CHAPTER 9:

Conclusions and Discussion

The International Computer and Information Literacy Study 2013 (ICILS 2013) investigated the ways in which young people have developed the computer and information literacy (CIL) that enables them to participate fully in the digital age. This study, the first in international research to investigate students' acquisition of CIL, has been groundbreaking in two ways. The first is its establishment of a crossnationally agreed definition and explication of CIL in terms of its component knowledge, skills, and understandings. The second is its operationalization of CIL as a crossnationally comparable measurement tool and marker of digital literacy.

The CIL construct was developed with reference to decades of research into the knowledge, skills, and understanding involved in effective use of information and communication technology (ICT). Various terms with similar but not identical meanings such as *information literacy*, *computer literacy*, *digital literacy*, and *ICT literacy* have been used to characterize this set of competences.

The CIL construct is described and explained in detail in the *ICILS Assessment Framework* (Fraillon, Schulz, & Ainley, 2013). The framework, developed in consultation with ICILS national research coordinators (NRCs) and other people expert in digital and ICT literacy, guided all aspects of the ICILS instrument development and data collection stages. One important outcome of this work has been the establishment of a crossnational, empirical foundation for describing the competencies underpinning the CIL construct.

The ICILS assessment of CIL is unique in the field of crossnational assessment because it comprises tasks grouped into self-contained, computer-based “modules” that reflect school-based research and communication. Included in each module is at least one “open” task wherein students create an information product (such as a poster, presentation, or website) using purpose-built software that applies the conventions of software interface design. The ICILS assessment is thus similar to classroom-based assessments that allow students freedom to work with a range of software tools on open-ended tasks.

However, in order to ensure standardization of students' experience and comparability of the resultant data, the ICILS 2013 assessment required students to work in a contained test environment, designed to prevent differential exposure to digital resources from outside that environment. Such exposure could have confounded the comparability (a necessary feature of instruments used in large-scale assessments) of the student data.

The previous chapters in this international report on ICILS 2013 provided information on CIL achievement across countries, the contexts in which CIL was being taught and learned, and the relationship of CIL as a learning outcome to student characteristics and school contexts.

To provide an overview in this current chapter of these earlier recorded results, we summarize the main study outcomes with respect to each of the four research questions that guided the study. We also discuss country-level outcomes concerned with aspects of ICT use in education as well as the findings from our bivariate and multivariate analyses designed to explore associations between CIL and student and school factors.

We then consider a number of implications of the study's findings for educational policy and practice. We conclude the chapter by suggesting future directions for international research on CIL education.

ICILS guiding questions

The four research questions that guided the study were these:

1. What variations exist between countries, and within countries, in student computer and information literacy?
2. What aspects of schools and education systems are related to student achievement in computer and information literacy with respect to:
 - (a) The general approach to computer and information literacy education;
 - (b) School and teaching practices regarding the use of technologies in computer and information literacy;
 - (c) Teacher attitudes to and proficiency in using computers;
 - (d) Access to ICT in schools; and
 - (e) Teacher professional development and within-school delivery of computer and information literacy programs.
3. What characteristics of students' levels of access to, familiarity with, and self-reported proficiency in using computers are related to student achievement in computer and information literacy?
 - (a) How do these characteristics differ among and within countries?
 - (b) To what extent do the strengths of the relations between these characteristics and measured computer and information literacy differ among countries?
4. What aspects of students' personal and social backgrounds (such as gender, socioeconomic background, and language background) are related to computer and information literacy?

Student proficiency in using computers

Student CIL proficiency was measured using an instrument comprising four thematic modules, each of which included discrete tasks¹ and each of which typically took less than a minute to complete. These tasks were followed by a large task that typically took 15 to 20 minutes to complete. The following discussion of student CIL proficiency includes examples taken from the After-School Exercise assessment module. The large task from this module required students to use given digital resources to create a poster advertising an after-school exercise program. Chapter 3 of this report provides a more detailed discussion, along with illustrative examples, of CIL proficiency.

The computer and information literacy (CIL) scale

The ICILS CIL scale, which has an average score set to 500 and a standard deviation of 100, comprises four proficiency levels. Accounts of what students should be able to achieve at each level serve to describe the scale.

Students working at Level 1 demonstrate familiarity with the basic range of software commands that enable them to access files and complete routine text and layout editing when directed to do so. Students can recognize some basic software conventions as well as the potential for misuse of computers by unauthorized users. Figure 9.1 provides an

¹ These tasks can be described as discrete because, although they are connected by the common narrative, students can complete each one sequentially without having to explicitly refer to other tasks.

Figure 9.1: Example Level 1 task

example of a Level 1 task. This task required students to identify the recipients of an email displaying the “From,” “To,” and “Cc” fields. The task assessed students’ familiarity with the conventions used to display the sender and recipients of emails.

The work involved in doing the large task (creating a poster) contained in the After-School Exercise module provides another example of achievement at Level 1. The Level 1 aspect of the task required students to provide evidence of planning the poster in terms of selecting colors that would denote the roles of the poster’s text, background, and images.

Students working at Level 2 demonstrate basic use of computers as information resources. Students are able to locate explicit information in simple electronic resources, select and add content to information products, and demonstrate some control of layout and formatting of text and images in information products. They demonstrate awareness of the need to protect access to some electronic information and of some possible consequences of unwanted access to information. Figure 9.2 provides an example of a Level 2 task.

The task shown in the figure required students to allocate “can edit” rights in the collaborative workspace to another student with whom, according to the module narrative, students were “collaborating” on the task. To complete this nonlinear skills task,² students needed to navigate within the website to the “settings” menu and then use its options to allocate the required user access. The Level 2 aspect of the module’s large task required students to produce a relevant title for the poster, and then format the title to make its role clear. Ability to use formatting tools to some degree in order to show the role of different text elements is thus an indicator of achievement at Level 2.

² Nonlinear skills tasks require students to execute a software command (or reach a desired outcome) by executing subcommands in a number of different sequences. The *ICILS Assessment Framework* (Fraillon et al., 2013) provides further information about the ICILS task and question types.

Figure 9.2: Example Level 2 task

Students working at Level 3 demonstrate sufficient knowledge, skills, and understanding to independently search for and locate information and then edit it to suit the audience for, and the purpose of, the information products they create. Students at this level are able to select relevant information from within electronic resources and develop information products that exhibit controlled layout and design. They also demonstrate awareness that the information they access may be biased, inaccurate, or unreliable. Figure 9.3 provides an example of a Level 3 task.

Figure 9.3: Example Level 3 task

The task shown in Figure 9.3 required students to explain how the greeting (highlighted in the email) might be evidence that the email is trying to “trick” them. Ability to recognize that a generic (rather than personalized) greeting is one possible piece of evidence is an example of achievement at Level 3. Examples of Level 3 achievements in the large-task poster include students being able to complete some adaptation of information from resources (as opposed to directly copying and pasting information) and ability to include images that are well aligned with the poster’s other elements.

Students working at Level 4 execute control and evaluative judgment when searching for information and creating information products. They also demonstrate awareness of audience and purpose when searching for information, selecting information to include in information products, and formatting and laying out the information products they create. They furthermore demonstrate awareness of the potential for information to be a commercial and malleable commodity and of issues relating to the use of electronically sourced third-party intellectual property. Figure 9.4 provides an example of a Level 4 task.

Figure 9.4: Example Level 4 task

As with the task shown in Figure 9.3, the task in Figure 9.4 asked students to explain how the email address of the sender (highlighted in the email) might be evidence of the email trying to “trick” them. Students who recognize that the email is from a “freemail” account (and not a company account) or that the email address does not match the root of the hyperlink are achieving at Level 4 rather than lower levels because they demonstrate a more sophisticated understanding of email protocols with respect to safe and secure use. Examples of Level 4 achievements in the After-School Exercise poster task include students rephrasing the key points from source information and using formatting tools consistently throughout the poster so that the roles of the different text elements are clear to the reader.

Student achievement on the CIL scale

We can interpret and compare students' CIL by referring to their CIL scale scores and the proficiency levels of the scale.

Student CIL varied considerably across the ICILS countries. The average national scores on the scale ranged from 361 to 553 scale points, a span that extends from below Level 1 to a standard of proficiency within Level 3. This range was equivalent to almost two standard deviations. However, we need to acknowledge that the distribution of country CIL means was skewed because of the means of three countries being significantly below the ICILS 2013 average and the means of 12 other countries being significantly above the ICILS 2013 average.

Eighty-one percent of students achieved scores that placed them within CIL Levels 1, 2, and 3. In all but two countries, Turkey and Thailand, the highest percentage of students was in Level 2.

Students' computer use and CIL

A long conducted and established research literature shows that students' social background characteristics³ and students' personal characteristics⁴ are associated with student achievement across a range of learning areas. These same student-level factors were associated with CIL proficiency in ICILS. Characteristics reflecting higher socioeconomic status were associated with higher CIL proficiency both within and across countries.

Female students had higher CIL scale scores in all but two countries (Thailand and Turkey, where the differences were not statistically significant). This finding was not unexpected given that CIL is heavily reliant on text-based reading skills and given past research showing that females tend to outperform males on tests of reading. Similarly, students who spoke the language of the CIL test (which is also the language of instruction in their country) also performed better on the assessment.

When we took the associations between these various student factors into account using multiple regression techniques, we found that the following variables had statistically significant positive associations with CIL in most countries: students' gender (female compared to male), students' expected educational attainment, parental educational attainment, parental occupational status, the number of books in the home, and ICT home resources.

ICILS also investigated student access to, familiarity with, and confidence in using computers. Students were asked a range of questions relating to their access to and use of computers at home, at school, and in other places. There is an assumption that the generation of young people that includes the ICILS target grade students (i.e., Grade 8) has grown up with computers as a ubiquitous part of their lives. However, questions remain as to how such access relates to their CIL.

Almost all ICILS students reported that they were experienced users of computers and had access to them at home and at school. On average across the ICILS countries, more than one third of the Grade 8 students said they had been using computers for seven

³ Especially those related to socioeconomic status, which include measures of parental occupational status, parental educational attainment, and the number of books in the home.

⁴ Such as gender, students' expected highest level of education, and whether or not the language of testing/instruction is also spoken at home.

or more years, with a further 29 percent reporting that they had been using computers for between five and seven years. Ninety-four percent of the students on average crossnationally reported having at least one computer (desktop, laptop, notebook, or tablet device) at home, while 48 percent reported having three or more computers at home. Ninety-two percent of students stated that they had some form of internet connection at home. Both number of computers students had at home and access to a home internet connection were positively associated with CIL scores.

The ICILS student questionnaire also asked students a range of questions about their frequency of computer use, the types of tasks they completed using computers, and their attitudes toward using computers. These questions were underpinned by hypotheses that increased computer use, and focused use, would be positively associated with CIL.

Students across the ICILS countries reported using computers more frequently at home than elsewhere. On average, 87 percent said they used a computer at home at least once a week, whereas 54 percent and 13 percent reported this same frequency of computer use at school and other places respectively.

Computer use outside school

ICILS 2013 data indicate that students were making widespread and frequent use of digital technologies when outside school. Students tended to use the internet for social communication and exchange of information, computers for recreation, and software applications for school work and other purposes.

On average across the ICILS countries, three-quarters of the students said they communicated with others by way of messaging or social networks at least weekly. Just over half said that they used the internet for “searching for information for study or school work” at least once a week, and almost half indicated that they engaged in “posting comments to online profiles or blogs” at least once each week. On average, there was evidence of slightly more frequent use of the internet for social communication and exchanging information among females than among males.

Students were also frequently using computers for recreation. On average across the ICILS countries, 82 percent of students reported “listening to music” on a computer at least once a week, 68 percent reported “watching downloaded or streamed video (e.g., movies, TV shows, or clips)” on a weekly basis, and 62 percent said they used the internet to “get news about things of interest,” also on a weekly basis. Just over half of all the ICILS students were “playing games” once a week or more. Overall, we recorded only a small, albeit statistically significant, gender difference in the extent of recreational use of computers, with males reporting slightly higher frequencies than females.

Students also reported using software applications outside school. Generally across the ICILS countries, the most extensive weekly use of software applications involved “creating or editing documents” (28% of students). Use of most other utilities was much less frequent. For example, only 18 percent of the students were “using education software designed to help with school study.” We found no significant difference between female and male students with respect to using software applications outside school.

Use of ICT for school work

Crossnationally, just under half (45%) of the ICILS students, on average, were using computers to “prepare reports or essays” at least once a week. We recorded a similar extent of use for “preparing presentations” (44%). Forty percent of students reported using ICT when working with other students from their own school at least weekly, and 39 percent of students reported using a computer once a week or more to complete worksheets or exercises.

Two school-related uses of computers were reported by less than one fifth of the students. These were “writing about one’s own learning,” which referred to using a learning log, and “working with other students from other schools.” Nineteen percent of students said they used a computer for the first of these tasks; 13 percent said they used a computer for the second.

The subject area in which computers were most frequently being used was, not surprisingly, information technology or computer studies (56%). On average, about one fifth of the students studying (natural) sciences said they used computers in most or all lessons. The same proportion reported using computers in most or all of their human sciences/humanities lessons. In language arts (the test language) and language arts (foreign languages), students were using computers a little less frequently: about one sixth of the students reported computer use in most or all lessons. Approximately one in seven students studying mathematics reported computer use in most mathematics lessons or almost every lesson. Of the students studying creative arts, just a little more than one in 10 reported computer use in most or all lessons.

The ICILS teacher questionnaire asked teachers to select one of their Grade 8 classes as a reference class and then to report their use of ICT in that class. The order of frequency of ICT use by subject was very similar to that reported by students. On average, the percentage of teachers using ICT was greatest if the reference class was being taught information technology or computer studies (95%), but it was also very high if the class was studying (natural) sciences (84%) or human sciences/humanities (84%). Seventy-nine percent of teachers whose reference class was engaged in language arts (test language) or language arts (foreign languages) reported using ICT in their teaching. Across countries, three quarters of teachers whose reference class was a creative arts class, and 71 percent of those teaching mathematics, said they used ICT in their teaching.

Students’ perceptions of ICT

The ICILS student questionnaire also gathered information about two aspects of student perceptions of ICT. One concerned students’ confidence in using computers (their ICT self-efficacy). The other was students’ interest and enjoyment in using ICT. The questions relating to students’ ICT self-efficacy formed two scales—*basic ICT skills* (such as searching for and finding a file) and *advanced ICT skills* (such as creating a database, computer program, or macro).

Some small gender differences were evident in basic ICT self-efficacy in seven countries, with males scoring lower than females in six of these countries. However, in the case of advanced ICT self-efficacy, males scored significantly and substantially higher than females in all 14 countries that met sampling requirements.

We found no consistent associations overall between advanced ICT self-efficacy and CIL scale scores, but did observe positive associations between basic ICT self-efficacy

and CIL scale scores. This finding is not unexpected given the nature of the CIL assessment construct, which is made up of information literacy and communication skills that are not necessarily related to advanced computer skills such as programming or database management. Even though CIL is computer based, in the sense that students demonstrate CIL in the context of computer use, the CIL construct itself does not emphasize advanced computer-based technical skills.

Students were asked to indicate their agreement with a series of statements about their interest and enjoyment in using computers and doing computing. Overall, students expressed interest in computing and said they enjoyed it. Greater interest and enjoyment was associated with higher CIL scores, an effect that was statistically significant in nine of the 14 countries that met the ICILS sampling requirements.

Teacher, school, and education system characteristics relevant to CIL

General approaches to CIL education

The ICILS countries differed in terms of the characteristics of their education systems, their ICT infrastructure, and their approaches to ICT use.

Data from international databases show large differences among countries in their economies and (of particular relevance to this current study) ICT infrastructure. Data from the ICILS national context survey suggest that most of the participating countries were supportive at either the national or state/provincial level or both levels for using ICT in education. Plans and policies mostly included strategies for improving and supporting student learning and providing ICT resources.

International databases also show that countries differ with regard to including an ICT-related subject at the primary and lower-secondary levels of education. Although almost all of the ICILS countries had a subject or curriculum area equivalent to CIL at one or more levels of their respective education systems, fewer than half of the participating countries said their education system supported using ICT for student assessments. Across the countries, teaching CIL-related content was set within specific ICT-related subjects and was also regarded as a crosscurricular responsibility.

Teacher capacity to use ICT was rarely a requirement for teacher registration. However, teacher capacity to use ICT was often supported during preservice and inservice programs. In general, nearly all countries offered some form of support for teacher access to and participation in ICT-based professional development.

Teachers and CIL

Generally, the ICILS data confirm extensive use of ICT in school education. Across the ICILS countries, three out of every five teachers said they used computers at least once a week when teaching, while four out of every five reported using computers on a weekly basis for other work at their schools. As we commented in an earlier chapter, it is not possible to judge whether the reported level of use was appropriate, but we can agree that it was extensive.

Teachers in most countries were experienced users of ICT and generally recognized the positive aspects of using ICT in teaching and learning at school, especially with respect to accessing and managing information. On balance, teachers reported generally positive attitudes toward the use of ICT, although many teachers were aware that ICT use could

have some detrimental aspects, such as adversely affecting students' development of writing, calculation, and estimation skills.

In general, teachers were confident about their ability to use many computer applications; two thirds of them expressed confidence in their ability to use these technologies for assessing and monitoring student progress. There were differences, however, among countries in the level of confidence that teachers expressed with regard to using computer technologies, and younger teachers tended to be more confident ICT users than their older colleagues.

A substantial majority of the ICILS teachers were using ICT in their teaching. This use was greatest among teachers who were confident about their ICT expertise and who were working in school environments where there was collaboration about and planning of ICT use, and where there were fewer resource limitations to that use. These were also the conditions that supported teaching CIL. These findings suggest that if schools are to develop students' CIL to the greatest possible extent, then teacher expertise in ICT use needs to be augmented, and ICT use needs to be supported by collaborative environments that incorporate institutional planning.

According to the ICILS teachers, the utilities (software) most frequently used in their respective reference classes were those concerned with wordprocessing, presentations, and computer-based information resources, such as websites, wikis, and encyclopedias. Teachers said that, within their classrooms, ICT was most commonly being used by their students to search for information, work on short assignments, and undertake individual work on learning materials. The survey data also suggest that ICT was often being used to present information in class and reinforce skills. Overall, teachers appeared to be using ICT most frequently for relatively simple tasks and less often for more complex tasks.

Schools and CIL

Data from the ICT-coordinator questionnaire showed that, in general, the schools participating in ICILS were well equipped in terms of internet-related and software resources. The types of computer resources available for use were more variable, however, with countries being less likely to have on hand tablet devices, a school intranet, internet-based applications for collaborative work, and a learning management system.

An examination of the ratio of number of students in a school per available computers showed substantial differences across countries. Ten of the 16 countries that met sampling requirements had more computers per student available in rural settings than in urban schools. We investigated the association between CIL and the ratio of students to computers in schools across countries and found that students from countries with greater access to computing in schools tended to have stronger CIL skills.

Computers in schools were most often located in computer laboratories and libraries. However, there was some variation among countries as to whether portable class-sets of computers or student computers brought to class were being used. Most schools had policies about the use of ICT, but there was substantial cross-country variation regarding policies relating to access to school computers for both students and members of the local community. The same can be said with regard to provision of laptops and other mobile learning devices for use at school or home.

The ICT-coordinators reported a range of hindrances to teaching and learning ICT. These typically related to resource provision and to personnel and teaching support. In general, the coordinators rated personnel and teaching support issues as more problematic than resource issues. However, there was considerable variation across schools within countries and across countries in the types of limitation arising from resource inadequacy.

Variation was also evident in the level of teachers' agreement with negatively worded statements about the use of ICT in teaching at school. Statements reflecting insufficient time to prepare ICT-related lessons, schools not viewing ICT as a priority, and insufficient technical support to maintain ICT resources all attracted relatively high levels of teacher agreement.

Both teachers and principals provided perspectives on the range of professional development activities relevant to pedagogical use of ICT. According to principals, teachers were most likely to participate in school-provided courses on pedagogical use of ICT, to talk about this type of use when they were within groups of teachers, and to discuss ICT use in education as a regular item during meetings of teaching staff. From the teachers' perspective, the most common professional development activities available included observing other teachers using ICT in their teaching, introductory courses on general applications, and sharing and evaluating digital resources with others via a collaborative work space.

Results from the multivariate analyses

These results showed that students' experience with computers as well as regular home-based use of computers had significant positive effects in many countries, even after we had controlled for the influence of personal and social context. ICT resources, particularly the number of computers at home, no longer had effects once we took socioeconomic background into account.

Only a few countries recorded significant influences of school-level variables on CIL, and some of these associations were not significant after we controlled for the effect of the school's socioeconomic context.

In a number of education systems, the extent of students' computer use (at home) and the extent to which students had learned about ICT-related tasks at school appeared to be influencing students' CIL. There is much potential here for secondary analyses directed toward further investigating the associations between CIL education and CIL outcomes within countries.

Reflections on policy and practice

The findings from ICILS 2013 can be considered to constitute two broad categories: the nature and measurement of CIL, and factors that relate to CIL proficiency.

ICILS has provided a description of the competencies underpinning CIL that incorporates the notions of being able to safely and responsibly access and use digital information as well as to produce and develop digital products. ICILS has also provided an empirically derived scale and description of the CIL learning progress that can be used to anchor interpretations of learning in this field. It furthermore provides a common language and framework that policymakers and scholars can use when deliberating about CIL education. This common framework and associated measurement scale also

offer a basis for understanding variation in CIL at present and for monitoring change in the CIL that results from developments in policy and practice over time.

Some of the findings of this report are similar to those of crossnational studies in other learning areas. For example, students from economically and socially advantaged backgrounds typically have higher levels of achievement. However, other findings relate specifically to the development of CIL through education.

One question raised by the ICILS results relates to the place of CIL in the curriculum. While many countries have some form of subject and curriculum associated with CIL, responsibility for addressing and assessing the relevant learning outcomes is less clear. Countries generally appear to use a combination of information technology or computer studies classes together with the expectation that the learning outcomes associated with CIL are a crosscurricular responsibility shared across discipline-based subjects.

The ICILS data show that teaching emphases relating to CIL outcomes were most frequently being addressed in technology or computer studies classes and in (natural) sciences and human sciences or humanities classes. Teachers and students differed in their perceptions of computer use across the subjects. Queries remain, however, about how schools maintain the continuity, completeness, and coherence of their CIL education programs. This last concern had particular relevance in several ICILS countries, where there was only limited, nonobligatory assessment of CIL-related competences, or where assessment took place only at the school level.

A second question relates to the role of ICT resource availability and its relationship to CIL. Overall, the ICILS data suggest that increased access to ICT resources at home and school are associated with higher levels of CIL, but only up to a certain point, as is evident at the different levels of our analyses. At the student level, each additional computer at home was associated with an increase in CIL. At the national level, higher average levels of CIL were associated with higher country rankings on the ICT Development Index (see Chapter 1), and lower ratios of students to computers. These associations are somewhat difficult to interpret fully given that higher levels of CIL resourcing are typically associated with higher levels of economic development, which itself has a strong positive association with CIL.

The ICILS results also suggest that the knowledge, skills, and understandings that comprise CIL can and should be taught. To some extent, this conclusion challenges perspectives of young people as *digital natives* with a self-developed capacity to use digital technology. Even though we can discern in the ICILS findings high levels of access to ICT and high levels of use by young people in and (especially) outside school, we need to remain aware of the large variations in CIL proficiency within and across the ICILS countries.

The CIL construct combines information literacy, critical thinking, technical skills, and communication skills applied across a range of contexts and for a range of purposes. The variations in CIL proficiency show that while some of the young people participating in ICILS were independent and critical users of ICT, there were many who were not. As the volume of computer-based information available to young people continues to increase, so too will the onus on societies to critically evaluate the credibility and value of that information.

Changing and more sophisticated technologies (such as social media and mobile technologies) are increasing the ability of young people to communicate with one another and publish information to a worldwide audience in real time. This facility obliges individuals to consider what is ethically appropriate and to determine how to maximize the communicative efficacy of information products. The knowledge, skills, and understandings that are the basis of the receptive and productive aspects of CIL can and need to be taught and learned through coherent education programs. The knowledge, skills, and understandings described in the CIL scale show that, regardless of whether or not we consider young people to be digital natives, we would be naive to expect them to develop CIL in the absence of coherent learning programs.

One message from the ICILS teacher data is that a certain set of factors appears to influence their confidence in using ICT and integrating CIL in their teaching. It is therefore worth repeating here that teachers' ICT use was greatest when the teachers were confident about their expertise and were working in school environments that collaborated on and planned ICT use and had few if any resource limitations hindering that use. These were also the conditions that supported teachers' ability to teach CIL.

Once threshold levels of ICT resourcing have been met in a school, we suggest that system- and school-level resourcing and planning should focus on increasing teacher expertise in ICT use. Attention should also be paid to implementing supportive collaborative environments that incorporate institutional planning focused on using ICT and teaching CIL in schools.

ICILS also showed differences in teacher attitudes toward and self-efficacy in using ICT in their teaching. Older teachers typically held less positive views than younger teachers about using ICT and expressed lower confidence in their ability to use ICT in their teaching practice. Programs developed to support teachers gain the skills and confidence they need to use ICT effectively would be valuable for all teachers. Consideration should also be given to ensuring that these programs meet the requirements of older teachers and, in some instances, directly target these teachers.

The ICILS results also call into question some of the idealized images commonly associated with visions of ICT in teaching and learning. In ICILS, both students and teachers were asked about students' use of computers in classes. Students reported most frequently using computers to "prepare reports or essays" and "prepare presentations" in class, and using utilities to "create or edit documents" out of school. When teachers were asked to report on their own use of ICT in teaching, the two practices reported as most frequent were "presenting information through direct class instruction" and "reinforcing learning of skills through repetition of examples." Although teachers reported high levels of access to and use of ICT in their professional work, including in the classroom, the ICILS data suggest that computers were most commonly being used to access digital textbooks and workbooks rather than provide dynamic, interactive pedagogical tools.

In a similar vein, one of the intended benefits of ICT, particularly web-technologies, is to support collaboration on tasks. Overall, the school-based use of ICT to support collaboration was not extensive. Low prevalence of ICT use was reported by teachers for practices such as "collaborating with parents or guardians in supporting students' learning," "enabling students to collaborate with other students (within or outside school)," and "mediating communication between students and experts or external

mentors.” Furthermore, the majority of teachers (and in the majority of countries) who participated in ICILS reported that ICT “limits the amount of personal communication among students,” a finding which suggests not only that teachers were not using ICT to support collaboration, but also that they believed ICT use inhibits communication among students.

Future directions for research

The ICILS data clearly show that the contexts for CIL education vary across countries, as do the influences of factors at the individual, school, and country levels on CIL. One approach to secondary analyses of the ICILS data by scholars could be to investigate, build, and test models that explain variations in CIL within ICILS countries. Examples of areas of interest are the impact of school and teaching approaches on the development of CIL in students and the related aspects of teacher professional learning that may contribute to building capacity for CIL education development.

One challenge in identifying the relationship between ICT resourcing and CIL proficiency is that, because ICT resourcing is expensive, it typically disappears as an explanatory factor in regression models once socioeconomic background factors are accounted for. This happens at the level of the student and also in the school. Further research using the ICILS data may uncover alternative ways of better describing the relationship between ICT resource availability and CIL proficiency.

Finally, ICILS has provided a baseline study for future measurement of CIL and CIL education across countries. A future cycle of ICILS could be developed to support measurement of trends in CIL as well as maintain the study’s relevance to innovations in software, hardware, and delivery technologies. Some possibilities for future iterations of ICILS could include internet delivery of the assessment, accommodation of “bring your own device” (BYOD) in schools, adapting a version for use on tablet devices, and incorporating contemporary and relevant software environments, such as multimedia and gaming. The key to the future of such research is to maintain a strong link to the core elements of the discipline while accommodating the new contexts in which CIL achievement can be demonstrated.

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