	S_USESTD	Use of ICT for study purposes	54,508	50.56	9.833	23.92	83.46
12	S_USECOM	Use of ICT for social communication	54,589	49.97	9.942	27.04	75.27
13	S_INTRST	Interest and enjoyment in using ICT	54,437	49.85	10.04	10.40	68.79
14	S_USEINF	Use of ICT for exchanging information	54,511	49.60	10.03	36.79	88.39
15	S_NISB	National index of students' socioeconomic background	49,409	0.0328	1.021	-3.750	3.070
16	T_USELRN	Teacher: Use of ICT for learning at school	51,331	50.21	4.786	35.59	77.52
17	T_USEAPP	Teacher: Use of specific ICT applications	51,331	50.19	4.667	34.95	69.47
18	T_USETCH	Teacher: Use of ICT for teaching at school	51,331	50.19	4.794	35.60	75.80
19	T_EFF	Teacher: ICT self-efficacy	51,331	50.71	4.421	18.56	64.19
20	T_EMPH	Teacher: Emphasis on teaching ICT skills	51,331	49.96	4.536	35.45	70.42
21	T_VWPOS	Teacher: positive views on using ICT in teaching and learning	51,331	49.63	4.967	31.39	76.88
22	T_VWNEG	Teacher: Negative views on using ICT in teaching and learning	51,331	48.99	4.881	10.56	70.72
23	T_RESRC	Teacher: Computer resources at school	51,331	50.04	6.273	24.95	77.03
24	T_COLICT	Teacher: Collaboration between teachers in using ICT	51,331	48.64	5.712	19.88	75.62

TABLE 2
ANALYSIS SAMPLE IN THE SELECTED 19 EDUCATION SYSTEMS

	Education System/Country	Abbreviation	Student sample size	Number of schools	Average number of students per school
1	Australia	AUS	4699	287	16.4
2	Chile	CHL	2924	174	16.8
3	Newfoundland and Labrador, Canada	CNL	1219	102	12
4	Ontario, Canada	COT	2404	152	15.8
5	Czech Republic	CZE	2947	170	17.3
6	Germany	DEU	1693	117	14.5
7	Denmark	DNK	1278	78	16.4
8	Hong Kong, SAR	HKG	1376	103	13.4
9	Croatia	HRV	2710	170	15.9
10	Korea, Republic of	KOR	2781	150	18.5
11	Lithuania	LTU	2471	161	15.3
12	Netherlands	NLD	1649	95	17.4
13	Norway	NOR	1929	116	16.6
14	Poland	POL	2691	156	17.3
15	Russian Federation	RUS	3042	187	16.3
16	Slovak Republic	SVK	2758	167	16.5
17	Slovenia	SVN	3420	213	16.1
18	Thailand	THA	3155	183	17.2
19	Turkey	TUR	2088	141	14.8

For the analyses pertaining to our research questions, data is included from 47,234 students (student level) in 2922 schools (school level) in our 19 selected countries. The particularly low participation rates in the teacher survey in the city of Buenos Aires (Argentina) and in Switzerland led to the exclusion of their teacher data from the ICILS 2013 international database. The average cluster size ranges from 12 to 18.5 Grade 8 students.

Among all the independent variables considered in the study (listed in the Appendix), only gender (IS1G02), expected level of education (IS1G03), and number of home desktop computer (IS1G13A) and number of home portable computers (IS1G13B) are ordinal integer variables. For gender, 1 is for girl and 2 is for boy. For the expected level of education, 1 is for the International Standard Classification of Education 1997 (ISCED 97)'s level 5A, which are programmes that are largely theoretically based and are intended to provide sufficient qualifications for gaining entry into advanced research programmes and professions with high skills requirements; or level 6, which is reserved for tertiary programmes that lead to the award of an advanced research qualification. The programmes are devoted to advanced study and original research. 2 is for ISCED 97's level 4, which are these programmes that straddle the boundary between upper secondary and post-secondary education from an international point of view, even though they might clearly be considered as upper secondary or post-secondary programmes in a national context. These programmes are often not significantly more advanced than programmes at ISCED 3 but they serve to broaden the knowledge of participants who have already completed a programme at level 3. The students are typically older than those in ISCED 3 programmes. They also typically have a full-time equivalent duration of between 6 months and 2 years; or level 5B, which are programmes that are generally more practical/technical/occupationally specific than ISCED 5A programmes. Duration categories: Short: 2 to less than 3 years; 3 to less than 5 years; Long: 5 to 6 Years; Very long: More than 6 years. 3 is for ISCED 97's level 3, the final stage of secondary education in most countries. Instruction is often more organized along subject-matter lines than at ISCED level 2 and teachers typically need to have a higher level, or more subject-specific, qualification than that at ISCED 2. In the typical duration of ISCED 3 programmes both across and between countries, there are substantial differences typically ranging from 2 to 5 years of schooling. 4 is for ISCED 97's level 2, the lower secondary level of education generally continues the basic programmes of the primary level, although teaching is typically more subject-focused, often employing more specialized teachers who conduct classes in their field of specialization. 5 is for ISCED 97's level 1, primary level of education or level 0 pre-primary level of education, that is, any levels lower than ISCED 97's level 2 (ISCED, 1997). For the number of home desktop computers, it ranges from 0 to 9, where 0 means no desktop computer at home and 9 means 9 or more desktop computers at home. For the number of home portable computers, it also ranges from 0 to 9, where 0 means no portable computer at home and 9 means 9 or more portable computers at home.

For all other independent variables, item response modeling provided an appropriate way of scaling questionnaire items. "ICILS used the ACER Conquest software package (Wu, Adams, Wilson, & Haldane, 2007) to analyze the item-scaling properties and the estimation of item parameters … After completing the estimation of the international item parameters from the calibration sample, we computed weighted likelihood estimations in order to obtain individual student scores. The transformation of weighted likelihood estimates to an international metric resulted in reporting scales with an ICILS average of 50 and a standard deviation of 10 for equally weighted datasets from the countries that met sample participation requirements." (Fraillon et. al., 2015, p. 183.) Item response Theory (IRT) is a way to analyze responses to tests or questionnaires with the goal of improving measurement accuracy and reliability.

Analysis Model

Since the variables expected to affect CIL have hierarchical or nested structures, the use of conventional statistical techniques such as multiple regression or ANOVA would be tainted by aggregation bias, misestimated precision, or the unit of analysis problem. Instead, a two-level hierarchical linear model (HLM) will be used to examine the effects of individual- and school- level variables on the CIL scores of Grade 8 school students. The analysis model is as follows.

Level-1 model (Student level):

$$Y_{ij} = \beta_{0j} + \sum_{q=1}^{15} \beta_{qj}(X_q)_{ij} + e_{ij}, \qquad e_{ij} \sim N(0, \sigma^2) \qquad (1)$$

Level-2 model (School-level):

$$\beta_{0j} = \gamma_{00} + \sum_{s=1}^{9} \gamma_{0s}(W_s) + u_{0j}, \qquad u_{0j} \sim N(0, \sigma^2 \qquad (2)$$

$$\beta_{1j} = \gamma_{10} \dots \beta_{qj} = \gamma_{q0}.$$

In this formula, Y_{ij} is the Computer and Information Literacy (CIL) test score of student 'i' going to school 'j'. In order to estimate the value, 15 student-level variables (X) and 9 school-level variables (W) are applied in order. This Hierarchical Linear Model has been used to study education issues in Bowers and Urick (2011), Delen and Bulut (2011), Gustafsson (2007), Kim and Bagaka (2005), Song and Kang (2012), Uyar and Brown (2007), and Young, Reynolds, and Walberg (1996) among others.

We follow Gerick, Eickelmann, and Bos (2017) when aggregating teacher data to the school level. "Within these analyses, weighting variables are included to account for the complex structure of the ICILS 2013 data: As teacher data is aggregated to the school level, providing information about the teaching staff in a participating school, and is defined as characteristic of the respective school, the weighting variable at the school level is conducted by combining the school base weight with the school nonparticipation adjustment for the teacher survey (WGTFAC1 × WGTADJ1T, Meinck and Cortes, Chapter 3, ICILS 2013 User Guide for the International Database (2015), p. 40)." (Gerick, Eickelmann, and Bos, 2017, p. 5.) The full information maximum likelihood method (FIML) was applied to estimate variance components.

RESULTS

Stata statistical software was used to estimate the model. For each of the 19 countries, we estimated both the random intercept and random intercept random coefficient models. Likelihood ratio tests prefer the random intercept model[2]. We examined the results of the random intercept HLM model to identify the significant variables affecting the CIL of the students and the results are presented in Table 3 in the Appendix.

For Australia, first, the intra-class correlation (ICC), which represents the proportion of the between-schools variance of the total variance consisting of within and between schools, is 0.188. This means that only 18.8% of the total of variance in the CIL score was explained from between schools variance[3].

With regard to student context variables, student's ICT self-efficacy basic skills increase the CIL score by 1.999 points whereas student's ICT self-efficacy advanced skills lower the CIL score by 0.570 point. The CIL test score of male students was 17.419 points lower than that of female students. As student's expected education level drops from ISCED Level 5A or 6 (which is the base level) to ISCED Level 4 or 5B, ISCED Level 3, ISCED Level 2, and I do not expect to complete [ISCED Level 2], the CIL score drops by 21.657, 27.760, 54.173, and 46.139 points, respectively. Each additional more desktop computer at home lowers the CIL score by 1.959 points whereas each additional more portable computer at home increases the CIL score by 0.870 points. As the scale index for learning ICT tasks at school increases by 1 unit, the CIL score increases by 0.399 point. As the scale index for interest and enjoyment in using ICT increases by 1 unit, the CIL score increases by 0.694 points. As the scale index for use of ICT for exchanging information increases by 1 unit, the CIL score decreases by 0.548 points. Finally, as the national index of students' socioeconomic background increases by 1 unit, the CIL score increases by 10.884 points.

With regard to teacher context variables at the school level, the use of specific ICT applications can lower the CIL test score by 3.504 points whereas the use of ICT for teaching at school increases the CIL score by 3.862 points. A more negative view on using ICT in teaching and learning can lower the CIL score by 1.198 points while a more pessimistic perspective on the lack of computer resources at school can lower the CIL score by 1.233 points.

For all other countries, similar interpretation applies. We find that student context variables are more influential than teacher context variables on student CIL score.

TABLE 3
RESULTS FOR TWO-LEVEL HIERARCHICAL LINEAR MODELS (HLM)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	Australia	Chile	Newfoundland and Labrador, Canada	Ontario, Canada	Czech Republic	Germany	Denmark	Hong Kong, SAR	Croatia
S_BASEFF	1.999***	2.515***	2.265***	2.089***	1.354***	0.860***	1.828***	1.582***	1.974***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
S_ADVEFF	-0.570***	-0.707***	-1.383***	-0.347*	-0.102	-0.120	-1.112***	-0.603**	-0.142
	(0.000)	(0.000)	(0.000)	(0.068)	(0.461)	(0.566)	(0.000)	(0.010)	(0.402)
2.IS1G02	-17.419***	-5.836*	-29.726***	-21.118***	-4.230*	-14.137***	-5.809*	-2.635	-0.148
	(0.000)	(0.065)	(0.000)	(0.000)	(0.085)	(0.000)	(0.059)	(0.502)	(0.959)
2.IS1G03	-21.657***	-19.362***	-32.312**	-18.752	-11.398***	-15.760**	-7.122	-8.993*	-22.102***
	(0.000)	(0.000)	(0.027)	(0.195)	(0.004)	(0.032)	(0.221)	(0.096)	(0.000)
3.IS1G03	-27.760***	-39.265***	-11.266	-23.751***	-26.664***	-14.356***	-19.510***	-14.104	-56.450***
	(0.000)	(0.000)	(0.164)	(0.000)	(0.000)	(0.000)	(0.000)	(0.119)	(0.000)
4.IS1G03	-54.173***	-78.224*	-15.651	-43.031***	-37.641***	-24.035***	-35.198***	-19.345***	-69.233***
	(0.000)	(0.081)	(0.228)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
5.IS1G03	-46.139***		-8.844	-59.750***	-19.681	-47.666***	-55.964**	1.328	-39.742
	(0.000)		(0.660)	(0.000)	(0.114)	(0.001)	(0.010)	(0.917)	(0.449)
IS1G13A	-1.959**	-1.924	1.418	-0.142	0.519	-2.074*	0.336	-3.580**	-1.634
	(0.021)	(0.249)	(0.595)	(0.906)	(0.659)	(0.076)	(0.819)	(0.028)	(0.198)
IS1G13B	0.870*	1.957**	1.982	1.526**	0.317	-0.971	1.074	2.270**	1.905**
	(0.096)	(0.046)	(0.185)	(0.031)	(0.655)	(0.343)	(0.169)	(0.023)	(0.044)
S_TSKLRN	0.399**	-0.133	0.417	0.546**	0.052	-0.445***	-0.067	0.436**	0.382**
	(0.031)	(0.391)	(0.141)	(0.012)	(0.639)	(0.008)	(0.723)	(0.044)	(0.013)
S_USEAPP	-0.209	0.315	0.641	-0.135	0.445***	0.168	-0.383	0.097	0.138
	(0.149)	(0.135)	(0.106)	(0.538)	(0.006)	(0.413)	(0.167)	(0.675)	(0.439)
S_USELRN	-0.034	-0.852***	-0.276	-0.599**	-0.167	-0.013	0.851***	-0.317*	-0.621***
	(0.880)	(0.000)	(0.594)	(0.011)	(0.240)	(0.958)	(0.004)	(0.081)	(0.000)
S_USEREC	-0.111	0.315	0.758**	0.638***	0.141	0.410	0.432	-0.129	0.301*
	(0.457)	(0.150)	(0.019)	(0.002)	(0.346)	(0.117)	(0.182)	(0.517)	(0.060)
S_USESTD	0.107	-0.164	-1.313***	-0.187	-0.449***	-0.508**	-0.172	-0.526**	-0.103
	(0.432)	(0.450)	(0.003)	(0.473)	(0.000)	(0.044)	(0.627)	(0.019)	(0.613)
S_USECOM	0.097	0.280	-0.382	-0.372	0.036	0.542**	-0.595**	0.100	0.592***

	(0.528)	(0.203)	(0.431)	(0.119)	(0.815)	(0.036)	(0.050)	(0.716)	(0.000)
S_INTRST	0.694***	0.374**	0.016	0.247	-0.191	0.479**	0.067	0.606***	-0.096
	(0.000)	(0.014)	(0.937)	(0.212)	(0.150)	(0.011)	(0.801)	(0.002)	(0.539)
S_USEINF	-0.548***	-0.563***	0.055	-0.058	-0.548***	-0.372**	-0.434*	0.058	-0.706***
	(0.000)	(0.006)	(0.893)	(0.774)	(0.000)	(0.044)	(0.055)	(0.840)	(0.000)
S_NISB	10.884***	10.557***	11.332***	9.523***	5.918***	4.051**	11.063***	-3.268	8.932***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.022)	(0.000)	(0.138)	(0.000)
T_USELRN	0.894	5.723**	0.145	-1.246	1.024	13.156***	1.466	9.109***	0.883
	(0.507)	(0.016)	(0.932)	(0.297)	(0.634)	(0.002)	(0.394)	(0.009)	(0.697)
T_USEAPP	-3.504**	0.905	-0.873	1.245	1.624	-10.927**	-1.026	-6.667*	4.660**
	(0.048)	(0.543)	(0.531)	(0.342)	(0.435)	(0.028)	(0.537)	(0.084)	(0.040)
T_USETCH	3.862*	-5.023**	-0.645	0.991	-0.673	-1.042	0.058	2.451	-4.590**
	(0.064)	(0.024)	(0.641)	(0.242)	(0.741)	(0.842)	(0.974)	(0.689)	(0.049)
T_EFF	-0.577	2.428***	-0.387	-0.737	0.061	1.833	-0.202	-0.452	1.650*
	(0.398)	(0.005)	(0.617)	(0.263)	(0.924)	(0.307)	(0.769)	(0.871)	(0.054)
T_EMPH	-1.897	-0.841	1.110	-0.956	-2.877	-7.198*	-0.045	-0.922	-0.363
	(0.213)	(0.549)	(0.371)	(0.232)	(0.120)	(0.058)	(0.967)	(0.839)	(0.840)
T_VWPOS	0.177	-0.677	-0.502	0.047	-0.472	-0.184	-1.288	-2.170	-1.697
	(0.848)	(0.425)	(0.372)	(0.898)	(0.493)	(0.937)	(0.189)	(0.654)	(0.207)
T_VWNEG	-1.198*	0.152	-0.068	-0.150	-1.317*	5.564***	1.057**	-5.793**	-1.205
	(0.080)	(0.841)	(0.900)	(0.579)	(0.097)	(0.000)	(0.030)	(0.046)	(0.250)
T_RESRC	-1.233***	-1.738***	-0.459	0.226	-1.006	-1.549	-0.983**	-1.709	0.121
	(0.001)	(0.001)	(0.442)	(0.481)	(0.143)	(0.155)	(0.018)	(0.390)	(0.852)
T_COLICT	-0.114	-1.590*	0.438	0.309	0.096	0.920	-0.282	-0.308	1.371
	(0.823)	(0.057)	(0.606)	(0.306)	(0.880)	(0.494)	(0.644)	(0.915)	(0.172)
Constant	645.002***	443.209***	564.222***	481.321***	704.247***	428.133*	595.360***	798.895***	414.854***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.050)	(0.000)	(0.004)	(0.000)
Observations	4,699	2,924	1,219	2,404	2,947	1,693	1,278	1,376	2,710
# of groups	287	174	102	152	170	117	78	103	170

Robust pval in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TABLE 3
RESULTS FOR TWO-LEVEL HIERARCHICAL LINEAR MODELS (HLM) CONTINUED

	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
VARIABLES	Korea, Republic of	Lithuania	Netherlands	Norway	Poland	Russian Federation	Slovak Republic	Slovenia	Thailand	Turkey
S_BASEFF	3.490***	2.358***	1.253***	2.280***	2.256***	1.997***	2.324***	2.132***	1.741***	1.574***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
S_ADVEFF	-1.334***	-0.796***	-0.490***	-0.976***	-0.546***	-0.789***	-0.716***	-1.004***	-1.592***	-0.790***
	(0.000)	(0.000)	(0.007)	(0.000)	(0.009)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
2.IS1G02	-18.817***	0.140	-19.253***	-17.383***	-3.131	1.637	0.786	-14.224***	-5.309	2.530
	(0.000)	(0.964)	(0.000)	(0.000)	(0.297)	(0.497)	(0.803)	(0.000)	(0.142)	(0.379)
2.IS1G03	-8.242*	-26.070***	-15.404***	-16.868***	-15.102***	-23.804***	-4.004	-16.563***	-16.925**	-19.356***
	(0.072)	(0.000)	(0.002)	(0.000)	(0.002)	(0.000)	(0.404)	(0.000)	(0.012)	(0.000)
3.IS1G03	-25.364***	-43.479***	-21.761***	-26.509***	-42.585***	-33.360***	-38.928***	-41.009***	-24.979***	-31.458***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
4.IS1G03	-34.738***	-50.392***	-47.365***	-18.460*	-70.576***	-34.678***	-64.857***	-55.094***	-33.627***	-26.154***
	(0.000)	(0.000)	(0.000)	(0.089)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
5.IS1G03	-156.394***	-84.141***	-46.796***	-32.718**	-117.322***	-29.563**	-35.041**	-37.699	-62.046***	-29.630***
	(0.000)	(0.000)	(0.000)	(0.047)	(0.000)	(0.017)	(0.039)	(0.368)	(0.000)	(0.001)
IS1G13A	-0.341	-1.582	-4.305***	-3.749***	-1.034	-0.567	-1.678	-0.694	4.986***	-0.296
	(0.864)	(0.289)	(0.001)	(0.002)	(0.536)	(0.659)	(0.352)	(0.483)	(0.004)	(0.902)
IS1G13B	1.005	1.748*	0.027	0.789	1.112	2.370***	-1.174	3.074***	6.174***	2.728
	(0.425)	(0.071)	(0.973)	(0.269)	(0.314)	(0.007)	(0.210)	(0.000)	(0.000)	(0.159)
S_TSKLRN	-0.210*	-0.289**	0.137	-0.240	-0.100	0.224*	0.147	0.142	0.704***	0.638***
	(0.067)	(0.046)	(0.488)	(0.140)	(0.471)	(0.068)	(0.345)	(0.281)	(0.005)	(0.000)
S_USEAPP	0.721***	-0.045	0.355	0.250	0.049	0.086	0.523***	0.008	0.031	0.413**
	(0.000)	(0.841)	(0.152)	(0.198)	(0.797)	(0.534)	(0.009)	(0.960)	(0.872)	(0.038)
S_USELRN	0.292**	-0.364**	-0.445*	0.459*	-0.075	-0.019	-0.276	0.279**	-0.402**	-0.578***
	(0.012)	(0.020)	(0.057)	(0.092)	(0.583)	(0.874)	(0.105)	(0.024)	(0.036)	(0.000)
S_USEREC	0.050	0.068	0.048	0.154	0.764***	-0.039	0.081	0.153	-0.213	0.393*
	(0.790)	(0.650)	(0.822)	(0.520)	(0.000)	(0.758)	(0.681)	(0.396)	(0.456)	(0.063)
S_USESTD	-0.395**	-0.012	-0.201	-0.380	-0.453**	-0.089	-0.283	-0.636***	-0.435*	-0.637***
	(0.011)	(0.949)	(0.343)	(0.163)	(0.012)	(0.594)	(0.188)	(0.000)	(0.052)	(0.000)
S_USECOM	0.729***	0.485**	0.058	-0.286	-0.002	0.660***	0.430**	0.410***	1.152***	1.247***
	(0.001)	(0.022)	(0.759)	(0.290)	(0.991)	(0.000)	(0.034)	(0.006)	(0.000)	(0.000)
S_INTRST	0.611***	-0.029	0.828***	0.487***	0.278*	-0.272*	0.308	0.443***	0.516***	0.264*
	(0.000)	(0.846)	(0.000)	(0.006)	(0.062)	(0.064)	(0.110)	(0.003)	(0.007)	(0.086)
S_USEINF	-0.728***	-0.412**	-0.438**	-0.512**	-0.654***	-0.593***	-0.358**	-0.258	-0.558**	-1.280***
	(0.001)	(0.018)	(0.028)	(0.013)	(0.001)	(0.000)	(0.023)	(0.112)	(0.031)	(0.000)

S_NISB	6.433***	7.582***		11.461***	9.320***	5.914***	12.907***	10.439***	3.407	5.228***
	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.160)	(0.003)
T_USELRN	-0.009	-3.974	10.507*	1.338	-3.611	0.779	2.502	0.352	0.343	2.983
	(0.997)	(0.228)	(0.060)	(0.462)	(0.177)	(0.814)	(0.556)	(0.855)	(0.944)	(0.415)
T_USEAPP	-0.401	4.957	1.080	-0.506	1.817	4.683	-3.083	3.391*	-2.975	4.036
	(0.866)	(0.308)	(0.819)	(0.801)	(0.198)	(0.300)	(0.399)	(0.071)	(0.304)	(0.200)
T_USETCH	2.483	-1.111	-8.802**	3.204***	0.140	-1.152	2.975	-3.209	-3.977	1.283
	(0.437)	(0.836)	(0.033)	(0.006)	(0.918)	(0.709)	(0.413)	(0.120)	(0.444)	(0.705)
T_EFF	0.267	1.016	-4.576	-0.752	-1.074	-1.349	-0.913	-0.448	2.395*	-0.050
	(0.869)	(0.510)	(0.130)	(0.415)	(0.195)	(0.255)	(0.541)	(0.633)	(0.063)	(0.965)
T_EMPH	-3.604	0.135	-2.817	-5.106***	3.159	-6.746	-0.061	1.205	7.915	-6.015
	(0.111)	(0.979)	(0.445)	(0.001)	(0.133)	(0.128)	(0.983)	(0.464)	(0.103)	(0.101)
T_VWPOS	-2.143*	-0.140	-7.355***	-0.824	-1.885*	-1.117	-2.191	-0.641	0.752	-1.571
	(0.050)	(0.959)	(0.000)	(0.227)	(0.055)	(0.389)	(0.151)	(0.396)	(0.485)	(0.213)
T_VWNEG	0.973	-1.526	-5.145**	-2.878***	-0.908	0.036	1.177	0.529	0.487	1.182
	(0.408)	(0.546)	(0.042)	(0.000)	(0.502)	(0.981)	(0.406)	(0.564)	(0.622)	(0.489)
T_RESRC	-1.894***	-0.831	-2.843**	0.181	-1.018	-0.139	0.176	-0.217	-2.262	-2.830***
	(0.008)	(0.429)	(0.012)	(0.674)	(0.231)	(0.883)	(0.875)	(0.653)	(0.107)	(0.005)
T_COLICT	5.387***	-2.639	-1.693	-0.209	-1.319	2.770**	0.332	0.878	0.273	1.574
	(0.002)	(0.164)	(0.318)	(0.701)	(0.209)	(0.034)	(0.756)	(0.203)	(0.795)	(0.230)
Constant	357.427***	669.612***	1,554.435***	751.087***	713.886***	546.010***	381.284**	351.705***	223.286**	338.607***
	(0.004)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.032)	(0.000)	(0.017)	(0.009)
Observations	2,781	2,471	1,649	1,929	2,691	3,042	2,758	3,420	3,155	2,088
# of groups	150	161	95	116	156	187	167	213	183	141

Robust pval in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Since our objective is to compare the coefficients uniformly, we re-estimate the HLM model for each of the 19 countries by requesting the standardized beta coefficients to be estimated. These results are presented in Table 4. For Australia, one standard deviation increase in student's ICT self-efficacy basic skills increases the CIL score by 0.231 standard deviation whereas one standard deviation increase in student's ICT self-efficacy advanced skills lowers the CIL score by 0.074 standard deviation. The CIL test score of male students was lower than that of female students by 0.121 standard deviation. As student's expected education level drops from ISCED Level 5A or 6 (which is the base level) to ISCED Level 4 or 5B, ISCED Level 3, ISCED Level 2, and I do not expect to complete [ISCED Level 2], the CIL score drops by 0.112, 0.149, 0.139, and 0.082 standard deviations, respectively. Each one standard deviation increase in the number of desktop computer at home lowers the CIL score by 0.037 standard deviation whereas each one standard deviation increase in portable computer at home increases the CIL score by 0.029 standard deviation, but this is no longer statistically significant. As the scale index for learning ICT tasks at school increases by one standard deviation, the CIL score increases by 0.040 standard deviation. As the scale index for interest and enjoyment in using ICT increases by one standard deviation, the CIL score increases by 0.094 standard deviation. As the scale index for use of ICT for exchanging information increases by one standard deviation, the CIL score decreases by 0.071 standard deviation. Finally, as the national index of students' socioeconomic background increases by one standard deviation, the CIL score increases by 0.152 standard deviation.

TABLE 4
STANDARDIZED BETA COEFFICIENTS (2-LEVEL HLM)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Australia AUS	Chile CHL	Newfoundland and Labrador, Canada CNL	Ontario, Canada COT	Czech Republic CZE	Germany DEU	Denmark DNK	Hong Kong, SAR HKG	Croatia HRV
S_BASEFF	0.231***	0.257***	0.263***	0.280***	0.181***	0.126***	0.230***	0.211***	0.211***
	(11.03)	(12.57)	(7.88)	(8.32)	(8.94)	(3.83)	(6.44)	(6.27)	(9.78)
S_ADVEFF	-0.074***	-0.087***	-0.199***	-0.052	-0.016	-0.017	-0.165***	-0.080*	-0.018
	(-3.85)	(-4.30)	(-4.35)	(-1.83)	(-0.74)	(-0.57)	(-4.97)	(-2.56)	(-0.84)
1.IS1G02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)
2.IS1G02	-0.121***	-0.037	-0.189***	-0.155***	-0.035	-0.107***	-0.046	-0.017	-0.001
	(-8.01)	(-1.84)	(-5.78)	(-6.47)	(-1.72)	(-4.63)	(-1.89)	(-0.67)	(-0.05)
1.IS1G03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)
2.IS1G03	-0.112***	-0.101***	-0.099*	-0.047	-0.052**	-0.048*	-0.035	-0.040	-0.129***
	(-7.90)	(-4.78)	(-2.22)	(-1.29)	(-2.91)	(-2.14)	(-1.22)	(-1.67)	(-5.95)
3.IS1G03	-0.149***	-0.127***	-0.033	-0.072***	-0.208***	-0.108***	-0.152***	-0.041	-0.331***
	(-9.41)	(-8.15)	(-1.39)	(-3.62)	(-10.67)	(-4.22)	(-5.09)	(-1.56)	(-13.55)
4.IS1G03	-0.139***	-0.055	-0.032	-0.089***	-0.080***	-0.154***	-0.118***	-0.080***	-0.120***
	(-7.98)	(-1.74)	(-1.20)	(-3.80)	(-4.68)	(-5.11)	(-4.33)	(-3.37)	(-7.37)
5.IS1G03	-0.082***		-0.011	-0.069***	-0.017	-0.043**	-0.058*	0.001	-0.019
	(-5.33)		(-0.44)	(-4.00)	(-1.58)	(-3.25)	(-2.56)	(0.10)	(-0.76)
IS1G13A	-0.037*	-0.021	0.020	-0.003	0.008	-0.037	0.006	-0.048*	-0.021
	(-2.30)	(-1.15)	(0.53)	(-0.12)	(0.44)	(-1.77)	(0.23)	(-2.20)	(-1.29)
IS1G13B	0.029	0.047*	0.056	0.053*	0.008	-0.022	0.034	0.053*	0.036*
	(1.66)	(2.00)	(1.33)	(2.16)	(0.45)	(-0.95)	(1.38)	(2.28)	(2.02)
S_TSKLRN	0.040*	-0.018	0.047	0.065*	0.009	-0.059**	-0.009	0.058*	0.050*
	(2.16)	(-0.86)	(1.47)	(2.50)	(0.47)	(-2.66)	(-0.36)	(2.01)	(2.49)
S_USEAPP	-0.026	0.035	0.071	-0.018	0.057**	0.023	-0.044	0.013	0.017
	(-1.44)	(1.49)	(1.62)	(-0.62)	(2.73)	(0.82)	(-1.38)	(0.42)	(0.77)
S_USELRN	-0.003	-0.093***	-0.026	-0.065*	-0.023	-0.001	0.099**	-0.042	-0.073***
	(-0.15)	(-4.52)	(-0.53)	(-2.53)	(-1.17)	(-0.05)	(2.90)	(-1.75)	(-4.08)
S_USEREC	-0.015	0.038	0.095*	0.087**	0.019	0.042	0.052	-0.017	0.038
	(-0.74)	(1.44)	(2.34)	(3.13)	(0.94)	(1.57)	(1.34)	(-0.65)	(1.88)

S_USESTD	0.013	-0.016	-0.158**	-0.023	-0.074***	-0.056*	-0.017	-0.060*	-0.012
	(0.79)	(-0.76)	(-2.94)	(-0.72)	(-3.53)	(-2.02)	(-0.49)	(-2.35)	(-0.51)
S_USECOM	0.013	0.034	-0.049	-0.054	0.005	0.071*	-0.060*	0.012	0.074***
	(0.63)	(1.27)	(-0.79)	(-1.56)	(0.23)	(2.10)	(-1.96)	(0.36)	(3.51)
S_INTRST	0.094***	0.047*	0.002	0.037	-0.029	0.066*	0.010	0.078**	-0.012
	(4.31)	(2.47)	(0.08)	(1.25)	(-1.44)	(2.54)	(0.25)	(3.13)	(-0.61)
S_USEINF	-0.071***	-0.069**	0.006	-0.008	-0.081***	-0.049*	-0.056	0.007	-0.087***
	(-3.83)	(-2.74)	(0.13)	(-0.29)	(-4.10)	(-2.01)	(-1.92)	(0.20)	(-3.74)
S_NISB	0.152***	0.149***	0.144***	0.140***	0.102***	0.062*	0.175***	-0.041	0.113***
	(9.08)	(5.90)	(3.75)	(4.65)	(5.46)	(2.29)	(5.53)	(-1.48)	(5.53)
T_USELRN	0.037	0.233*	0.008	-0.099	0.052	0.587**	0.064	0.335**	0.036
	(0.66)	(2.41)	(0.09)	(-1.04)	(0.48)	(3.03)	(0.85)	(2.60)	(0.39)
T_USEAPP	-0.130*	0.039	-0.049	0.094	0.096	-0.486*	-0.045	-0.232	0.200*
	(-1.98)	(0.61)	(-0.63)	(0.95)	(0.78)	(-2.20)	(-0.62)	(-1.73)	(2.06)
T_USETCH	0.154	-0.234*	-0.040	0.074	-0.037	-0.047	0.003	0.083	-0.189*
	(1.85)	(-2.26)	(-0.47)	(1.17)	(-0.33)	(-0.20)	(0.03)	(0.40)	(-1.97)
T_EFF	-0.024	0.104**	-0.021	-0.050	0.003	0.078	-0.010	-0.016	0.068
	(-0.85)	(2.84)	(-0.50)	(-1.12)	(0.09)	(1.02)	(-0.29)	(-0.16)	(1.93)
T_EMPH	-0.074	-0.036	0.062	-0.076	-0.169	-0.315	-0.002	-0.029	-0.019
	(-1.24)	(-0.60)	(0.90)	(-1.20)	(-1.55)	(-1.90)	(-0.04)	(-0.20)	(-0.20)
T_VWPOS	0.008	-0.031	-0.033	0.004	-0.022	-0.009	-0.057	-0.057	-0.055
	(0.19)	(-0.80)	(-0.89)	(0.13)	(-0.69)	(-0.08)	(-1.31)	(-0.45)	(-1.26)
T_VWNEG	-0.054	0.008	-0.005	-0.014	-0.078	0.352***	0.059*	-0.174*	-0.041
	(-1.75)	(0.20)	(-0.13)	(-0.56)	(-1.66)	(5.09)	(2.17)	(-2.00)	(-1.15)
T_RESRC	-0.101***	-0.133***	-0.039	0.023	-0.090	-0.142	-0.084*	-0.076	0.008
	(-3.34)	(-3.43)	(-0.77)	(0.70)	(-1.47)	(-1.42)	(-2.36)	(-0.86)	(0.19)
T_COLICT	-0.006	-0.090	0.029	0.030	0.008	0.053	-0.016	-0.011	0.050
	(-0.22)	(-1.91)	(0.52)	(1.02)	(0.15)	(0.68)	(-0.46)	(-0.11)	(1.37)
N	4699	2924	1219	2404	2947	1693	1278	1376	2710

Standardized beta coefficients; t statistics in parentheses
="* p<0.05 ** p<0.01 *** p<0.001"

TABLE 4
STANDARDIZED BETA COEFFICIENTS (2-LEVEL HLM) CONTINUED

	(10) Korea, Republic KOR	(11) Lithuania LTU	(12) Netherlands NLD	(13) Norway NOR	(14) Poland POL	(15) Russian Federation RUS	(16) Slovak Republic SVK	(17) Slovenia SVN	(18) Thailand THA	(19) Turkey TUR
S_BASEFF	0.391***	0.281***	0.149***	0.271***	0.228***	0.250***	0.238***	0.265***	0.178***	0.195***
	(15.60)	(12.82)	(6.97)	(9.82)	(9.90)	(12.12)	(11.84)	(11.68)	(7.19)	(9.62)
S_ADVEFF	-0.134***	-0.098***	-0.072**	-0.139***	-0.066**	-0.096***	-0.086***	-0.160***	-0.151***	-0.093***
	(-5.75)	(-3.93)	(-2.67)	(-3.91)	(-2.60)	(-4.44)	(-4.17)	(-6.19)	(-7.20)	(-3.82)
1.IS1G02	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)
2.IS1G02	-0.110***	0.001	-0.131***	-0.126***	-0.022	0.011	0.005	-0.108***	-0.028	0.013
	(-5.44)	(0.05)	(-5.44)	(-5.65)	(-1.04)	(0.68)	(0.25)	(-5.82)	(-1.47)	(0.88)
1.IS1G03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)
2.IS1G03	-0.032	-0.159***	-0.080**	-0.089***	-0.059**	-0.124***	-0.014	-0.125***	-0.046*	-0.064***
	(-1.80)	(-7.98)	(-3.02)	(-3.60)	(-3.09)	(-7.02)	(-0.84)	(-5.98)	(-2.51)	(-4.44)
3.IS1G03	-0.080***	-0.183***	-0.143***	-0.134***	-0.290***	-0.127***	-0.227***	-0.261***	-0.089***	-0.108***
	(-4.43)	(-9.79)	(-5.13)	(-5.55)	(-12.27)	(-8.79)	(-11.87)	(-10.20)	(-4.59)	(-6.33)
4.IS1G03	-0.076***	-0.150***	-0.232***	-0.037	-0.154***	-0.080***	-0.130***	-0.150***	-0.089***	-0.090***
	(-5.13)	(-8.33)	(-7.60)	(-1.70)	(-8.42)	(-5.95)	(-6.06)	(-7.26)	(-4.81)	(-5.75)
5.IS1G03	-0.040***	-0.103***	-0.102***	-0.014*	-0.100***	-0.027*	-0.027*	-0.027	-0.069***	-0.057***
	(-7.79)	(-7.06)	(-4.27)	(-1.98)	(-6.79)	(-2.38)	(-2.06)	(-0.90)	(-3.70)	(-3.38)
IS1G13A	-0.003	-0.019	-0.078***	-0.066**	-0.012	-0.006	-0.018	-0.012	0.056**	-0.002
	(-0.17)	(-1.06)	(-3.46)	(-3.06)	(-0.62)	(-0.44)	(-0.93)	(-0.70)	(2.90)	(-0.12)
IS1G13B	0.015	0.029	0.001	0.023	0.022	0.047**	-0.022	0.067***	0.096***	0.028
	(0.80)	(1.80)	(0.03)	(1.11)	(1.01)	(2.68)	(-1.25)	(3.48)	(4.90)	(1.41)
S_TSKLRN	-0.031	-0.036*	0.018	-0.032	-0.015	0.030	0.016	0.021	0.057**	0.061***
	(-1.83)	(-2.00)	(0.69)	(-1.47)	(-0.72)	(1.82)	(0.94)	(1.08)	(2.79)	(4.09)
S_USEAPP	0.098***	-0.005	0.039	0.031	0.006	0.011	0.053**	0.001	0.003	0.049*
	(4.21)	(-0.20)	(1.43)	(1.29)	(0.26)	(0.62)	(2.59)	(0.05)	(0.16)	(2.07)
S_USELRN	0.043*	-0.049*	-0.044	0.039	-0.010	-0.003	-0.029	0.036*	-0.034*	-0.063***
	(2.53)	(-2.33)	(-1.91)	(1.69)	(-0.55)	(-0.16)	(-1.62)	(2.26)	(-2.10)	(-3.72)
S_USEREC	0.006	0.009	0.005	0.017	0.099***	-0.006	0.009	0.020	-0.019	0.051
	(0.27)	(0.45)	(0.22)	(0.64)	(4.86)	(-0.31)	(0.41)	(0.85)	(-0.74)	(1.86)

S_USESTD	-0.055*	-0.002	-0.022	-0.037	-0.052*	-0.010	-0.027	-0.081***	-0.038	-0.078***
	(-2.56)	(-0.06)	(-0.95)	(-1.40)	(-2.50)	(-0.53)	(-1.32)	(-4.22)	(-1.94)	(-3.71)
S_USECOM	0.084***	0.055*	0.007	-0.028	-0.000	0.089***	0.049*	0.061**	0.113***	0.148***
	(3.30)	(2.30)	(0.31)	(-1.06)	(-0.01)	(4.36)	(2.12)	(2.73)	(3.82)	(5.60)
S_INTRST	0.070***	-0.004	0.105***	0.066**	0.036	-0.031	0.034	0.067**	0.047**	0.030
	(3.56)	(-0.19)	(4.41)	(2.74)	(1.86)	(-1.85)	(1.60)	(2.96)	(2.71)	(1.71)
S_USEINF	-0.074**	-0.052*	-0.054*	-0.062*	-0.080***	-0.082***	-0.042*	-0.039	-0.054*	-0.146***
	(-3.22)	(-2.37)	(-2.19)	(-2.50)	(-3.30)	(-3.77)	(-2.28)	(-1.59)	(-2.15)	(-6.98)
S_NISB	0.074***	0.099***		0.164***	0.128***	0.078***	0.159***	0.153***	0.039	0.055**
	(4.23)	(4.37)		(7.12)	(5.43)	(4.24)	(7.15)	(8.09)	(1.41)	(3.01)
T_USELRN	-0.000	-0.198	0.376	0.059	-0.173	0.050	0.122	0.016	0.019	0.169
	(-0.00)	(-1.21)	(1.88)	(0.74)	(-1.35)	(0.24)	(0.59)	(0.18)	(0.07)	(0.82)
T_USEAPP	-0.013	0.239	0.036	-0.018	0.079	0.304	-0.152	0.165	-0.170	0.218
	(-0.17)	(1.02)	(0.23)	(-0.25)	(1.29)	(1.04)	(-0.84)	(1.81)	(-1.03)	(1.28)
T_USETCH	0.080	-0.055	-0.294*	0.141**	0.007	-0.079	0.141	-0.150	-0.233	0.073
	(0.78)	(-0.21)	(-2.13)	(2.78)	(0.10)	(-0.37)	(0.82)	(-1.55)	(-0.77)	(0.38)
T_EFF	0.007	0.041	-0.136	-0.030	-0.041	-0.083	-0.033	-0.020	0.098	-0.002
	(0.17)	(0.66)	(-1.52)	(-0.82)	(-1.29)	(-1.14)	(-0.61)	(-0.48)	(1.86)	(-0.04)
T_EMPH	-0.106	0.005	-0.088	-0.182**	0.157	-0.353	-0.003	0.055	0.414	-0.395
	(-1.59)	(0.03)	(-0.76)	(-3.24)	(1.50)	(-1.52)	(-0.02)	(0.73)	(1.63)	(-1.64)
T_VWPOS	-0.071	-0.005	-0.284***	-0.036	-0.072	-0.057	-0.069	-0.030	0.029	-0.059
	(-1.96)	(-0.05)	(-4.47)	(-1.21)	(-1.92)	(-0.86)	(-1.44)	(-0.85)	(0.70)	(-1.24)
T_VWNEG	0.030	-0.063	-0.193*	-0.136***	-0.036	0.002	0.041	0.021	0.020	0.048
	(0.83)	(-0.60)	(-2.03)	(-4.51)	(-0.67)	(0.02)	(0.83)	(0.58)	(0.49)	(0.69)
T_RESRC	-0.077**	-0.053	-0.155*	0.013	-0.069	-0.010	0.010	-0.016	-0.089	-0.176**
	(-2.66)	(-0.79)	(-2.52)	(0.42)	(-1.20)	(-0.15)	(0.16)	(-0.45)	(-1.61)	(-2.81)
T_COLICT	0.147**	-0.132	-0.076	-0.011	-0.060	0.167*	0.014	0.046	0.009	0.063
	(3.04)	(-1.39)	(-1.00)	(-0.38)	(-1.26)	(2.12)	(0.31)	(1.27)	(0.26)	(1.20)
N	2781	2471	1649	1929	2691	3042	2758	3420	3155	2088

Standardized beta coefficients; t statistics in parentheses
="* p<0.05 ** p<0.01 *** p<0.001"

With regard to teacher context variables at the school level, the use of specific ICT applications can lower the CIL test score by 0.130 standard deviation whereas the use of ICT for teaching at school increases the CIL score by 0.154 standard deviation, but this is no longer statistically significant. A more negative view on using ICT in teaching and learning can lower the CIL score by 0.054 standard deviation, but this has also become insignificant. A more pessimistic perspective on the lack of computer resources at school can lower the CIL score by 0.101 standard deviation.

For all other countries, similar interpretation applies. We find that student context variables are more influential than teacher context variables on student CIL score. In summary, our estimation results show that socioeconomic factors contribute significantly and positively to students CIL scores in all countries except for Hong Kong (SAR, China), and Thailand, whereas data for S_NISB is missing for the Netherlands. In the following countries or regions male students' CIL scores are statistically lower than those of female students: Australia, Newfoundland and Labrador, Canada, Ontario, Canada, Germany, Republic of Korea, Netherlands, Norway, and Slovenia. Countries that show no statistical difference in CIL scores between male and female students include Chile, Czech Republic, Denmark, Hong Kong (SAR, China), Croatia, Lithuania, Poland, Russian Federation, Slovak Republic, Thailand, and Turkey.

We then find the average beta coefficient for all 19 countries, taking the absolute value, and ranking them from largest to smallest. This result is in Table 5. From Table 5, we learn that the top five influential factors include ICT self-efficacy basic skills which has a positive effect on students' CIL scores. Students' socioeconomic background also has a positive effect on their CIL scores. The negative effect is mainly due to students' lower expectation of education, especially for those students whose education expectation stop at ISCED 97's level 3 and level 2. Students' ICT self-efficacy in advanced skills has a negative effect on their CIL scores, but teachers' use of ICT for learning at school has a positive effect on students' CIL scores. In Table 5, we also find the minimum and maximum for each independent variable's beta coefficient and which country takes that minimum or maximum values. However, as in Hatlevik, Throndsen, Loi, and Gudmundsdottir (2018), it is hard to identify common pattern across countries. "This requires extensive knowledge about country specific characteristics." (Hatlevik, Throndsen, Loi, and Gudmundsdottir, 2018, p. 117.)

TABLE 5
RANK ON THE ABSOLUTE VALUE OF BETA COEFFICIENTS

Rank	VAR	AVE	**Absolute**	MIN	Country	MAX	Country
1	S_BASEFF	0.23	0.23	0.13	Germany	0.39	Korea, Republic
2	3.IS1G03	-0.15	0.15	-0.33	Croatia	-0.03	Newfoundland and Labrador, Canada
3	4.IS1G03	-0.11	0.11	-0.23	Netherlands	-0.03	Newfoundland and Labrador, Canada
4	S_NISB	0.11	0.11	-0.04	Hong Kong, SAR	0.18	Denmark
5	S_ADVEFF	-0.09	0.09	-0.20	Newfoundland and Labrador, Canada	-0.02	Czech Republic, Germany, Croatia
6	T_USELRN	0.09	0.09	-0.20	Lithuania	0.59	Germany
7	2.IS1G03	-0.08	0.08	-0.16	Lithuania	-0.01	Slovak Republic
8	T_RESRC	-0.07	0.07	-0.18	Turkey	0.02	Ontario, Canada
9	2.IS1G02	-0.06	0.06	-0.19	Newfoundland and Labrador, Canada	0.01	Russian Federation, Slovak Republic, Turkey
10	T_EMPH	-0.06	0.06	-0.40	Turkey	0.41	Thailand
11	S_USEINF	-0.06	0.06	-0.15	Turkey	0.01	Newfoundland and Labrador, Canada; Hong Kong, SAR;
12	5.IS1G03	-0.05	0.05	-0.10	Netherlands	0.00	Hong Kong, SAR
13	T_VWPOS	-0.05	0.05	-0.28	Netherlands	0.03	Thailand
14	S_USESTD	-0.04	0.04	-0.16	Newfoundland and Labrador, Canada	0.01	Australia
15	S_INTRST	0.04	0.04	-0.03	Czech Republic	0.11	Netherlands
16	S_USECOM	0.03	0.03	-0.06	Denmark	0.15	Turkey
17	T_USETCH	-0.03	0.03	-0.29	Netherlands	0.15	Australia
18	IS1G13B	0.03	0.03	-0.02	Germany	0.10	Thailand
19	S_USEREC	0.03	0.03	-0.02	Australia	0.10	Newfoundland and Labrador, Canada; Poland
20	S_USEAPP	0.02	0.02	-0.04	Denmark	0.10	Korea, Republic
21	S_USELRN	-0.02	0.02	-0.09	Chile	0.10	Denmark
22	IS1G13A	-0.02	0.02	-0.08	Netherlands	0.06	Thailand
23	S_TSKLRN	0.01	0.01	-0.06	Germany	0.07	Ontario, Canada
24	T_COLICT	0.01	0.01	-0.13	Lithuania	0.17	Russian Federation
25	T_VWNEG	-0.01	0.01	-0.19	Netherlands	0.35	Germany
26	T_USEAPP	0.01	0.01	-0.49	Germany	0.30	Russian Federation
27	T_EFF	0.00	0.00	-0.14	Netherlands	0.10	Chile

Last, we estimate a three-level HLM model with random intercepts with students' school being level 2 and students' country being level 3. The estimated regression coefficients as well as the corresponding standardized beta coefficients are shown in Table 6. Looking at column (1), we still see the previous relationships between the CIL scores, and each individual independent variable still hold. In general, the positive relationships present between CIL score and students' computer and information basic efficacy, students' having more laptop computers at home, students' using computer and information applications at school, students' use computer and information for recreation, students' using computer technology for communication, students' interest in computer and information technology, students' socioeconomic background, and teachers' use of computer technology for learning at school. We still see the male students generally have lower CIL scores than female students. Looking at column (2), the biggest positive impact on CIL score is from students' computer and information basic efficacy skills. Other significant and positive impacts on CIL are from students' socioeconomic background, students' use of computer technology for communication, and teachers' use of computer technology for learning at school. Finally, although male students have lower CIL scores than female students, it has become statistically insignificant.

TABLE 6
RESULTS FOR THREE-LEVEL HIERARCHICAL LINEAR MODEL
(3-LEVEL HLM)

VARIABLES	(1) beta	VARIABLES	(2) Standardized beta
S_BASEFF	1.898***	S_BASEFF	0.196***
	(0.000)		(7.83)
S_ADVEFF	-0.794***	S_ADVEFF	-0.080***
	(0.000)		(-4.67)
2.IS1G02	-5.690*	2.IS1G02	-0.030
	(0.071)		(-1.80)
2.IS1G03	-18.996***	2.IS1G03	-0.069***
	(0.000)		(-10.23)
3.IS1G03	-29.932***	3.IS1G03	-0.118***
	(0.000)		(-10.01)
4.IS1G03	-34.598***	4.IS1G03	-0.080***
	(0.000)		(-11.07)
5.IS1G03	-40.163***	5.IS1G03	-0.037***
	(0.000)		(-5.63)
IS1G13A	-0.348	IS1G13A	-0.004
	(0.672)		(-0.42)
IS1G13B	1.584**	IS1G13B	0.035*
	(0.011)		(2.55)
S_TSKLRN	0.122	S_TSKLRN	0.013
	(0.375)		(0.89)
S_USEAPP	0.309***	S_USEAPP	0.032**
	(0.003)		(2.97)
S_USELRN	-0.143	S_USELRN	-0.016
	(0.316)		(-1.00)
S_USEREC	0.188**	S_USEREC	0.019*
	(0.049)		(1.97)
S_USESTD	-0.364***	S_USESTD	-0.038***
	(0.000)		(-4.15)

S_USECOM	0.718***	S_USECOM	0.074***
	(0.000)		(4.61)
S_INTRST	0.284**	S_INTRST	0.029*
	(0.011)		(2.55)
S_USEINF	-0.698***	S_USEINF	-0.071***
	(0.000)		(-5.53)
S_NISB	7.103***	S_NISB	0.076***
	(0.000)		(13.06)
T_USELRN	2.444**	T_USELRN	0.118*
	(0.046)		(2.00)
T_USEAPP	-0.776	T_USEAPP	-0.037
	(0.567)		(-0.57)
T_USETCH	0.010	T_USETCH	0.000
	(0.993)		(0.01)
T_EFF	-0.277	T_EFF	-0.013
	(0.709)		(-0.37)
T_EMPH	-1.408	T_EMPH	-0.063
	(0.343)		(-0.95)
T_VWPOS	-0.300	T_VWPOS	-0.015
	(0.295)		(-1.05)
T_VWNEG	1.386	T_VWNEG	0.065
	(0.181)		(1.34)
T_RESRC	-1.044**	T_RESRC	-0.064*
	(0.045)		(-2.01)
T_COLICT	0.441	T_COLICT	0.025
	(0.423)		(0.80)
Constant	420.180***		
	(0.000)		
Observations	45,585	N	45585
Number of groups	18		
Robust pval in parentheses *** p<0.01, ** p<0.05, * p<0.1		Standardized beta coefficients; t statistics in parentheses * p<0.05, ** p<0.01, *** p<0.001	

CONCLUSIONS

The objective of this paper is to examine 19 education systems with regard to the relevance of both student-level and school-level factors such as gender, socioeconomic background, the use of ICT by teachers in teaching and learning on students' CIL, as measured in IEA ICILS 2013.

The main result shows that, across all the 19 countries where data is available, students' ICT self-efficacy in basic skills has a very large and significantly positive effect on students' CIL test scores. National Index of Students Socioeconomic Background also has very large and significantly positive impact on students' CIL test scores except for Hong Kong (SAR, China), and Thailand, where they have an insignificant coefficient on the National Index of Students Socioeconomic Background (S_NISB) respectively, while Netherlands is excluded due to the lack of data on this variable. Another important finding is that in 8 out of the 19 countries there is a gender gap in which male students usually have a statistically and significantly lower CIL test scores than female students.

Our results agree with many other studies using ICILS 2013. For example, our results agree in many aspects with Hatlevik, Throndsen, Loi, and Gudmundsdottir (2018) which used multivariate path analysis to answer the research questions that they addressed. First, both their and our studies found a positive relationship between ICT self-efficacy in basic skills and students' CIL scores, however there was also a negative relationship between ICT self-efficacy in advanced skills and students' CIL scores. It remains to be examined if increased ICT self-efficacy will increase CIL in general and Hatlevik et. al. (2018) recommended using longitudinal studies to exam the relationship between ICT self-efficacy and CIL. Second, both their and our studies indicated that students' as well as teachers' ICT use have some positive effects on students' CIL scores, but most of these variables are statistically insignificant. "It is still uncertain if more emphasis in schools on the development of students' ICT will strengthen and increase their CIL." (Hatlevik, Throndsen, Loi, and Gudmundsdottir, 2018, p. 118.) Third, both their and our studies showed that students' socioeconomic backgrounds are important for understanding variations in students' CIL scores. This implies that family background may explain digital inequity and the digital divide. To prevent and dismiss the digital divide, Hatlevik et. al. (2018) advocated that schools should take action to help students develop ICT literacy. Fourth, both their and our studies found that female students obtain higher CIL scores than male students. "This result may indicate a change in previous gender stereotypes." (Hatlevik et. al., 2018, p. 118.) However, the present study does not provide any information about why the gender differences in students' CIL scores occurred. Understanding the gender gap may be helpful for instruction in schools. (Hatlevik, Throndsen, Loi, and Gudmundsdottir, 2018).

This study opens several opportunities for future research based on the limitations and results found through our analyses. The model is partly supported in 19 countries. However, in the future we could also explore the insight into the national school system in these countries. Finally, a panel data if available would be better for finding causal relationships. "The ICILS 2013 study has a cross-sectional design. A longitudinal design could be beneficial to control for country-fixed effects and selection biases." (Hatlevik, Throndsen, Loi, and Gudmundsdottir, 2018, p. 118.)

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ENDNOTES

1. The OECD defines the digital divide as "the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard to both their opportunities to access information and communication technology (ICTs) and to their use of Internet for a wide variety of activities" (OECD, 2001). Source: Tømte and Hatlevik (2011, p. 1418).
2. The results are available from the authors upon request.
3. The intra-class correlation (ICC) results for all the 19 countries are available from the authors upon request.

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